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Organizational Inducements and Social Motives: A Game Theoretic Analysis

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ORGANIZATIONAL INDUCEMENTS AND SOCIAL MOTIVES:
A GAME THEORETIC ANALYSIS

by
RICHARD G. DAVIS

A dissertation submitted in partial fulfillment of the
requirements for the degree of

DOCTOR OF PHILOSOPHY
in
SYSTEMS SCIENCE

Portland State University

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Title: Organizational Inducements and Social Motives: A Game
Theoretic Analysis.

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Game theory was used to analyze compensation systems based on individual and group incentives. Payoff formulas were developed for these incentives assuming different preferences for individual and social outcomes. Two levels of contributions were considered: 1) "defection" - the minimum acceptable level of contributions, and 2) "cooperation" - a level of discretionary contributions

above the minimum. The discretionary contributions associated with cooperation were represented as a cost to the individual.

A classification scheme for uniform n-person games was developed using the approach of Rappaport and Guyer (1966) for 2 X 2 games. This classification scheme defines the natural outcome (cooperation or defection) for each game. The analysis considered the Individual motive, based on maximizing self-interest, and five social motives (Collective, Competitive, Altruism, Equity and Aggression). These motives reflect preferences for outcomes based on payoffs to self and others. The results indicate the natural outcome and game category for different values of the individual and group incentive factors. Satisficing theory was also used to analyze the natural outcome for the Individual motive.

Evolutionary game theory was used to develop two simulation models for social motives. The models interpret social motives as 1) genuine preferences for specific social outcomes, or 2) indirect strategies for maximizing individual payoffs. These models explore the interaction of social motives and the resulting impact on the level of cooperation.

The results were used to develop effectiveness criteria for selecting inducement systems which should promote cooperation. Additionally, cost curves were used to determine the least cost inducement system. Based on these

results, inducement systems using absolute incentives are recommended over systems using competitive incentives. Competitive incentives should only be considered when there is limited need for coordination between individuals and where aggressive and/or competitive behavior is acceptable.

The study has theoretical as well as practical implications. Game theory provides a method for expanding expectancy theory to include expectations about the actions of others and provides a framework for integrating expectancy theory and other theories based on social motives (e.g. equity theory). The use of dynamic models from evolutionary game theory breaks new ground in the theory of motivation.

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CHAPTER I

INTRODUCTION

This study applies the methods of game theory to the design of organizational inducement systems. The focus of the study is on increasing our understanding of how inducement systems motivate individual contributions in support of organizational goals. Organizational inducement systems based on individual and group incentives are studied using the methods of game theory. This study is comprised of three phases of analysis. The three phases are depicted in Figure 1, which shows an overview of the study.

In the first phase, game theory is used to analyze a range of inducement systems to determine the values of individual and group incentives needed to motivate individuals to contribute their efforts towards the goals of the organization. This analysis provides a conceptual framework for studying motivation that moves beyond the individual as the unit of analysis. The methods that are developed allow expectations about the actions of others to be used in analyzing an individual's decision to contribute to the organization. This phase reflects the Individual motive, which is based on a preference for maximizing payoffs to self.

Figure 1. Overview of the study.

In the second phase, the payoffs for the inducement systems being studied are reformulated to reflect preferences for five alternative social motives:

1) Collective, 2) Competitive, 3) Altruism, 4) Equity, and 5) Aggression. The methods developed to analyze the Individual motive are used in this phase to determine the ability of inducement systems to motivate individuals with varying social motives. This work provides a framework for expanding expectancy theory to include preferences regarding social outcomes as well as individual outcomes.

In the third phase, a method for studying the evolution of social motives is presented. Two dynamic learning models are developed using concepts from evolutionary game theory. These simulation models provide a basis for determining how social motives might evolve in response to the inducement system being used by an organization. This method is also used to examine the effects of the evolution of social motives on the level of group cooperation.

Drawing from the results of these three phases of analysis, criteria are identified for use in selecting organizational inducement systems. These criteria can assist practitioners in selecting inducements systems that should be effective in promoting individual and group cooperation with the goals of the organization. Inducement systems meeting these effectiveness criteria are then reviewed based on the costs of the inducement system to the organization. On the basis of these evaluations, recommendations and

guidelines are given regarding inducement systems which should be effective and efficient in gaining the cooperation of individuals with the goals of the organization.

Inducements

Business organizations, as social systems, are characterized by the cooperation of individuals seeking to achieve common economic goals. The coordination of the actions of individuals to accomplish these goals is the primary purpose of business organizations. Barnard (1938) viewed business organizations as "cooperative systems" and defined the organization as a "system of consciously coordinated activities or forces of two or more persons". For Barnard, the motivation for an individual to join an organization is the access to the economic and social rewards which result from coordinated activity.

Barnard (1938) and Simon (Simon, 1957; March and Simon, 1958) have been responsible for the development of the concept of the inducements-contributions contract. They characterize participation in an organization as involving an unwritten contract between the organization and the individual wherein the organization offers inducements to the individual in exchange for the individual's contributions to the goals of the organization. Only when the value of these exchanges benefit both the organization and the individual does there exist a stable basis for organizational cooperation. For this to occur, individuals

must place a higher value on the inducements they receive than on their contributions. Similarly, the organization must place a higher value on the contributions it receives from the individual than it does on the inducements it returns in exchange.

Because inducements are often based on the level of contributions, individuals must choose their level of contributions based on the inducements they hope to earn. Organizations must select the level and types of inducements they wish to offer for these contributions. These choices will vary depending upon the nature of the organization and the needs of individuals within the organization. Inducements may be material or non-material (Barnard, 1938). Material inducements include pay, benefits and physical working conditions. Non-material inducements include prestige, recognition, social interaction and satisfaction of important personal values.

A multiplicity of inducements exists within organizations. In business organizations, pay is the principal material inducement. Because money spent in wages or for other incentives is not available for other important purposes (e.g. stockholders, taxes, reinvestment), it represents a scarce resource. As a result, the management of compensation programs is a critical function within most business organizations. Paying too much in wages can lead to bankruptcy. Paying too little can lead to a failure to

retain individuals needed to perform the work of the organization.

The business literature contains many examples of pay systems designed to increase individual performance (Lawler, 1981). In recent years (O'Dell, 1987), a great deal of attention has been focused on compensation as a way of increasing productivity and responding to growing international competition. Pay systems can be considered to be made up of three types of incentives: 1) base pay (e.g. salary or hourly pay), 2) individual incentives (e.g. piece rates, commissions and merit pay), and 3) group or system incentives (e.g. profit sharing, gainsharing and bonus plans).

The need to manage the payment of inducements leads to the problem of how best to structure inducement systems to make them more effective in gaining the cooperation of individuals and more efficient in their use of organizational resources. This study explores this question by using the methods of game theory to analyze different classes of inducement systems.

Motivation

Pay systems are based on a variety of assumptions about what motivates employees to put forth effort towards meeting organizational goals. The literature on work motivation is extensive (Pinder, 1984). While scores of theories of motivation have been proposed, the majority of them find

their origins in the assumption that individuals are driven by self-interest to "seek pleasure and avoid pain" (Vroom, 1964).

Since the time of Adam Smith (1776), "economic man" has been one of the principal models used in understanding human behavior. This model of human behavior has led to pay systems that have generally been designed around the assumption that individuals will choose a level of effort that maximizes the value of inducements less contributions. This approach is consistent with the majority of the theories of motivation, particularly the various forms of expectancy theory (Lawler & Suttle, 1973).

The literature on work motivation has been primarily concerned with motivation as an individual (within-person) process (Mitchell, 1982). With the exception of equity theory (Adams, 1963), the major cognitive theories of motivation fail to account for the effects of group processes on individual motivation. Equity theory (Adams, 1964) proposes that individuals are motivated to seek equality in the ratios of inducements to contributions between themselves and relevant others.

The human relations school of organizational behavior has pointed out that informal groups often exert powerful influences on individual motives. This was illustrated in the Hawthorne studies (Roethlisberger & Dickson, 1939) and the application of a piece rate to individuals working in the Wiring Room. In this case, individuals chose to limit

their output to levels below those which would have yielded the highest net return. These restrictions in contributions were based on group norms that defined the appropriate rate of work for individuals in the Wiring Room. In that study, the work group's actions reflected a belief that their collective interests were served by setting productivity norms, rather than allowing each individual to pursue a level of productivity that maximized the individual's self-interest. While the work on group processes has not resulted in a formal theory of motivation, it does illustrate the need for a more expansive theory of motivation - one capable of considering social as well as individual motives.

The Wiring Room study illustrates a problem which is common in social settings - the conflict between individual and social motives. Hardin (1968) has pointed out how a variety of social problems (e.g. overpopulation, pollution) can be understood as conflicts between individual and collective goals. Dawes (1980) has referred to these conflicts as social dilemmas. These dilemmas are of special interest to society, since the problem of balancing individual and collective interests must be satisfactorily resolved if social institutions are to be successful.

Game Theory

Game theory has been used to analyze a variety of social dilemmas (Hamburger, 1978). As developed by Von Neumann and Morgenstern (1944), game theory is a normative

theory. It attempts to explain how individuals should behave, rather than attempting to predict how they will behave. Von Neumann and Morgenstern base their theory on so-called "norms of rationality." These norms follow from the assumption that people should behave so as to maximize their self-interest. These "norms" or principles of rationality are one of the key assumptions of game theory. By hypothesizing that human behavior conforms to these normative rules, researchers have been able to use game theory for descriptive as well as normative purposes. Given the widespread acceptance of the view that individuals pursue their self-interests, game theory is a useful starting point in analyzing organizational inducement systems. At the same time, it is important that assumptions about rationality be made explicit. Researchers have often been guilty of failing to explicitly state their assumptions regarding rationality.

In applying game theory to this study, payoffs to individuals are based on the inducement system in use within the organization. The inducement system specifies what payoffs an individual receives for differing levels of contributions. For simplicity, only two levels of contributions are considered. Additional levels of cooperation could be included in the analysis, but have been excluded because they would unduly complicate the presentation of theoretical concepts and results.

Adopting the language commonly used in game theory, the two levels of contributions are labeled "defection" and "cooperation". Defection is defined as the minimum acceptable level of contributions needed to maintain membership in the organization. Cooperation is defined in terms of a specified level of discretionary contributions over the minimum. As used in this study, "cooperation" and "defection" refer to an individual's level of contributions towards the goals of the organization. Since other definitions of cooperation and defection are commonly used in discussing organizations (i.e. "cooperation" may mean with other individuals, as opposed to the organization as a higher level unit), care must be taken to distinguish those usages from the context specific definitions used in this study.

The payoffs for each level of contributions depend on the difference between the value of contributions and the value of inducements, as determined by the individual. Since inducements and contributions involve a number of differing quantities, a common unit of comparison is needed. Game theory typically expresses payoffs in terms of "utils" although other units of comparison (i.e. dollars) can be used.

Inducements can include base pay and individual and group incentives. These incentives may be positively or negatively valued (i.e. rewards vs. punishments). As an example, consider the following inducement system for a

2-person organization. Each individual receives a base salary of \$3000/month, which they receive for the minimum level of contributions. They also receive a group incentive based on their collective contributions. If both individuals contribute at the level defined as cooperation, then they each receive a \$600 group incentive for the month. If only one individual cooperates, then they each receive \$300.

Finally, assume that the extra effort associated with cooperation has an equivalent cost of \$800 to each player.

The payoffs for this inducement system are as follows:

$$\begin{aligned} DD &= \$3000 \text{ base pay} + \$0 \text{ group incentive} - \$0 \\ &\text{contributions} = \$3000 \end{aligned}$$

Note: DD refers to the payoff to a defector when the other person also defects. CD refers to the payoff to a cooperator when the other person defects.

$$\begin{aligned} CC &= \$3000 \text{ base pay} + \$600 \text{ group incentive} - \$800 \\ &\text{contributions} = \$2800 \end{aligned}$$

$$\begin{aligned} DC &= \$3000 \text{ base pay} + \$300 \text{ group incentive} - \$0 \\ &\text{contributions} = \$3300 \end{aligned}$$

$$\begin{aligned} CD &= \$3000 \text{ base pay} + \$300 \text{ group incentive} - \$800 \\ &\text{contributions} = \$2500 \end{aligned}$$

The payoff matrix for this inducement system is shown in Figure 2. For this set of payoffs, each individual receives a higher payoff from defection than from cooperation. This occurs regardless of the choice (defect or cooperate) made by the other person. As such, defection is a dominating strategy and would be classified by game theory

as the rational choice. This outcome can occur in organizations where group incentives are set at too low a level to offset the added contributions required to earn those incentives.

		Player 2	
		C	D
Player 1	C	2.8 2.8	3.3 2.5
	D	2.5 3.3	3.0 3.0

Note: Payoffs are in thousands of dollars.

Figure 2. Payoff matrix for 2-person inducement system using group incentives.

The first phase of this study examines selected combinations of base pay and individual and group incentives to determine which inducement systems lead to cooperation as a rational outcome. Using inducement systems similar to the one shown above, varying levels of group and individual incentives are analyzed to determine their ability to promote cooperation.

As a part of this analysis, a classification scheme for uniform n-person games was developed to specify the "natural outcome" - the outcome most consistent with the principles

of rationality used in game theory. This classification scheme follows an approach used by Rappaport and Guyer (1966) to develop a taxonomy of 2 X 2 games.

The majority of the work done in this study is based on the analysis of 10-person groups. The 10-person case provides insights into how group size influences the results and illustrates the general n-person method of analysis. The simpler 2-person case is used on occasion to present the model in the easily understood format of the 2 X 2 game. Where appropriate, generalized n-person formulas are developed to present the major results of this phase of the study.

Also included in phase I is a supplemental analysis based on the satisficing theory of Simon (1976). Satisficing theory hypothesizes that individuals who are receiving "satisfactory outcomes" may continue with their existing behavior rather than searching for a new and possibly better alternative. As a result, an individual receiving a satisfactory outcome from a given behavior (e.g. defection) might continue that behavior even though game theory indicates that another behavior (e.g. cooperation) would lead to a superior outcome.

Returning to our earlier inducement system, suppose that in addition to group incentives, the organization also has individual rewards of \$300 for cooperators. The revised payoff matrix is now shown in Figure 3. For this set of payoffs, defection is a dominating strategy. Each individual

receives a higher payoff from defecting than from cooperating, regardless of whether the other individual cooperates or defects. Unlike the previous case, however, the joint outcome that results when both individuals choose to defect is inferior to the payoff each would receive from joint cooperation, (i.e. $DD < CC$). In this example, both individuals would be better off if they agreed to cooperate rather than seeking to maximize their individual gains through defection. This payoff matrix is an example of a class of games known as "prisoner's dilemma" games. It is a class of games that has been studied extensively (Rappaport and Chammah, 1965) because of the conflict between individual and collective rationality inherent in the game.

		Player 2	
		C	D
Player 1	C	3.1 3.1	3.3 2.8
	D	2.8 3.3	3.0 3.0

Note: Payoffs are in thousands of dollars.

Figure 3. Payoff matrix for 2-person inducement system using individual rewards and group incentives.

Social Motives

Over 1000 papers have been published on the prisoner's dilemma. Despite the normative recommendation to defect that follows from a narrow technical analysis of this game, the experimental literature presents a vastly more complex picture of human motives and actions. Of particular interest is the research on social motives. Several authors (Pruitt, 1967 & 1970; Messick & McClintock, 1968) have used the prisoner's dilemma and other social dilemma games to identify motives beyond individual maximization. Kuhlman and Marshello (1975) have identified four motives: 1) self maximization (individual), 2) joint maximization (collective), 3) difference maximization (competitive), and 4) other's maximization (altruism). MacCrimmon and Messick (1976) have proposed a framework for social motives that contains three additional basic motives: 1) difference minimization (equity), 2) other's minimization (aggression) and 3) self minimization (self-sacrifice).

While only the first of the motives listed above is based on the norms of rationality generally used in game theory, they do reflect the strong societal norms evident in everyday life. Because individuals often choose apparently "irrational" strategies based on their social motives, it is important that the designer of organizational inducement systems know whether a given inducement system is able to promote cooperation in a variegated environment of social motives.

The second phase of this study examines selected inducement systems to judge their ability to promote cooperation across a variety of social motives. This analysis uses five of the six social motives identified above. The motive of self-sacrifice is considered to be unrealistic and has been dropped from the analysis. The results of this portion of the study identify the levels of group and individual incentives that should cause individuals to cooperate for each of the social motives being considered.

Behavioral Evolution

Game theory has also been used in theoretical biology to study how behavioral patterns such as altruism and reciprocity can evolve (Hamilton, 1964; Trivers, 1971; and Maynard-Smith, 1982). Using the evolutionary concepts of Darwin (1859), these studies have demonstrated how behaviors can be genetically transmitted. More recently, these concepts have been extended to cover the evolution of learned behaviors (Dawkins, 1976). This approach can be used to study the evolution of social motives in an organizational context.

The third phase of this study reviews selected inducement systems to determine how a population of differing strategies might evolve, and to what extent the level of cooperation would be affected. The method used to study the evolution of strategies is based on the work of

Axelrod (1984), who used a computer simulation to model a prisoner's dilemma game for a population of individuals with differing strategies. The strategies were submitted by theoreticians from around the world. In Axelrod's study, the populations for each of the strategies were initially set equal, and then adjusted after each round based on their relative payoffs in the prior round. The simulation was allowed to run until equilibrium populations for each of the strategies were reached.

The approach used in this study is similar to the one used by Axelrod. The frequencies of each of the social motives are initially set equal, and the simulation is run to determine how the frequencies evolved. Two simulation models were used. One model treats motives as strategies for acquiring material payoffs, while the other treats motives as genuine preferences with their own inherent value. Additionally, the overall level of cooperation was also determined from the equilibrium populations.

Implications

The study concludes by discussing the practical implications and theoretical significance of the methods and the results. The three phases of analysis are used to develop criteria for selecting inducement systems which should be effective in promoting individual contributions towards the goals of the organization. The most efficient inducement systems meeting these criteria are identified

based on the costs of the inducement system to the organization. The results are discussed for each class of inducements and recommendations given for applying the results to the design of real-world inducement systems. The limitations of the study are also presented and suggestions given for additional empirical and analytical work.

The theoretical significance of the study is also discussed. The relationship of this work to expectancy theory and other theories of motivation is presented. The use of game theory to expand the approach of expectancy theory is highlighted. This expansion allows expectancy theory to move beyond the individual as the unit of analysis by including: 1) an analysis of the decisions of others, and 2) the consideration of social as well as individual outcomes. Recommendations are given for future work to develop an integrated theory of motivation capable of incorporating a range of social motives.

CHAPTER II

REVIEW OF THE LITERATURE

This study is based on work being done in four distinct areas: 1) motivation, 2) inducements 3) social motives, and 4) behavioral evolution. Ideas from research in these areas have been brought together using methods from game theory and theoretical biology to study how behaviors and social motives are shaped by organizational inducement systems.

The business and industrial psychology literatures have dealt extensively with the question of individual motivation. A great deal has also been written about the role of inducements in business organizations. These literatures have tended to deal with motivation and inducements using the individual as the unit of analysis. A less well known area of work in social-psychology has developed around the problem of social dilemmas - situations where individual motives conflict with social motives. Game theory has been applied to the study of social dilemmas to determine the extent to which individual behavior is influenced by social motives. Much of the literature on motivation and social motives assumes that individual preferences are fixed. Recent work in theoretical biology has used game theory to show how learned behaviors can evolve within a population. The methods of evolutionary game

theory can be applied to the evolution of social motives within an organizational setting.

Motivation

Motivating workers has become one of the dominant issues in modern industrial society. Businesses, in particular, have found that motivating workers is often essential to their profitability and their ability to survive in an increasingly competitive world economy. This recognition has led to an extensive research literature on the topic of motivation.

Needs Theories. Numerous approaches have been taken to the study of motivation. Maslow (1943) and Alderfer (1969) proposed theories of motivation based on human needs. Maslow (1943) proposed that individuals are motivated by five basic needs: 1) physiological needs, 2) safety needs, 3) love needs, 4) esteem needs, and 5) self-actualization needs. According to Maslow, these needs are arranged in a hierarchy of prepotency, such that one level of needs is primary in influencing the motivation of an individual at a given time. Only when lower level needs are substantially satisfied will the individual be motivated by the next level of needs.

Alderfer (1969) proposed a similar needs based theory of motivation. Alderfer's ERG theory specifies three classes of human needs: 1) existence, 2) relativeness, and 3) growth. Rather than proposing a simple hierarchy of prepotency, Alderfer suggested that transferability,

satisfaction-progression and frustration-regression are the three mechanisms determining which class of needs will most influence individual motivation.

Despite the popularity of Maslow's hierarchy, neither of these needs-based theories has been supported through research studies (Pinder, 1984). As a result, little current work is being done in the area of needs-based motivation (Mitchell, 1982).

Reinforcement Theories. Behaviorists, working largely from animal studies, have proposed various reinforcement theories to explain motivation. Skinner (1969) and others believe that motivation could be described as learned behavior resulting from an individual's history of rewards and punishments. This research has focused on the use of positive and negative reinforcement to alter the frequency of a given behavior and the role of various reinforcement schedules in creating learned behaviors. In general, these theories are careful to avoid any assumptions about the internal state or cognitions of individuals. Predictions are based upon the observable history of reinforcements. A substantial body of research in support of these theories exists (Pinder 1984).

Cognitive Theories. The largest area of current motivation research includes those theories characterized as cognitive theories. The cognitive theories can be subdivided into three main theories (Pinder, 1984): 1) equity theory, 2) goal-setting theory, and 3) expectancy theory.

Adams (1963) proposed that individuals are motivated by concerns over equity. Underpayment or overpayment can occur relative to a standard or to a referent individual. When underpayment or overpayment exists, individuals are motivated to increase or decrease their effort to adjust for the perceived inequity. Research on equity has generally supported the predictions of the theory regarding underpayment. The theory has been less satisfactory in predicting behavior involving overpayment (Pritchard, 1969).

Path-goal or goal-setting theories have been proposed by Locke (1968) and Latham and Locke (1979) and can be traced back to some of the original ideas of Fredrick Taylor (Locke, 1982). These theories suggest that individuals are motivated when they have specific, difficult-to-achieve goals in combination with detailed supervisory feedback. Commitment to these goals is enhanced through good supervisory relations. Resistance to goals is overcome through training, participation in goal-setting and rewards. Field research on goal-setting has sometimes documented dramatic increases in productivity, although goal-setting is often difficult to manage in certain organizational settings (Latham and Wexley, 1981).

The third and most significant of the cognitive theories is expectancy theory. First proposed by Vroom (1964), expectancy theory has been the most heavily researched and accepted of the numerous theories of motivation (Pinder, 1984). Vroom described his theory as

being based on the hedonistic assumption that individuals act so as to "maximize pleasure and minimize pain". Vroom's theory defined motivation as a force acting on a person to choose a particular action based on the interaction of 1) the person's expectancy that particular outcomes will result from the act, and 2) the valence of these (first-level) outcomes. The valence of the first-level outcomes is a function of the valences of all other second-level outcomes and the instrumentality of the first-level outcome in attaining these second-level outcomes.

Expectancy theory proposes that humans make choices based on judgments about existing conditions and expectations about the future. This contrasts with the learning theories which rely solely on the history of reinforcements in predicting behavior. In most regards, however, there exist few differences between the propositions of expectancy theory and those of the learning theories (Pinder, 1984). This is not surprising, since expectations regarding the future are influenced by what has occurred in similar situations in the past.

Lawler (1971) and others have proposed various alternative forms of expectancy theory. Lawler expressed the motivational force as $[E \rightarrow P][P \rightarrow O]V$, where $[E \rightarrow P]$ is the expectancy or conditional probability that a given effort will result in a given performance outcome and $[P \rightarrow O]$ is the expectancy that a given performance outcome will result in outcomes with valence V . The valence of a set of outcomes

is the positive or negative value of those outcomes to the individual.

Various forms of expectancy theory were reviewed by Lawler and Suttle (1973). Their review of prior research showed moderate support for expectancy theory, with the best correlations between effort and motivational force occurring for the $[E \rightarrow P][P \rightarrow O]V$ form of the theory. However, other simpler forms of expectancy theory ($[E \rightarrow P]$ and $[P \rightarrow O]$), were nearly as good at predicting behavior. Valence did not improve the predictability of the theory, although this may have been a result of a lack of significant differences in the valences of the outcomes associated with the experiments.

The work of Lawler and Suttle (1973) is typical of work in the field. While numerous forms of expectancy theory have been confirmed in a variety of experimental settings, the correlations between actual effort and predictions based on expectancy measures have generally been modest (0.3 to 0.5). The lack of strong empirical support for expectancy theory has led researchers to question the methodologies used in past research. In their review of methodological problems, Campbell and Pritchard (1976) pointed out several problems with past research on expectancy theory. These include:

- 1) lack of a clear specification of the dependent variable (effort),
- 2) lack of test instruments with reliability and construct validity, and
- 3) improper experimental design (between-person versus within-person).

In research where

more attention has been given to correcting these methodological problems, the results have generally been more supportive of expectancy theory (Wanous, Keon and Latack, 1983).

Deci (1971) has confronted expectancy theorists with another more fundamental problem by proposing that the level of motivation due to intrinsically motivating outcomes is influenced by the use of extrinsic rewards. As an example, an increase in the extrinsic rewards associated with a given level of performance might lower the individual's intrinsic motivation to perform at that level. If true, changes in the motivational force could not be predicted from changes made in extrinsic rewards, since levels of intrinsic motivation would subsequently change. While not a direct refutation of expectancy theory, Deci's propositions would limit the application of expectancy theory in designing reward systems, since the effects of changing the inducement system could not be predicted. Support for Deci's propositions has been mixed (Guzzo, 1979; Pritchard, Campbell and Campbell, 1977).

Pfeffer (1982) has criticized expectancy theory on the grounds that it deals only with the individual as the unit of analysis. Pfeffer argues that the limited success of expectancy theory may be due to its inability to include the effects of the social and environmental context on individual behavior. Mitchell (1982) has also pointed out that expectancy theorists view motivation as an "individual,

intentional" process, with no real attempt to understand how group processes enter into the picture.

Summarizing the existing research on motivation, it is clear that despite having a number of methodological problems, expectancy theory is the most widely accepted theory of motivation. While it has been gained acceptance by many theorists and practitioners, the theory has a mixed record in term of its predictive ability. More fundamentally, however, expectancy theory has focused on the individual as the unit of analysis. While expectancy theory is potentially capable of incorporating organizational influences on individual expectancies, no clear framework for doing this has emerged. One of the challenges facing expectancy theorists is to incorporate their work into a framework that reflects the influences of the organizational environment on individual motivation.

Inducements

Barnard (1938) was one of the first authors to formulate a theory of business organizations as "cooperative systems." Barnard saw organizations as existing to accomplish a common purpose. Individuals choose to cooperate in seeking these common organizational goals based on the satisfaction of personal motives. These personal motives may be economic and/or social in nature.

Barnard was careful to distinguish the goals of the organization from those of individuals within the

organization. Individuals may be able to satisfy their goals independent of whether the organization reaches its goals. Indeed, individual goals are often in conflict with organizational goals (e.g. unionization).

Barnard saw one of the functions of the executive as managing the "effectiveness and efficiency" of inducements. Inducements are effective when they gain the required level of individual contributions. Inducements are efficient when they use a minimum of organizational resources. To gain the level of contributions needed to achieve organizational goals, individuals must receive sufficient inducements to justify their contributions. The types of inducements available within an organization may be either material or nonmaterial and include pay, benefits, working conditions, promotion, prestige, security, social interaction, feelings of loyalty, sense of accomplishment and personal recognition.

Based on Barnard's work, March and Simon (1958) developed the idea of the inducements-contributions contract. According to these authors, individuals make contributions to the organization based on a perceived value of inducements over contributions. The inducements-contributions contract involves questions of 1) membership and 2) discretionary contributions. When the value of inducements associated with membership outweigh the costs of the contributions expected by the organization, there is a basis for joining the organization. In exchange for joining

the organization, the individual agrees to perform specified tasks and to submit to the authority of the organization in certain matters (e.g. conduct, hours of work, job assignments). Individuals often choose from among various employment opportunities based on which organization offers the most favorable inducements-contributions contract.

Following the decision to participate in an organization, an individual is faced with the choice of what level of discretionary contributions to put forth beyond the minimum required to maintain membership. Organizations often make use of incentive systems to gain these discretionary contributions. According to the Barnard-Simons theory, the individual's decision regarding level of contributions is also based on the comparison of the expected value of inducements to the cost of contributions. This approach is consistent with the approach used by the expectancy theorists.

A variety of individual and group incentive systems have been developed to promote individual contributions (Lawler, 1983). Incentives can be either positive or negative. The majority of these systems have relied primarily on pay or other material inducements. Piece rates are an example of one of the simplest forms of incentive systems.

Individual incentive systems have been used extensively in business organizations (Lawler, 1983; Bernardin and Beatty, 1984). These systems generally involve a comparison

of individual performance against established standards. These standards can take such diverse forms as commissions, piece rates, or performance objectives (O'Dell, 1987). Other individual incentive systems appraise performance in competitive terms, comparing one individual against others in similar positions. Competitive incentives, such as sales contests, are often in marketing and sales organizations (Colletti, 1988).

Other incentive systems common in business organizations are group bonuses, gainsharing and profit sharing plans (Doyle, 1983). These incentive systems are based on the performance of the organization or a selected group of employees. These plans often base incentives on meeting financial, production or cost-reduction goals. Rewards are typically distributed on a system-wide basis without regard to individual performance. Examples include stock ownership, profit sharing and various gainsharing plans (e.g. Rucker, Improshare, Scanlon).

While many different inducement systems have been used by organizations, they each involve a combination of base pay plus individual and/or group incentives. While pay and benefits form the basis of the inducement systems found in most modern businesses, other noncash incentives, such as gifts, paid vacations, promotion or recognition awards are also available. These incentives are generally less easy to administer on a system-wide basis (Barnard, 1938).

Not all inducements are under the control of the organization. As illustrated by the Hawthorne studies (Roethlisberger and Dickson, 1939), groups can exert powerful influences on individuals within an organization. Hackman (1976) credits groups with a range of discretionary stimuli which can be used to bring an individual's behavior into line with group norms. Hackman sees group stimuli as affecting behavior in two ways: 1) directly, when the group rewards or punishes an individual, and 2) indirectly, when the individual's informational or effective state is modified.

Group norms often act to influence decision making rules for individuals within the group. As Hackman (1976) has noted, conveying information to others in the group is one of the main reasons for forming group norms. These norms allow new entrants into the organization to quickly make decisions based on the cumulative experience of the group.

In addition to contributing to the idea of the inducements-contributions contract, Simon (1976) has also pointed out that individuals often behave in ways inconsistent with maximizing self-interest. In Simon's words individuals do not "have the wits to maximize". Instead, they adopt decision making strategies that lead to satisfactory outcomes, rather than optimal outcomes. This "satisficing" behavior leads individuals to choose heuristic rules for making otherwise complex decisions. Tversky and Kahneman (1984) have done extensive research on decision

making heuristics and biases. Other authors have shown how various biases could have developed in real-world settings.

Social Motives

Individuals are often faced with situations where self-interest conflicts with collective or group interests. When this occurs, a social dilemma is said to exist (Dawes 1980). In 1968, Hardin wrote his classic essay "The Tragedy of the Commons", outlining how problems such as overpopulation and pollution could be understood as social dilemmas (Hardin, 1968). Hardin's essay and the emerging societal concern over social problems have led to a heightened interest in finding solutions to these social dilemmas.

Prisoner's Dilemma. Game theorists have dealt extensively with social dilemmas (Hamburger, 1978). The most famous of these, the prisoner's dilemma, has been used to model a number of social problems. The prisoner's dilemma has been the subject of a tremendous amount of both theoretical and experimental work (Rappaport and Chammah, 1965). In the simplest form of the prisoner's dilemma, two individuals are envisioned to have a choice between behaviors labeled as "cooperation" and "defection". A typical payoff matrix is shown in Figure 4.

In this game, each player has a dominating strategy of defection, such that regardless of the strategy chosen by one player, the other player receives a higher payoff from the choice to defect. The prisoner's dilemma has the

		Player 2	
		C	D
Player 1	C	12 12	18 0
	D	0 18	6 6

Figure 4. Payoff matrix for a 2-person prisoner's dilemma game.

property that when both players choose their dominant strategy, they each receive a lesser payoff than they would by mutually agreeing to cooperate. The prisoner's dilemma has the paradoxical result that the individually rational choice is collectively irrational.

Hundreds of experiments have been conducted to determine whether individuals will choose to behave in accordance with individual or collective rationality when confronted by the prisoner's dilemma. In these experiments game theory is being used for predictive purposes. The results have been highly variable (Rappaport and Chammah, 1965). In some experiments, the results are consistent with individual rationality, while in others collectively rational behavior is observed. Attempts to explain why individuals choose either defection or cooperation have

looked at a number of factors, including group size, sex of player, number of players, type of rewards, size of rewards and initial instructions.

Pruitt (1968 and 1970) has published data showing that individuals alter their level of cooperation depending upon how the payoff matrix is presented to the group. Pruitt decomposed the payoff matrix shown in Figure 4 into a series of payoff tables that separate the payoffs under the player's own control from those controlled by the actions of the other player. Figure 5 shows three decompositions of one prisoner's dilemma game.

	own	other
C	6	6
D	12	-6

	own	other
C	0	12
D	6	0

	own	other
C	-6	18
D	0	6

Figure 5. Three decompositions of a 2-person prisoner's dilemma game.

Each of these three decompositions can be generated from the payoff matrix shown in Figure 4. Pruitt observed that when subjects were presented with the three decompositions, differing levels of cooperation were observed for each. Pruitt suggested that these differences might be due to psychological reactions to the decompositions into payoffs under one's own control and those controlled by the other player.

Social Motives. Messick and McClintock (1968) proposed that individuals are motivated by social motives beyond maximizing payoffs to self (Individual motive), such as maximizing joint payoffs (Collective motive) or maximizing relative differences between self and other's payoffs (Competitive motive). They proposed that social motives could be investigated by examining social dilemma games where the values of various payoffs cause one or more motives to be preferred. Based on these three social motives, Messick and McClintock identified six classes of games. The six classes differ in what social motives would be satisfied by choosing alternative actions (e.g. cooperation or defection). Games from these classes were used to determine whether differences in the choices made by individuals could be attributed to preferences for certain social motives. Their empirical results support the proposition that individuals are influenced by social as well as individual motives.

McClintock, Messick, Kuhlman and Campos (1974) continued this work on social motives and found that the likelihood of an action being chosen increased as the number of social motives satisfied by that action increased. These authors considered the three motives presented in the earlier work by Messick and McClintock (1968) plus the added motive of aggression (i.e. minimizing payoffs to others).

The presence of social motives was confirmed in a study by Liebrand and van Run (1985). These authors used two

methods to determine the social motives of individuals from groups of students in the United States and the Netherlands. They considered four motives: 1) altruistic (maximize other's payoffs), 2) cooperative (maximize joint payoffs), 3) individualistic (maximize own payoffs), and 4) competitive (maximize difference between own and other's payoffs). After determining the dominant social motives of individuals, the individuals were formed into groups ($n=8$) to participate in a simulated social dilemma game that allowed individuals to take resources from a common pool. In the simulation, taking resources from the pool helped individuals in the short run, but led to long-term resource problems for the group. As expected, individuals with competitive and individualistic motives took more resources than individuals with cooperative motives. Individuals with altruistic motives took the least amount of resources.

MacCrimmon and Messick (1976) proposed a framework for social motives to aid in understanding social behaviors and their impacts on social systems. They identify six basic social motives: 1) self-interest, 2) self-sacrifice, 3) altruism, 4) aggression, 5) cooperation, and 6) competition. These six motives can be converted into mathematical operators of summations and differences of payoffs found in the matrix representation of a social dilemma game. They go on to suggest that other more complex motives, such as conditional motives based on score feedback

or other external cues, may be useful in developing a better understanding of social motives.

The work on social motives by the authors discussed above has centered on using social dilemma games to verify the presence of differing social motives in individuals. The games used by these authors were selected for their ability to force choices between various social motives. This literature differs from the work done in this study in several important ways. First, this study is based on a specific topic area, organizational inducements. Second, this study attempts to find games (inducement systems) which promote a single behavior (cooperation) over as wide a range of social motives as possible. Finally, the study expands the work on social motives by considering how social motives might evolve in response to a specific inducement system.

Evolution of Behavior

The conflict between individual and collective rationality inherent in the prisoner's dilemma undermines the belief that the greatest common good will be achieved when individuals pursue their self-interest. As a result, there have been a number of attempts to find a way to overcome this paradox (Shubik, 1970; Rappaport, 1967). These attempts often involve a restructuring of the game, such as allowing for communications between the parties (Schelling, 1963). Hardin (1968) took a more pessimistic

view, concluding that the only stable solution lies in "mutual coercion - mutually agreed upon".

The approaches listed above rely upon the addition of features not originally included in game theory. Game theorists have attempted to resolve the paradox in a different manner by considering the game to be one with multiple plays (iterative) rather than involving only a single play (Shubik, 1970; Hamilton and Axelrod, 1981). This approach allows for conditional strategies based on the strategies used by other players in earlier rounds. The attempt here is to resolve the paradox by finding a conditional strategy where cooperation becomes both individually and collectively rational.

Analyses of this type have shown that in cases where the game is of an indeterminate number of plays and where the probability of playing an additional round exceeds a threshold value (based on the payoffs for cooperation and defection), then strategies other than defection are rational. The most famous of these strategies is tit-for-tat.

Altruism and Kinship. The approach used to find a rational basis for cooperation in the prisoner's dilemma follows the approach used by theoretical biologists to explain symbiotic and altruistic relationships in nature. Hamilton (1964), Trivers (1971) and Maynard-Smith (1982) have made extensive use of game theory in developing a theory of behavioral evolution.

Hamilton (1964) has used game theory to show how altruistic behavior on behalf of an individual with a close kinship relation could increase the altruist's Darwinian fitness - the frequency of one's own genes in the gene pool. Hamilton showed that even though the altruistic act may reduce the altruist's chance of survival, it can increase the likelihood that his genes are passed along through the genes of the close kin who benefited from the altruistic behavior.

The strength of Hamilton's theory has been demonstrated by its ability to provide an explanation for the evolution of social insects. With the exception of termites, all social insects from the order Hymenoptera share the common reproductive trait that females are diploid (two sets of chromosomes) and males are haploid (one set of chromosomes). Because of this trait, females are more closely related to their sisters than to their daughters. As a result, females can best pass on their genetic material by helping in the rearing of sisters rather than by raising their own daughters. Using these kinship relations, Hamilton was successful in providing an explanation for the reproductive division of labor in social insects.

Trivers (1971) extended this approach to include reciprocal altruism not based on kinship relations. Reciprocal altruism can occur between individuals of the same species or between individuals from different species. Trivers showed that where individuals come into contact

frequently enough to allow for multiple opportunities to reciprocate altruistic acts on behalf of one another, then altruism would increase an individual's Darwinian fitness.

Trivers has used this approach to explain cleaning symbioses in certain species of fish and warning calls in birds. Trivers has also proposed an explanation of reciprocal altruism in humans. He includes the following types of behavior as examples of reciprocal altruism:

1) helping in times of danger; 2) sharing food; 3) helping the sick, wounded, or very old or very young; 4) sharing implements, and 5) sharing knowledge. Trivers finds that altruistic behavior generally involves a small cost to the giver when compared to the benefit to the beneficiary. Altruistic behavior becomes advantageous when there is a sufficient probability that the act will be reciprocated in the future.

Trivers goes on to suggest that individuals have a tendency towards both altruism and cheating (i.e. not reciprocating altruism in the future). Individuals can increase reproductive success if they find ways to cheat while others engage in reciprocal altruism. Trivers proposes that individuals have evolved complex psychological systems to uncover and punish cheaters and to identify and reward altruists. Elements of the psychological system could include friendship, guilt, reparative altruism, moralistic aggression, gratitude and sympathy.

Maynard-Smith (1978) has made extensive use of game theory to explain the evolution of behavior in a wide range of species (slime mold to humans). He has developed and made extensive use of the concept of an evolutionarily stable strategy. Simply stated, an evolutionarily stable strategy (ESS) is a strategy with the property that when it is adopted by an entire population, it can resist invasion by any other mutant strategy. The concept of the ESS is linked to the biologist notion of Darwinian fitness. Using the concept of the ESS, biologists can make use of principles from evolution to describe genetically-based behaviors.

The approach of the theoretical biologists to the evolution of cooperative and altruistic behaviors has typically taken a "gene's eye" view. Social behaviors are attributed to a genetically determined predisposition for the behavior. In most cases, a genetic basis for behavior is assumed without any identification of the actual genes or mechanisms involved. More recent work has drawn a distinction between genetically-based behaviors and those based on learning or culture. Much of the controversy surrounding sociobiology hinges on the question of genetic versus cultural factors in the development of human behaviors (Barlow and Silverberg, 1980).

Learned Behaviors. Dawkins (1976) breaks with most biologists by treating cultural evolution as a separate phenomena from genetic evolution. Dawkins coins the term "memes" to refer to artifacts in the cultural world that are

similar to genes in their ability to grow in use through replication, fecundity and copying fidelity. While Dawkins sees cultural and genetic evolution in analogous terms, he does not attempt to provide a genetic basis for cultural evolution. In a similar vein, Boulding (1982) distinguishes between the slow process of genetic evolution and the rapid evolution of culture over the past few thousand years.

In recent years, some theoretical biologists have extended evolutionary game theory to cover learning processes. These learning processes influence how culturally based behaviors are adopted and modified. Harley (1981) and Maynard-Smith (1984) postulate that individuals have rules for learning new behaviors. These learning rules are thought to be influenced by genetic factors such that natural selection would lead to an evolutionarily stable learning rule. An evolutionarily stable learning rule is a rule for learning the ESS in a single generation. Harley showed that a learning rule (relative payoff sum) that based its selection of strategies on the payoffs from earlier trials would be an evolutionarily stable learning rule. The relative payoff sum learning rule chooses the strategy it will use at each trial based on the relative payoff sums of each strategy. It is a stochastic rule in that individuals continue to play all strategies with a frequency based on their cumulative payoffs from each strategy. Prior payoffs are discounted using a memory retention factor.

Dawkins (1980) suggests that the concept of the ESS can be extended cover learned behaviors. He labels such a strategy as a Developmentally Stable Strategy (DSS). A DSS is a learned behavior that can resist being replaced by another behavior based on its increased fitness to the individual during his lifetime.

Axelrod (1984) used a similar approach to investigate the evolution of cooperation in an iterated prisoner's dilemma game. Axelrod solicited strategies from game theorists, economists and others. These strategies were entered into a computer based tournament where each strategy initially has equal numbers (population) of individuals playing that strategy. Individuals were allowed to interact with each other on a random basis. Each individual was able to recognize each of the other players and had a complete history of all prior encounters with each player. At the end of each round of the tournament, the population of each strategy was adjusted based upon the relative payoffs during that round. The simulation was ran until the proportion of the population represented by each strategy reached an equilibrium.

Using the computer simulation, Axelrod was able to demonstrate the robustness of tit-for-tat (and some other strategies) when confronted by a wide range of competing strategies. While Axelrod's computer simulation does not indicate which strategies are evolutionarily stable, the simulation does show what proportion of the final population

each strategy would represent. These equilibrium populations are important in understanding the overall behavior (i.e. cooperation or defection) of the population.

CHAPTER III

METHODS

Game Theory

The methods used in this study are based on the mathematical theory of strategic games developed by Von Neumann and Morgenstern (1944). Better known as game theory, this branch of mathematics deals with decision making situations involving multiple players, where the outcomes from each player's choice are influenced by the choices made by other players. Game theory has been widely applied in economics and other disciplines where agents must make choices involving payoffs which depend on the choices of others as well as their own.

The word "game" carries many connotations - football, chess, tic-tac-toe, etc. The games dealt with by game theory are formal games. They are models of situations, such as the nuclear arms race, which may seem to have little in common with the games mentioned above. The games dealt with by game theory have five basic elements: 1) players, 2) choices, 3) outcomes, 4) preferences, and 5) strategies. These elements define a game within the mathematical framework required by game theory. Luce and Raiffa (1957) provide a good introduction to the general approach and methods of game theory.

Players. To be a game, the situation being modeled must have multiple players. Players are usually viewed as cognitive actors, such as individuals, groups or nations. However, game theory can also consider non-cognitive entities, such as lower organisms or nature treated as an agent. In this study, individuals who are employees of a business organization will be of primary interest.

Much of game theory deals with games involving two players, so-called 2-person games. These games are useful because they are less complex than games involving multiple players where the number of choice combinations which must be considered quickly becomes unmanageable. These 2-person games are also useful because they can be represented by 2-dimensional payoff matrices showing the outcomes of each combination of choices made by the two players. This study uses 2-person games to develop a model of organizational inducements in a easily understood and manageable framework.

A 10-person model is used to present the majority of the results from this study. The 10-person model is used for two reasons: 1) to show how a larger group size influences the results, and 2) to illustrate the method of analysis which can be used in the general n -person case. Additionally, several of the important results from the study are generalized to the n -person case.

Choices. The second element of a game is the presence of choices. Each choice represents an alternative course of action on the part of a player. These choices are usually

thought of as being made based on principles of rationality. However, it is often useful to consider choices made on other bases.

This study examines the choices an individual makes about the level of contributions he will make towards the goals of the organization. Two levels of contributions are considered. The first level represents the minimum level of contributions which an individual must make in order to maintain membership in the organization. In a business organization, this is the minimum level of contributions expected of an employee. Failure to provide this level of contribution would be reason for termination. Using a common label from game theory, this level of contributions is referred to as "defection". The defection involves the withholding of discretionary contributions above the minimum.

The second level of contributions being considered represents a specified level of contributions over the minimum. This higher level of contributions might take the form of a fixed number of sales, performance against established standards, or meeting a budget target. It might be easily achieved or might require major effort on the part of the individual. This level of discretionary contributions is referred to as "cooperation".

In this study the labels of "defection" and "cooperation" are used to describe choices in terms of their support for the goals of the organization. Cooperation with

the goals of the organization is different than cooperation with other individuals within the organization. In some cases it may be that cooperation between individuals would lead to defection from the goals of the organization. Union strikes are an example of cooperation between individuals which results in defection from the goals of the organization.

These two levels of contributions are useful to consider because they can be used as the basis for providing individual rewards and/or punishments to players. Many modern compensation practices are based on paying individuals based on their level of contributions to the organization. Obviously, individuals in real organizations are faced with an almost infinite number of choices regarding their level of contributions. This study considers only two choices in the level of contributions. While other intermediate levels could be considered, the added complexity would detract from the presentation of key ideas and results. Nothing in the method, however, requires that only two level of contributions be considered. While somewhat more cumbersome, this method can be extended to multiple levels of cooperation.

Outcomes. The third element of a game is the set of outcomes that occur for each player as a result of his choice and the choices made by the other players. The outcomes or payoffs can take many forms, such as termination, money, effort expended, or promotion. In this

study, the outcomes are considered to result from the choice by players to defect or cooperate. Outcomes may include a negative component and a positive component. These two components are: 1) the added effort required to achieve the level of contributions labeled as cooperation (negative), and 2) the payoffs that the individual receives from the organization based on his or her level of contributions (positive). These payoffs (inducements) are assumed to take the form of extrinsic payments and are represented in terms of a utility scale. Organizations typically make use of a wide variety of extrinsic inducements. In addition to pay and benefits, organizations use recognition, noncash awards, perquisites and employee discipline. The relation between an individual's payoffs and his contributions is assumed to be defined by the organization's inducement system.

Preferences. The fourth element of a game is the set of preferences for each of the players. Players will value certain outcomes over others. In game theory, outcomes are usually converted to an interval scale, where the least valued outcome has zero utility (measured in "utils") and the highest valued outcome has utility of one utile.

The outcomes from cooperation includes not only the inducements which the player receives from the organization, but also the effort associated with the higher level of contributions defined as cooperation. This added effort must be treated as a disutility or cost to the player.

Lotteries are typically used to determine the utility of a range of outcomes (Rubinstein, 1975). In this study, a common utility scale is assumed for both inducements and contributions. This allows the utility of inducements to be compared with the disutility of effort. The disutility of the effort required to contribute at the level defined as cooperation is assigned a value of minus one (-1.0) utiles. The utilities of various inducements are then established in terms of this interval scale. This allows for the utilities of inducements and contributions to be combined into a single payoff function. In testing the results of this study, researchers will need to use a common measurement scale for determining the utilities of contributions and inducements. Care will also need to be taken to avoid scaling problems (i.e. insignificant rewards, nonlinear utility functions, etc.).

This study treats each of the individuals in a given game as having identical preferences and choices. This assumption allows for considerable simplification of the analysis by converting the game to a uniform n-person game. In real organizations, individuals vary in their skills and the effort needed to accomplish differing tasks. The values they place on their contributions and the inducements they receive also vary.

This assumption is not as limiting as it may seem. Motivation is an individual process operating within the person (Mitchell, 1982). The model of motivation developed

in this study allows individuals to make choices based on their expectations of how others will behave. The model assumes that the individual's expectations about what is rational for others are consistent with what he considers to be rational for himself. While individuals within a group may have differing preferences, an individual may well make choices based on the belief that others have similar preferences. This "like me" bias is one that is often encountered in the real world. It is a useful heuristic bias when other information is not available. However, where individuals have detailed knowledge about the preferences of others, a more expansive analysis would be needed. The complexities involved in including multiple players with different motives goes beyond the scope of this study.

Strategies. The final element of a game is its set of strategies. Individuals often make their choices based on a specified strategy. A strategy is a decision rule for choosing between alternative actions. Individuals need not be conscious of their strategies. Strategies can be habitual patterns of behavior based on genetic factors. They may also change in response to reinforcement or learning.

Strategies may be pure (e.g. always defect) or mixed (e.g. defect 60% and cooperate 40%). They may also be conditional strategies, such as defect if the majority cooperated on their last play. The social motives being considered will generally result in a pure strategy for a

given inducement system. In some cases, however, mixed strategies must also be considered.

Inducement System Model

To apply game theory to the study of inducements, it is first necessary to build a model of the inducement systems being studied. The inducement system specifies the positive and negative inducements that individuals receive in exchange for their contributions to the organization. Inducements can be broken down into three components: 1) base pay, 2) individual incentives, and 3) group incentives. In developing this model of inducement systems, a number of symbols will be used. Table I shows a list of symbols used in this study.

Base pay is that portion of an individual's compensation which is independent of both the individual's level of contributions and the contributions made by others in the organization. Base pay is of limited interest in this study because it is not linked to the individual's choices about his level of contributions or to the choices of others. Base pay becomes important when the individuals assess whether their total compensation is satisfactory. For the purposes of this study, it will be assumed that total compensation is perceived as satisfactory when it is set at the market rate for the position. In the real world, individuals might expect to be compensated above market if

TABLE I
LIST OF SYMBOLS

<u>Symbol</u>	<u>Definition</u>
c	# of cooperators
d	# of defectors
n	group size ($n=c+d$)
r	reward factor
p	penalty factor
g	group incentive factor
$C(c)$	payoff function for cooperation
$D(c)$	payoff function for defection
i or j	subscript for social motives
k	# of rounds in simulation model
$f(i,k)$	frequency of motive i in round k
$EPC(i,k)$	expected payoff for cooperation for motive i in round k
$EPD(i,k)$	expected payoff for defection for motive i in round k
$b(i,k)$	behavior of motive i in round k
$PC(i,k)$	actual payoff for cooperation for motive i in round k
$PD(i,k)$	actual payoff for defection for motive i in round k
$P_{\max}(i)$	maximum possible payoff for motive i
$P_{\min}(i)$	minimum possible payoff for motive i
$P(i,k)$	relative payoff for motive i in round k

the firm is notably successful. Conversely, individuals from a failing company might expect less compensation.

The second component of inducements is individual incentives. These incentives can be either positive (rewards) or negative (penalties). Many modern compensation systems for nonunion employees make use of some form of individual incentives for employees (O'Dell, 1987). Lawler (1983) and others have proposed that an individual's pay be based on his level of performance (i.e. contributions). Lawler has been active in recommending "pay for performance" as the basis of inducement systems for business. A recent survey (O'Dell, 1987) showed that 28% of American firms use some form of individual incentives. Under many individual incentive plans, the incentive is linked to a specified level of contributions. Piece rates and sales commissions are examples of this type of incentive.

In this study, the term "absolute" is used to refer to individual incentive systems that tie rewards and/or penalties to a specified level of contributions. Absolute rewards are positive incentives given to individuals who contribute at the level defined as cooperation. The size of the reward is determined by the reward factor (r) which gives the value of the reward relative to the cost of the added effort associated with cooperation. Absolute penalties are negative incentives assessed against individuals who contribute at the level of contributions defined as defection. The size of the penalty is determined by the

penalty factor (p), which gives the value of the penalty relative to the cost of the added effort associated with cooperation.

A second form of individual incentives are those that are based on the individual's performance relative to others in the organization. Unlike absolute incentives, the payoffs from competitive incentives depends on the level of contributions of others. As an example, sales organizations sometimes pay bonuses to individual sales representatives who sell more than their peers. The term "competitive" is used in this study to refer to incentive systems that link individual rewards and penalties to the relative contributions of other individuals. While intra-organizational competition is common, it is not generally a formal part of the inducement system (except in sales organizations). Individuals compete for recognition, job assignments, promotions and other perquisites. Even in organizations where absolute incentives are used, the expected level of contributions is influenced by competition. Where competitive incentives are a formal part of the inducement system, they often take the form of special cash and noncash incentives or recognition rewards.

Sales organizations sometimes use sales contests to create internal competition between sales representatives. These contests can be based on achieving quotas, competing against others, team competition or improving on past performance. A recent report on sales incentives (Colletti,

1988) indicated that while quotas were the most popular basis of competition, the second most common basis was competing against others. The report notes that this preference for quotas (versus competing against others) may be due to the increasing need for cooperation between sales representatives across product lines.

Competitive rewards can be formulated in a number of different ways. Because they are infrequently used and often only included as an informal part of the inducement system or as special incentive/recognition programs, there is little in the literature on the design of competitive incentives. In many cases, managerial discretion plays a major role in how competitive incentives are distributed - with regard to both size and frequency. O'Dell (1987) indicates that the majority of recognition awards typically go to only 5% of the population.

The payoff formulas developed for this study base the size of competitive rewards and penalties on the difference between the discretionary contributions of the individual and the average level of discretionary contributions by the group. When only a few cooperate the reward is large, while when many cooperate the reward is small. Conversely, when only a few defect the penalty is large, while when many defect the penalty is small. The reward to each cooperator is defined as $r(1-(c/n))$ and the penalty to each defector is defined as $p(0-(c/n))$ or $-p(c/n)$; where:

r = reward factor

p = penalty factor

c = # of cooperators

d = # of defectors

n = # of individuals in group ($n=c+d$)

While other formulations are possible, this formulation has the common sense feature that the size of the reward (or penalty) increases as the difference between the level of contributions by the individual and the level of contributions by the group increases. Additionally, these formulas are easily analyzed because of their simple form and because they yield payoff functions that vary linearly with the number of cooperators.

The third component of inducements is group incentives. These are incentives that are paid to each individual based on the overall performance of the group or organization. Unlike individual incentives, each individual receives the group incentive regardless of his contributions to the group's performance. A number of group incentives have been used in business organizations - profit sharing, Scanlon Plan, Rucker Plan, Improshare and others. While the administrative details of these plans differ, they each make incentive payments based on the overall performance of the group.

In this study, the aggregate level of contributions (number of cooperators) is used as a surrogate for group performance. The size of the group incentive increases with the number of cooperators and the size of the group

incentive factor (g). Each individual in the group receives a group incentive equal to $g(c/n)$, where:

g = group incentive factor

c = # of cooperators

n = # of individual in group

Like the reward and penalty factors, the group incentive factor is given relative to the cost of the added effort associated with individual cooperation. When g equals one ($g=1.0$) and each individual in the group cooperates ($c=n$), the group incentive payment to each individual just offsets the cost of contributing the added effort.

Inducement systems make use of base pay, individual incentives and group incentives in differing combinations. Ignoring base pay for the moment, we can identify two types of inducement systems 1) inducement systems based on absolute individual incentives and 2) inducement systems based on competitive individual incentives. These two types of inducement systems may or may not include group incentives. Within each of these types of inducement systems, we can classify inducement systems based on whether they make use of rewards, penalties or both. This results in six classes of inducement systems as shown in Table II.

Included in Table II are the formulas for the payoffs to cooperators and defectors for each of the six classes of inducement systems. Group incentives are included in the formulas, but can be removed by setting the group incentive factor (g) equal to zero. An infinite number of inducement

TABLE II
CLASSES OF INDUCEMENT SYSTEMS

<u>Classes</u>	<u>Formula</u>
Absolute	
Rewards	$C(c) = g(c/n) + r$ $D(c) = g(c/n)$
Penalties	$C(c) = g(c/n)$ $D(c) = g(c/n) - p$
Both	$C(c) = g(c/n) + r$ $D(c) = g(c/n) - p$
Competitive	
Rewards	$C(c) = g(c/n) + r(1 - c/n)$ $D(c) = g(c/n)$
Penalties	$C(c) = g(c/n)$ $D(c) = g(c/n) - p(c/n)$
Both	$C(c) = g(c/n) + r(1 - c/n)$ $D(c) = g(c/n) - p(c/n)$
$C(c)$ = Payoff Function for Cooperators	
$D(c)$ = Payoff Function for Defectors	

Note: The above formulas show inducements only and the total payoffs for cooperators must be decreased to reflect the cost of contributions.

systems can be defined for each of the six general types by varying the values of r , p and g . These six classes of inducement systems have two main variables, 1) individual incentives (r and/or p), and 2) group incentives (g). These two variables will form the axes for mapping the analytical results of each class of inducement systems.

Figure 6 shows the payoff functions for an inducement system using absolute rewards ($r=1.2$) and group incentives ($g=1.1$) and a group size of ten ($n=10$). Figure 7 shows the same data, but in the format normally used in game theory. In Figure 7, the two lines have been shifted to illustrate

Figure 6. Payoffs for absolute rewards ($r=1.2$, $g=1.1$).

Figure 7. Payoffs for absolute rewards using game theory format ($r=1.2$, $g=1.1$).

the payoffs one would receive from changing strategies. To show how Figure 7 is used, suppose that a player is one of c cooperators. This player can continue to cooperate or choose to become a defector. Changing from cooperation to defection increases the number of defectors from d to $d+1$. The question in the player's mind is, therefore, whether he would receive a better payoff as one of $d+1$ defectors or as one of c cooperators. The format used in Figure 7 allows for a quick comparison between these two payoffs. By making this comparison for each possible outcome (i.e. $c=1$ to $c=n$), this format can be used to see if one strategy dominates the other. If the two payoff curves do not cross, then the upper curve is a dominating strategy.

Social Motive Formulation

The model of inducement systems developed above specifies the players, choices and outcomes based on the class of inducement system and the values of the incentive parameters r , p and g . Because the outcomes have been converted to a utility scale, preferences could normally be ignored assuming that individuals would prefer their maximum outcome. In this study, however, we consider the possibility that individuals will make choices reflecting social motives which go beyond self-maximization.

Two interpretations of social motives occur in the literature. The first, from the social-psychology literature (Messick and McClintock, 1968), considers these motives to

reflect genuine preferences for various social outcomes. Viewed in this way, outcomes which satisfy the social motive(s) of the individual are preferred. The second interpretation of social motives comes from the literature on evolutionary game theory (Trivers, 1964). Social motives are treated as strategies for optimizing outcomes (i.e. as strategies whose "real" purpose is still self-maximization). These strategies have varying success in gaining outcomes that increase the fitness of the individual. In this study, both of these interpretations are considered.

Six social motives are considered in this study

- 1) Individual, 2) Collective, 3) Competitive, 4) Altruism, 5) Equity, and 6) Aggression.

These motives are taken from the social-psychology literature (MacCrimmon and Messick 1976). Figure 8 depicts these motives in terms of the relationship between payoffs to self and payoffs to others. To apply game theoretic methods to these motives, it is necessary to reformulate the payoffs for these motives in terms of the payoffs which resulted from the model of inducement systems developed earlier.

The Individual motive is based on a preference for maximizing the payoff to self. The Individual motive is typically the only motive considered by game theory. This motive is sometimes referred to as "self-maximization". This motive serves as the basis for most models of "economic man" and is consistent with the approach of expectancy theory.

Figure 8. Graphical representation of social motives.

The payoff formulas developed in the previous section (see Table II) for the six classes of inducement systems are given in terms of their utility to the individual. As such, they are also the correct formulas for the Individual motive. These payoffs for the Individual motive can also be used as the basis for defining the payoffs for the other social motives. Table III gives the relationship between the payoffs from the Individual motive and the other social motives. These formulations are equivalent to those used by MacCrimmon and Messick (1976).

TABLE III
MATHEMATICAL REPRESENTATION OF SOCIAL MOTIVES

<u>Social Motive</u>	<u>Formula</u>
Individual	$C_{\text{Indiv.}} = C$ $D_{\text{Indiv.}} = D$
Collective	$C_{\text{Coll.}} = (cC+dD)/n$ $D_{\text{Coll.}} = (cC+dD)/n$
Competitive	$C_{\text{Comp.}} = C - ((c-1)C+dD)/(n-1)$ $D_{\text{Comp.}} = D - (cC+(d-1)D)/(n-1)$
Altruism	$C_{\text{Altru.}} = ((c-1)C+dD)/(n-1)$ $D_{\text{Altru.}} = (cC+(d-1)D)/(n-1)$
Equity	$C_{\text{Equity}} = -\text{ABS}(C - ((c-1)C+dD))/(n-1)$ $D_{\text{Equity}} = -\text{ABS}(D - (cC+(d-1)D))/(n-1)$
Aggression	$C_{\text{Aggr.}} = -((c-1)C+dD)/(n-1)$ $D_{\text{Aggr.}} = -(cC+(d-1)D)/(n-1)$

Note: The argument has been dropped from the payoff functions for cooperation ($C(c)=C$) and defection ($D(c)=D$).

The preference reflected in the Collective motive is the maximization of the overall outcome for the group. This is accomplished by maximizing the joint (or collective) payoffs to the individuals in the group.

The Competitive motive reflects a preference for doing better than others in the group. The size of the monetary payoff is unimportant, so long as one does better than others. This motive can be characterized as maximizing the difference between the individual's payoff and the average payoff to other players.

The Altruism motive is based on the preference of increasing the welfare of others. This motive attempts to maximize the payoffs to others, while disregarding payoffs to self. While similar to the Collective motive, there are important differences between these two motives. In particular, the altruist will sacrifice his own interests if it benefits others. This self-sacrificial behavior becomes important when considering group incentives and competitive rewards and penalties.

The preference reflected in the Equity motive is equality of payoffs. The payoffs for this motive are based on minimizing the difference between the payoff to the individual and the average payoff to others. Both underpayment and overpayment are of concern in this motive. As a result, the mathematical representation of the Equity motive is based on the absolute value of the difference between payoffs to self and payoffs to others. Because game

theory usually deals with maximization (vs. minimization), the payoff formula shown in Table III includes a minus sign to convert the formula to an equation to be maximized. The Equity and Competitive motives are closely related, C_{Equity} is equal to $-\text{ABS}(C_{\text{Comp.}})$ and D_{Equity} is equal to $-\text{ABS}(D_{\text{Comp.}})$.

The Aggression motive is based on the preference to have others achieve their worst outcome. As such, it is the opposite of the Altruism motive. It is represented by minimizing the average payoff to others. The minus sign included in the formula shown in Table III is used to convert the payoffs to an equation to be maximized. Except for this minus sign, the payoff functions for the Altruism and Aggression motives are identical.

Analysis

With the players, choices, outcomes and preferences defined, it is possible to apply the methods of game theory to the problem of strategic choice. Game theory makes its recommendations about what choices a player should make based on assumptions about how a rational individual would behave. These assumptions are often referred to as principles of rationality (Rubinstein, 1975).

The first of these assumptions is that the other players are rational and that they make their choices based on the same principles of rationality. The second principle is the maximin criterion. This criterion states that each

player should make a choice that guarantees the player his maximin payoff. The maximin payoff is the maximum of the minimum payoffs a player can secure through his own action. Consider the payoff matrix shown in Figure 9. This payoff matrix shows the payoffs to player 1 only. Player 1 can choose action A or action B. By choosing action B, player 1 can guarantee a payoff of 4 utiles. In contrast, choosing action A only secures a payoff of 2 utiles. Choosing B guarantees the maximum of the minimum possible payoffs. This is the maximin choice.

		Player 2	
		A	B
Player 1	A	2	9
	B	6	4

Figure 9. Example of maximin strategy for a 2-person game.

The maximin criterion is one of the central assumptions of game theory. Other decision making criteria might be used in studying inducement systems (e.g. maximax, minimax, Laplace, minimum regret, etc.). These alternative decision making criteria are described by Rubinstein (1975). Because this study follows the approach of game theory, the maximin criterion is of primary importance. These other criterion, while of interest, are beyond the scope of this study.

Using the maximin criterion it is possible to find the equilibrium solution for zero-sum games. In a zero-sum game,

the size of the total payoff is fixed, so that gains by one player come at the expense of other players. The games this study deals with are nonzero-sum games. Indeed, it is the possibility that individuals will share in the value created through their coordinated actions that causes individuals to join business organizations. For nonzero-sum games, some added principles are needed to find the maximin solution. To understand the additional principles of rationality used in this study, it is first necessary to define several concepts from game theory (see Raiffa and Luce, 1957).

The first of these concepts is that of dominance. One strategy dominates another strategy if and only if the payoffs for using that strategy are no worse and in at least one case better than the payoffs for the other strategy, regardless of the choices made by the other players. In the inducement systems shown earlier in Figure 7, cooperation is a dominating strategy over defection. Regardless of the level of cooperation of others, an individual receives a higher payoff from cooperation than from defection. By contrast, there is no dominating strategy for the inducement system shown below in Figure 10.

The second concept of importance is that of an equilibrium outcome. An equilibrium outcome is one where no player can unilaterally change his strategy without diminishing his own payoff, assuming that the other players maintain their strategy. In Figure 7, the equilibrium outcome occurs when all players use the dominating strategy

Figure 10. Example of inducement system with no dominating strategy.

($c=10$). This is a boundary equilibrium, since all of the players adopt this strategy. Because there are no defectors left to move to the dominating strategy, no one can improve their payoff. In Figure 10, there are two boundary equilibria outcomes 1) all cooperators ($c=10$), and 2) all defectors ($d=10$). Note that for both of these equilibrium outcomes, no player can change his strategy without lowering his payoff.

An equilibrium can be either Pareto optimal or deficient. An outcome is Pareto optimal if there is no other outcome where at least one player is better off and where no players are worse off. Conversely, a Pareto deficient outcome is one for which at least one other outcome exists which is better for at least one player and as good for all other players. The inducement system shown in Figure 7 has one equilibrium outcome ($c=10$) and that equilibrium is Pareto optimal. Figure 10 shows an inducement system that has both a deficient equilibrium ($d=10$) and a Pareto optimal equilibrium ($c=10$).

The presence of an equilibrium does not ensure that the equilibrium is Pareto optimal. Figure 11 shows an inducement system that has a single deficient equilibrium ($d=10$). In this figure, defection is a dominating strategy and the equilibrium outcome occurs when all players defect. This equilibrium outcome is deficient because each player receives a higher payoff when all players cooperate ($c=10$). Figure 11 is an example of an 10-person prisoner's dilemma.

Figure 11. Example of inducement system with a dominating strategy and a deficient equilibrium outcome.

Taxonomy of Games

Rappaport and Guyer (1966) developed a taxonomy of 2 X 2 games to describe the strategic features of these games. In building their taxonomy, they made use of an ordinal scale (versus interval scale) for defining payoffs. The use of an ordinal scale allowed them to build a concise, yet comprehensive taxonomy. However, the absence of an interval scale required that they abandon the concept of a mixed strategy. As a replacement, they developed the concept of the natural outcome to describe these games. In developing the concept of the natural outcome, several added principles of rationality were used by these authors. They are as follows:

- 1) If a player has a dominating strategy, he will choose it.
- 2) If only one player has a dominating strategy, then the other player will select the strategy that maximizes his outcome assuming that the other player chooses their dominating strategy.
- 3) If the game has a single Pareto optimal equilibrium, then each player will choose the strategy that contains it.
- 4) If a dominating strategy does not exist, and there is no Pareto equilibrium or more than one, then each player will choose the strategy that contains his maximin outcome.

After defining the natural outcome, the above authors used the concept to develop a taxonomy of the 78 possible 2 X 2 games. Of these 78 games, only the 12 symmetric games

are of relevance to this study. Figure 12 shows the types of games which are possible in this study and the category of game into which they fall. The natural outcome is always shown in the upper left corner of the payoff matrix.

GAMES WITH DOMINATING STRATEGY

No Conflict Games

4,4	3,2
2,3	1,1

4,4	3,1
1,3	2,2

4,4	2,3
3,2	1,1

Single Pareto Equilibrium Games

3,3	4,2
2,4	1,1

3,3	4,1
1,4	2,2

Single Deficient Equilibrium Game

2,2	4,1
1,4	3,3

GAMES WITH NO DOMINATING STRATEGY

No Conflict Games

4,4	2,1
1,2	3,3

4,4	1,3
3,1	2,2

4,4	1,2
2,1	3,3

Two Equilibria Games with Non-equilibrium Outcome

3,3	2,4
4,2	1,1

2,2	3,4
4,3	1,1

2,2	4,3
3,4	1,1

Note: 4 = Best, 1 = Worst.

Figure 12. Taxonomy of symmetric 2-person games (from Rappaport and Guyer 1966).

For the present study, the 12 general games types shown in Figure 12 result in 24 actual games - 12 where cooperation is the natural outcome and 12 where defection is the natural outcome. These games fall into the following categories (Rappaport and Guyer, 1966):

1) Dominating Strategy - No Conflict. These are games where there is a dominating strategy that results in an equilibrium that yields the best outcome for all players. This equilibrium is absolutely stable.

2) Dominating Strategy - Single Pareto Equilibrium. These games have a dominating strategy that results in a single equilibrium which is Pareto optimal. Games in this category are extremely stable.

3) Dominating Strategy - Single Deficient Equilibrium. These are games where the dominating strategy results in an equilibrium which is a deficient outcome. The only game in the category is the prisoner's dilemma. Games in this category are strongly stable.

4) No Dominating Strategy - No Conflict. These are games where there is no dominating strategy and there are two equilibria, one of which yields the best outcome to both players. These are no conflict games and the natural outcome for these games is absolutely stable.

5) No Dominating Strategy - Two Equilibria Games with Non-equilibrium Outcome. These are games where there is no dominating strategy and where there are two Pareto equilibria, neither of which is the natural outcome. Games

in this category are unstable. The non-equilibrium outcome for these games may be either a pure strategy or a mixed strategy. In a mixed strategy, individuals ensure their maximin payoffs by varying their choice of action with a specified frequency. The optimum frequency for each action is dependent on the actual values of the payoffs (interval scale).

Because Rappaport and Guyer (1966) use an ordinal scale, they are unable to determine which games have a mixed strategy. Instead, they use the maximin outcome (based on the outcomes from the pure strategies) to define the natural outcome for these games. This is a weakness in their classification scheme. They recognize the problem of the mixed strategy and appropriately label the natural outcome for such games as "unstable".

For the purposes of this study, the classification scheme of Rappaport and Guyer (1966) must be modified to apply to uniform n-person games. These modifications are a part of the work done in this study. The modified game categories are shown below.

1) Category I - Dominating Strategy - Single Pareto Equilibrium. These games have a dominating strategy that results in a single equilibrium which is Pareto optimal. Games in this category are extremely stable.

This category includes the first two categories used above to describe symmetric 2-person games. These two categories are closely related; the only difference being

that for the no conflict games, the Pareto equilibrium results in the maximum possible payoff. Collapsing these categories also allows for a clearer presentation of results. Figure 13 shows four Category I games. Two of these games have linear payoff functions and two have nonlinear payoff functions. The games included examples of both cooperation and defection as the natural outcome.

2) Category II - Dominating Strategy - Single Deficient Equilibrium. For this category, the dominating strategy results in an equilibrium which is a deficient outcome. The games in the category are the prisoner's dilemma games. Games in this category are strongly stable. Figure 14 shows four examples of Category II games.

3) Category III - No Dominating Strategy - Pareto Equilibrium Outcome. These are games where there is no dominating strategy and there are two boundary equilibria, one of which is Pareto optimal. Figure 15 shows four examples of Category III games. Each of the Category III games shown in Figure 15 have an intersection point for the two payoff lines. Below the intersection point, defection is a dominating strategy with a boundary equilibrium at $d=10$. Above the intersection point, cooperation is a dominating strategy and there is a boundary equilibrium at $c=10$.

While the natural outcome for these games is extremely stable, it is potentially less accessible in the n -person case than in the 2-person case. In 2-person games, an individual can unilaterally adopt the strategy containing

Figure 13. Examples of Category I games.

Figure 14. Examples of Category II games.

Figure 15. Examples of Category III games.

the Pareto optimal equilibrium. The other player is then faced with a choice of moving to the Pareto equilibrium or choosing an inferior outcome. This property makes the Pareto equilibrium very accessible in 2-person games. For n-person games, however, a coalition of individuals is generally needed to move the group from one equilibrium to the other. The change in accessibility of the natural outcome makes games in Category III less desirable in the n-person case ($n > 2$) than in the 2-person case.

For the inducement systems and social motives considered in this study, one of the boundary equilibria was always found to be Pareto optimal. While this is always the case for linear payoff functions, it is not necessarily the case for nonlinear payoff functions. For nonlinear payoff functions, it is possible that both boundary equilibria are deficient (i.e. there is a nonboundary outcome that is Pareto optimal). According to the decision making rules proposed by Rappaport and Guyer (1966), the individual would choose the strategy that contains the their maximin outcome. If interval scales were considered the maximin rule might lead to a mixed strategy for these games. While these games are not relevant to this study, they may occur in other analyses of n-person uniform games. These types of games can be treated as a new category - games with no dominating strategy and deficient boundary equilibria.

4) Category IV - No Dominating Strategy - Non-equilibrium Outcome. These are games where there is no

dominating strategy and where there are multiple nonboundary equilibria, none of which is the natural outcome. Figure 16 show four examples of games form this category. Like Category III games, there is an intersection point for the payoff functions. However, below the intersection point cooperation is a dominating strategy and above the intersection point defection is a dominating strategy. This creates an equilibrium outcome at the point of intersection. Because individuals can be either cooperators or defectors, there are multiple equilibria at the intersection point. Note that Rappaport and Guyer's use of an ordinal scale makes it impossible for them to determine whether the maximin solution involves a mixed strategy or a pure strategy for 2-person games from this category. Instead, they determine the natural outcome based on which pure strategy contains the maximin outcome. The maximin solution based on the outcomes from the pure strategies may be different than the maximin solution when mixed strategies are considered. Because the natural outcome for games in this category do not involve an equilibrium, these games are considered to be unstable.

The four categories of games can be considered to form a hierarchy based on the stability and accessibility of the natural outcome. These properties influence the effectiveness of the game in reaching and maintaining the natural outcome. From a game theoretic perspective, Category I games are the most stable, since they have a

Figure 16 . Examples of Category IV games.

dominating strategy that leads to a Pareto optimal equilibrium. Reaching this equilibrium only requires that individuals pursue their self-interest. Therefore, for inducement systems where cooperation is the natural outcome, Category I games are preferred over the other categories of games because of their effectiveness in achieving the natural outcome. Conversely, Category I games are the least preferred when defection is the natural outcome.

Category II games are second most preferred games, since they have a dominating strategy and the equilibrium is reached when individuals pursue the dominating strategy. The third most preferred games are Category III games. This category of games has two boundary equilibria, one of which is Pareto optimal. The difficulty with this category of games is that the presence of the second boundary equilibria may keep the system from reaching the natural outcome. For 2-person games, the preferences for categories II & III would be reversed, since the Pareto equilibrium is readily accessible in the 2-person case. The least preferred category of games is Category IV. These games have a natural outcome that is not an equilibrium outcome. As a result there is always a temptation for individuals to defect from the natural outcome.

Phase I Analysis

In the first phase of analysis, the modified classification system shown above was used to map the

natural outcomes and game categories for the six classes of inducement systems previously developed. This phase of the analysis is based on the Individual motive. The values of the parameters r , p and g were used as inputs into the payoff formulas shown in Table II. The resulting payoffs define a specific game, which can be classified in terms of its natural outcome and game category. As an example, consider the inducement system with absolute rewards and group incentives and with the system parameters set at $n=2$, $r=0.5$, and $g=1.2$. Because the inducement systems dealt with in this study involve symmetric games, the payoffs for only one of the players need to be indicated to define the payoffs for all other players. The payoffs for player 1 from this inducement system are shown in Figure 17.

		Player 2	
		C	D
Player 1	C	0.7	0.1
	D	0.6	0

Figure 17. Payoff matrix for a 2-person inducement system using absolute rewards ($r=0.5$, $g=1.2$).

In this game, cooperation is a dominating strategy. The single equilibrium ($c=2$) is Pareto optimal and also gives each player his best outcome (0.7 utiles). This game falls within Category I - games with a dominating strategy and a single Pareto equilibrium.

By altering the values of r and g , it is possible to map the natural outcome and category of game over a range of values. This results in a graph showing the regions over which differing categories of games occur and whether cooperation or defection is the natural outcome. Figure 18 shows such a mapping for 10-person inducement systems based on competitive rewards and penalties plus group incentives. This analysis was done for the same classes of inducement systems shown in Table II. A complete set of mapping for the 10-person case for each of the six classes of inducement systems is shown in Appendix A.

Satisficing. Two variations to the Individual motive were also analyzed. These variations are based on the decision making theory of satisficing developed by Simon (1976). Under Simon's theory, individuals only search for alternative actions when their payoffs fall below a threshold (satisfactory) level. In this analysis, the threshold value is considered to be met when the value of inducements exceeds the value of contributions.

Satisficing theory assumes that individuals do not search for a new behavior as long as their outcomes remain satisfactory. Because individuals begin as either cooperators or defectors, two variations must be considered 1) initial cooperators, and 2) initial defectors. These two initial behaviors require separate analyses. After selecting the initial behavior, the analysis then determines whether cooperation or defection is the natural outcome. Note that

Figure 18. Map of natural outcomes for the Individual motive based on competitive rewards and penalties.

the initial behavior and the natural outcome may be different. The "satisficer's" payoff for the inducement system being considered is then checked to see if it is positive (satisfactory) for the satisficer's initial behavior (cooperate or defect). If the payoff is positive, the satisficer's initial behavior continues. If the payoff is negative, the individual searches for a new behavior that improves his outcomes. This search is assumed to result in the individual changing his behavior to match the natural outcome. Because this study is interested in the question of how to promote cooperation, the focus of the satisficing analysis is on determining when satisficing theory would predict that individuals would depart from cooperation as the natural outcome. Regions where defection is the natural outcome are ignored in this portion of the analysis.

The analysis of initial cooperators differs slightly from the analysis for initial defectors. In looking at cooperation as the initial behavior, the important question is whether cooperators receive a positive outcome from cooperation. The analysis assumes that all other individuals choose to cooperate when calculating whether cooperation results in a positive outcome. When looking at defection, however, the question is whether there is any possibility that a defector would receive a positive outcome when cooperation is the natural outcome. The analysis, therefore, considers all possible levels of cooperation and defection

to determine whether defectors could receive a positive outcome.

Figures 19 & 20 show the results of this analysis for inducement systems using competitive rewards and penalties. In Figure 19, the initial behavior is defection. The cross-hatched area shows the inducement systems where defectors could receive a positive payoff, even though cooperation is the natural outcome. In Figure 20, the initial behavior is cooperation. The cross-hatched area shows the inducement systems where cooperation is the natural outcome and where cooperators receive a positive payoff. The complete set of results for the satisficing analysis is included in Appendix A. Two maps are included for each of the six classes of inducement systems based on cooperation and defection as the initial behaviors.

Figure 19. Map of satisficing behavior of initial defectors based on competitive rewards and penalties.

Figure 20. Map of satisfying behavior of initial cooperators based on competitive rewards and penalties.

Phase II Analysis

The first phase of analysis was based on the payoff formulas from Table II. These payoffs are equivalent to the Individual motive (self-maximization). The second phase of analysis uses the same methods to analyze five additional social motives 1) Collective, 2) Competitive, 3) Altruism, 4) Equity, and 5) Aggression. Table III gives the payoff formulas used to represent these motives. A typical set of results for the five motives are shown in Figures 21-25. These results are based on the use of competitive rewards and penalties and a 10-person group. Similar maps were developed for each of the six classes of inducement systems and the five social motives considered in phase II. The complete set of results for the second phase of analysis are shown in Appendix B.

Figure 21. Map of natural outcomes for the Collective motive based on competitive rewards and penalties.

Figure 22. Map of natural outcomes for the Competitive motive based on competitive rewards and penalties.

Figure 23. Map of natural outcomes for the Altruism motive based on competitive rewards and penalties.

Figure 24. Map of natural outcomes for the Equity motive based on competitive rewards and penalties.

Figure 25. Map of natural outcomes for the Aggression motive based on competitive rewards and penalties.

Phase III Analysis

The third phase of the analysis uses ideas from theoretical biology to examine the evolution of social motives in response to the environment created by the inducement system of the organization. Theoretical biologists have made use of evolutionary game theory to provide explanations for the social behavior of animals (Dawkins, 1976; and Maynard-Smith, 1982). In applying evolutionary game theory to the study of organizational inducements, the approach used by theoretical biologists must be modified to reflect the differences between the organizational environment and the natural environment. The most significant of these differences is that organizational behaviors occur over a short period of time when compared with the multitude of generations associated with genetic evolution. These organizational behaviors are considered to be primarily shaped through organizational learning.

Because behaviors are considered to evolve through learning rather than reproductive success, an organizational fitness measure must be found to replace Darwinian fitness (the frequency of a gene in the population). The fitness measure used in this study is the frequency with which individuals use a particular social motive in choosing between cooperation and defection.

In the model developed for this study, learning replaces natural selection in transmitting behaviors. This leads to the question of how this learning occurs. Earlier,

it was discussed that social motives could be interpreted as 1) genuine preferences, or 2) strategies for maximizing material payoffs. These alternative interpretations lead to differing assumptions about how individual learning occurs in response to an organizational inducement system.

When social motives are interpreted as preferences, this study assumes that individuals continue to make use of a motive as long as they find that motive's social outcomes to be satisfactory. This occurs when individuals receive favored outcomes, as defined by the motive's preferences. As an example, a player with the social motive of Altruism might be "satisfied" with a smaller personal payoff (inducements less contributions) provided that his actions resulted in a larger payoff to the group. If social motives reflect preferences, then such a player might continue to adopt this motive, even though a larger material payoff might result from another social motive. In this study, we will assume that the degree of satisfaction with a motive will influence the frequency with which it is used during the next inducement period. A player will be satisfied when he receives the best possible outcome and unsatisfied when he receives the worst possible outcome.

When social motives are interpreted as strategies for maximizing personal payoffs, the frequency of motives will be assumed to depend upon the actual payoffs to the individual (inducements less contributions). Under this interpretation, the fitness of a social motive depends only

upon its relative success in maximizing inducements less contributions when compared against other motives. This measure of fitness does not depend on whether the preferences of the motive are satisfied.

Simulation Models. In developing simulation models for these alternative interpretations of social motives, the organization is considered to be populated by individuals making choices between cooperation and defection based on the Individual motive and the five social motives described earlier. The frequencies with which these motives are used to choose between cooperation and defection are variable. The models do not assign the motives to individuals, but treats them as frequencies within the entire population. As an example, if a given motive had a frequency of 0.5 in the population, it might be used all of the time by half of the population or might be used by each individual half of the time.

Each round (k) in the simulation represents one inducement period for the organization. The frequency ($f(i,k)$) with which each motive (i) is used can be set from 0.0 to 1.0. The initial values of $f(i,k)$ are set such that all six motives start out with an equal frequency (i.e. $f(i,0)=0.167$). The expected payoffs for successive rounds are calculated using the level of cooperation from the previous round, with no memory of prior results. The calculation of the expected payoffs for cooperation ($EPC(i,c(k-1))$) and defection ($EPC(i,c(k-1))$) is based on

the level of cooperation in the prior round. The calculation assumes that the level of cooperation of others remains unchanged from the previous round.

Using these expected payoffs, a comparison is made between the expected payoffs for cooperation ($EPC(i, c(k-1))$) and defection ($EPD(i, c(k-1))$) for each of the motives. The choice to behave as a cooperator ($b(i, k)=1$) or a defector ($b(i, k)=0$) is based upon whether cooperation or defection has the larger payoff. The initial values of $b(i, k)$ for each motive are based on the natural outcome from the analysis done in phases I and II (i.e. $b(i, 0)=1$ if the natural outcome for motive i is cooperation, otherwise $b(i, 0)=0$).

The new level of cooperation ($c(k)$) is then calculated using the prior frequencies for each of the motives and each motive's choice to cooperate or defect for this round. Using this information the actual payoffs for cooperation ($PC(i, k)$) and defection ($PD(i, k)$) are calculated for each of the motives. These calculations are based on the equations shown earlier in Tables II and III.

The model then determines the relative payoff for each motive compared to the payoff for the other motives during that round. The relative payoffs are based on a scale (0.0-1.0) derived from the best and worst possible outcomes ($P_{\max}(i)$ and $P_{\min}(i)$). $P_{\max}(i)$ is the maximum payoff for motive i from either cooperation or defection for all possible levels of cooperation. For cooperators, the relative payoff $P(i, k) = (PC(j, k) - P_{\min}(j)) / (P_{\max}(j) - P_{\min}(j))$.

For defectors, $P(i,k) = (PD(j,k) - P_{\min}(j)) / (P_{\max}(j) - P_{\min}(j))$. Note that the relative payoff scale can be based on the payoff functions for the motive being analyzed ($i=j$) or the payoff functions for a different social motive.

Two models were developed in this study which use different payoff functions in determining the relative payoffs. The first model is based on interpreting motives as preferences. This model calculates the relative payoff for each motive based on the payoff functions for that motive ($i=j$). The second model interprets motives as strategies for maximizing individual payoffs. This model calculates relative payoffs based on the Individual motive (i.e. based on what individuals receive themselves, with no regard to the payoffs to others).

The first model is referred to as the "Satisfaction Model", since individuals adopt motives that are successful in satisfying the preferences of the motive. The second model is labeled the "Fitness model", since individuals choose motives that succeed in acquiring personal rewards linked to the individual's future fitness. These relative payoffs ($P(i,k)$) are then used to determine the frequencies of the six motives for the next round. The formula used to calculate the new frequencies is shown below:

$$f(i,k) = f(i,(k-1)) * P(i,k) / \text{SUM}(f(i,(k-1)) * P(i,k)).$$

Figure 26 shows the flowchart and formulas used in developing the two simulation models.

Motive Evolution. The two simulation models shown in Figure 26 were used to determine the evolution of each motive and the steady-state level of cooperation. The frequencies (f) of the six motives were initially be set equal to one another ($f=0.167$) and then allowed to evolve based on each strategy's payoffs. At the end of each round, the relative payoffs for each social motive was determined and the frequency of that motive adjusted. Each simulation was ran until equilibrium frequencies for each of the motives were reached. The steady-state level of cooperation was also determined for each of the simulations.

Figure 27 illustrates the results from one such simulation. The results are for the Satisfaction model and a 10-person inducement system using competitive rewards and penalties ($r=1.25$, $p=1.25$, $g=0.5$). In this simulation, the level of cooperation increased from 0.5 to 1.0. In the process, the Aggression motive displaced the other motives. The complete set of results for phase III are shown in Appendix C.

Figure 26. Simulation flowchart and formulas.

Figure 27. Evolution of social motives for satisfaction model based on competitive rewards and penalties ($r=1.25$, $p=1.25$, $g=0.5$).

CHAPTER IV

RESULTS

The results from the three phases of analysis outlined in Chapter III are presented in this chapter. The results of the first two phases of analysis define the regions where cooperation and defection are the natural outcomes for the six classes of inducement systems being considered. The results from phase I of the analysis cover the Individual motive and two variations based on the theory of satisficing (Simon, 1976). The results from phase II cover the other social motives 1) Collective, 2) Competitive, 3) Altruism, 4) Equity, and 5) Aggression.

The results of the third phase of analysis show the evolution of motives in response to a particular inducement system. These results illustrate how the frequencies of the social motives might evolve and what the net effect would be on the steady-state level of group cooperation. Results are presented for two models, one based on motive fitness (Fitness model) and the other on motive satisfaction (Satisfaction model).

Inducement Systems

Six classes of inducement systems were developed for use in this study (see Table II). These six classes make use

of group incentives in combination with rewards and/or penalties. The rewards and penalties are based on either absolute or competitive standards. While these inducements systems can be used to represent a wide variety of real-world inducements, they are not inclusive of all possible types of inducement systems. The equations used to develop the six classes of inducement systems are based on idealized incentives. Real-world inducement systems are rarely as well-defined as the equations for the various inducement systems would indicate. Competitive incentives, in particular, are often based on subjective judgements and ill-defined payoffs. While a more complete analysis would consider more classes of inducement systems and alternative formulations for individual and group incentives, the classes of inducement systems presented in this study are useful in understanding 1) how various incentives work together to influence motivation, and 2) what behaviors might follow from the choice of competitive incentives over absolute incentives.

While a comprehensive analysis of inducement systems is beyond the scope of this study, it is important to know whether the six classes of inducement systems being studied describe a sufficiently diverse cross-section of inducement systems. A partial answer to this question can be obtained by checking to see if the four categories of uniform n-person games discussed in Chapter III occur for the Individual motive. Table IV summarizes the diversity of game

categories that occur for each of the six classes of inducement systems based on an analysis of 10-person groups for the six classes of inducement systems being considered.

TABLE IV
GAME CATEGORIES
FOR THE SIX CLASSES OF INDUCEMENTS SYSTEMS
BASED ON 10-PERSON GROUP

<u>Class</u>	<u>Natural Outcome</u>	
	Cooperate	Defect
Absolute		
Rewards	I	I,II
Penalties	I	I,II
Both	I	I,II
Competitive		
Rewards	I,IV	I,II,IV
Penalties	I,III	I,II,III
Both	I,II	I,II

Note: The same categories of games occur for the 2-person case.

As can be seen from Table IV, each of the four categories of games is included under at least one of the six classes of inducement systems for both the natural outcome of cooperation and defection. While other formulas for the incentives could be considered, they would not result in any new categories of games. This is at least a suggestive argument that the six classes of inducement systems are adequate for the general investigation being done in this research.

Phase I Results

The cornerstone of this research is the analysis of the Individual motive. The mathematical representation of this motive is based directly upon the payoffs to the individual from the inducement system under consideration. This motive finds its basis in the classical view of economic man as a utility maximizer. This approach is consistent with the approach of expectancy theory.

Absolute Rewards and/or Penalties. Three classes of inducement systems based on absolute incentives were considered: 1) absolute rewards, 2) absolute penalties, and 3) absolute rewards and penalties. These inducement systems use fixed incentives to reward and/or penalize individuals based on their contributions relative to a fixed standard of contributions defined as cooperation.

Figures 28 & 29 show the payoff functions for the Individual motive for two inducement systems using absolute rewards and/or penalties ($r=1.5$, $p=0.0$, $g=0.5$ and $r=0.0$, $p=1.5$, $g=0.5$). The payoff functions for these two inducement systems are quite similar, the only difference being an offset resulting from the use of rewards in one case and penalties in the other. From a game theoretic perspective, this offset is unimportant. Because game theory is based on an interval scale, games that differ by a fixed offset are equivalent to one another. In general, the game theoretic analysis of any two inducement systems using absolute rewards and/or penalties will be equivalent if the sums of

Figure 28. Payoffs for absolute rewards ($r=1.5$, $g=0.5$).

Figure 29. Payoffs for absolute penalties ($p=1.5$, $g=0.5$).

the reward and penalty factors are equal (e.g. $r=1.5$, $p=0.0$ is equivalent to $r=0.0$, $p=1.5$) and the group incentive factors are equal. This finding is reflected in the results shown in Appendix A for the Individual motive.

Figure 30 shows the results of the analysis of the Individual motive for the 10-person case. Three categories of games occur for the Individual motive for inducement systems based on absolute rewards and/or penalties - two where defection is the natural outcome and one where cooperation is the natural outcome.

To simplify the discussion of the regions that come out of this study, a shorthand notation is used to label the natural outcome and category of game associated with each region. This shorthand uses the letter "C" or the letter "D" to indicate whether cooperation or defection is the natural outcome. The letter is followed by a Roman numeral indicating what game category is involved. As an example, an inducement systems from a CII region would have cooperation as the natural outcome and would be a Category II game.

Two regions have defection as the natural outcome. The first region (DI) has values of r, p and g such that $(r+p+g)<1.0$. For inducement systems within this region, defection is a dominating strategy and the equilibrium outcome is Pareto optimal. This inducement system can be represented by a Category I game.

An example of an inducement system from this region is shown in Figure 31 ($r=0.125$, $p=0.125$, $g=0.25$). Note that the

Figure 30. Map of natural outcomes for the Individual Motive based on absolute rewards and/or penalties.

Figure 31. Category I game with defection as the natural outcome and based on absolute rewards and penalties ($r=0.125$, $p=0.125$, $g=0.25$).

payoff line for cooperation lies below the payoff line for defection. This means that regardless of the level of cooperation of others, an individual always receives a higher payoff by choosing to defect. As a result, defection is a dominating strategy. Because defection is a dominating strategy, the natural outcome is for each individual to defect. This leads to a single equilibrium ($c=0$) and that equilibrium is Pareto optimal (i.e. there is no other outcome where each individual receives an equal or better payoff).

The second region (DII) where defection is the natural outcome includes the area with values of r, p and g such that $(r+p+g)>1.0$ and $r+p+(g/10)<1.0$. Inducement systems in this region fall within Category II, games where there is a dominating strategy that leads to a deficient outcome. As an example, consider the inducement system with $r=0.25$, $p=0.25$, $g=2.0$ as shown in Figure 32. For inducement systems in this region, defection is the dominating strategy. The equilibrium outcome occurs when each individual defects ($c=0$). Unlike the region discussed above, this equilibrium is deficient (i.e. there is another outcome ($c=10$) where each individual receives a better payoff). Inducement systems in this region fall within the class of games commonly known as "prisoner's dilemma" games.

Outside of these two regions of defection, cooperation is the natural outcome. Inducement systems with absolute rewards and/or penalties lead to cooperation as the natural

Figure 32. Category II game with defection as the natural outcome and based on absolute rewards and penalties ($r=0.25$, $p=0.25$, $g=2.0$).

outcome when $r+p+(g/10)>1.0$. These inducement systems fall within Category I. An example of an inducement system in this region (CI) is shown in Figure 33 ($r=0.75$, $p=0.75$, $g=1.0$). As can be seen, cooperation is a dominating strategy and the equilibrium outcome ($c=10$) is Pareto optimal.

The regions defined above are based on the analysis of inducement systems where the group size is ten ($n=10$). To determine the region where cooperation is the natural outcome for the general n -person case, consider the payoff functions for cooperation and defection shown below:

$$C(c)=r+g(c/n)-1$$

$$D(c)=-p+g(c/n)$$

Note: The payoff functions are taken from Table II. The cost of contributions (-1.0 utiles) has been included in the payoff for cooperators.

For cooperation to be a dominating strategy, the payoff for cooperation must exceed the payoff for defection for all levels of cooperation and therefore:

$$C(c)>D(c-1)$$

$$r+g(c/n)-1>-p+g((c-1)/n)$$

$$r+p+g((c-(c-1))/n)>1$$

$$r+p+(g/n)>1$$

Note: If the level of cooperation of others is c , a cooperator's choice to defect decreases the level of cooperation to $c-1$, while the choice to continue to cooperate does not alter the level of cooperation.

The above equations show that for inducement systems based on absolute rewards and/or penalties, cooperation will be a dominating strategy when the value of $r+p+(g/n)$ exceeds

Figure 33. Category I game with cooperation as the natural outcome and based on absolute rewards and penalties ($r=0.75$, $p=0.75$, $g=1.0$).

the cost of the added effort for cooperation. In this study, the cost of cooperation has been used to define the utility scale. It is defined as having a value of -1.0 utiles.

Competitive Rewards. The analysis of the three classes of inducement systems based on competitive rewards and/or penalties is more complex than the analysis of inducement systems using absolute rewards and/or penalties. Unlike the case with absolute rewards and/or penalties, competitive rewards result in different game categories than do competitive penalties. Figures 34 & 35 show two inducement systems ($r=1.5, p=0, g=0.5$ and $r=0, p=1.5, g=0.5$), with values of r, p and g found earlier to lead to equivalent games for inducement systems using absolute rewards and penalties. Note the dissimilarities between these two inducement systems when compared to Figures 28 & 29. These differences occur because competitive rewards shift the slope of the payoff line for cooperators, while competitive penalties shift the slope of the payoff line for defectors. Recall that absolute rewards and penalties do not change the slope of either payoff line. Because of these differences, it is necessary to discuss the three classes of inducement systems based on competitive rewards and/or penalties separately.

The use of competitive rewards leads to five regions, three where defection is the natural outcome (DI, DII & DIV) and two where cooperation is the natural outcome (CI & CIV). These regions are as shown in Figure 36. Two of the regions

Figure 34. Payoffs for competitive rewards ($r=1.5$, $g=0.5$).

Figure 35. Payoffs for competitive penalties

Figure 36. Map of natural outcomes for the Individual motive based on competitive rewards.

of defection (DI & DII) are similar to the regions of defection which occur for the inducement systems based on absolute rewards and penalties. This should not be surprising, since when the values of r and p approach zero, the payoffs for systems based on absolute rewards and systems based on competitive rewards are approximately equal.

The first of these regions (DI) has values of r and g such that $r < (10-g)/9$ and $g < 1.0$. This region has a dominating strategy of defection and the natural outcome is Pareto optimal. The second region (DII) has values of r and g such that $r < (10-g)/9$ and $g > 1.0$. This region has a dominating strategy of defection and the equilibrium outcome ($c=0$) is deficient.

The third region (DIV) includes Category IV games, where defection is the natural outcome. This region has values of g between 0.0 and 1.0 and values of r such that $r > (10-g)/9$. While defection is the natural outcome for this region, it is not a dominating strategy. Consider, for example, the inducement system shown in Figure 37 ($r=1.5$, $g=0.5$). When the level of cooperation exceeds 0.366, defection has a higher payoff than cooperation. Conversely, when the level of cooperation is less than 0.366, cooperation has the better payoff.

In addition to there being no dominating strategy, neither pure cooperation ($c=10$) or pure defection ($c=0$) is an equilibrium outcome. In general, the payoff lines for

Figure 37. Category IV inducement system with defection as the natural outcome and based on competitive rewards ($r=1.5$, $g=0.5$).

inducement systems in this region intersect when c/n is equal to $1-(1-g/n)/r$. This result is found as follows:

$$C(c)=D(c-1)$$

$$g(c/n)+r(1-c/n)-1=g((c-1)/n)$$

$$r(1-c/n)=1-g/n$$

$$c/n=1-(1-g/n)/r$$

Note that this is an equilibrium outcome, since changing from cooperation to defection or defection to cooperation does not affect one's payoffs. It should also be noted that the equilibrium outcome is different than the outcome where both cooperators and defectors receive equal payoffs. The payoffs for cooperation and defection are equal when $c/n=1-1/r$.

Because there is no dominating strategy and neither pure defection or cooperation is a Pareto optimal outcome, the choice of the natural outcome is based on the maximin strategy. The maximin strategy chooses the outcome that gives the best of the worst possible outcomes. For the inducement system shown in Figure 37, the worst outcome from defection ($c=0$) is preferred over the worst outcome from cooperation ($c=10$). Defection is the maximin strategy and the natural outcome for inducement systems in this region.

The concept of the natural outcome was developed by Rappaport and Guyer (1966) as a tool for classifying games. Their classification system is based on the ordinality of payoffs (ordinal scale) and does not rely on the actual values of the payoffs (interval scale). As a result of using

an ordinal scale, these authors were unable to make use of the concept of a mixed strategy. This limitation is particularly apparent when dealing with games falling within Category IV.

While neither pure strategy results in an equilibrium outcome, a solution does exist if mixed strategies are considered. A mixed strategy is one where alternative choices are made with a specified probability or frequency. The solution for the mixed strategy for an inducement system from this region ($r=1.5$, $g=0.5$) is shown graphically in Figure 38. Refer to Rubinstein (1975) for a discussion of this graphical method of analysis.

The two vertical axes show the payoffs for cooperation $C(c)$ and defection $D(d+1)$ for all possible values of c (i.e. $c=0$ to $c=10$). The connecting lines show the mixed strategy payoffs for choosing cooperation ($C(c)$) with a frequency of f and choosing defection ($D(d+1)$) with frequency $1-f$. The mixed strategy is found by determining the value of f that yields the highest maximin payoff from the mixed strategy payoff lines (see Figure 38). For the inducement system being shown ($r=1.5$, $g=0.5$) the mixed strategy occurs when individuals cooperate with a frequency of $f=0.33$ and defect with a frequency of $f=0.67$. Note that this is a nonequilibrium outcome, since defectors would do better by switching to cooperation (see Figure 37).

The payoff lines shown in Figure 38 are somewhat unique in that each line intersects at a common point. This is a

Figure 38. Graphical solution of the mixed strategy for competitive rewards, ($r=1.5$, $g=0.5$).

general result that can be shown by considering the solution for the intersection of the payoff lines for any two successive levels of cooperation, c and $c+1$. The intersection point (f) is found as follows:

$$\begin{aligned}
 fC(c) + (1-f)D(d+1) &= fC(c+1) + (1-f)D(d) \\
 f(g(c/n) + r(1-c/n) - 1) &= f(g((c+1)/n) + r(1-(c+1)/n) - 1) \\
 &\quad + (1-f)g(c-1)/n \quad + (1-f)g(c/n) \\
 fg(c/n) + fr - fr(c/n) - f &= fg(c+1)/n - fr(c+1)/n - f \\
 &\quad + f(c-1)/n - fg(c-1)/n \quad f(c/n) - fg(c/n) \\
 fg(c/n) - fr(c/n) + g(c/n) &= fg(c/n) + fg/n - fr(c/n) \\
 &\quad - g/n - fg(c/n) + fg/n \quad - fr/n + g(c/n) - fg(c/n) \\
 -g/n &= -fr/n \\
 fr &= g \\
 f &= g/r
 \end{aligned}$$

Because the mixed strategy payoff lines for any two successive levels of cooperation intersect at g/r , it is also the case that the mixed strategy payoff lines for every level of cooperation intersect at g/r . As a result, the maximin strategy has a value of f equal to g/r .

In addition to the three categories of games where defection is the natural outcome, this class of inducement systems has two regions where cooperation is the natural outcome (CI & CIV). The easier of these two regions to understand occurs when the value of the group incentive factor is greater than the number of individuals in the group (i.e. $g > 10$). Cooperation is a dominating strategy for this region (CI) and the resulting equilibrium outcome is

Pareto optimal (Category I). This result occurs regardless of the value of the reward factor (r).

The boundaries of this region in the n -person case are found by determining what values of r and g are needed for cooperation to be a dominating strategy. For cooperation to be a dominating strategy, the payoff for cooperation must exceed the payoff for defection for all levels of cooperation and therefore:

$$C(c) > D(c-1)$$

$$g(c/n) + r(1-c/n) - 1 > g((c-1)/n)$$

$$gc + r(n-c) - n > gc - g$$

$$r(n-c) + g > n$$

Since $(n-c) \geq 0$ and $r \geq 0$, the value of $r(n-c) \geq 0.0$. Because dominance requires that $C(c) > D(c-1)$ for every level of c and because the minimum value of $n-c$ is zero, it is true that:

$$g > n$$

This is a general result for all group sizes. It should be apparent, however, that when the size of the group is large, the organization must use equally large group incentives ($g > n$) to fall within this region. Note that when the value of g is equal to n , then $g/n = 1.0$ and the cost of contributing is compensated for by the group incentive.

The second and more interesting region of cooperation (CIV) is the area with values of r such that $r > (10-g)/9$ and values of g such that $1.0 < g < 10$. This region contains inducement systems which fall within Category IV - games with no dominating strategy and a natural outcome that is

not an equilibrium outcome. Consider the inducement system with $r=3.0$, $p=0.0$, $g=2.0$ as shown in Figure 39. When the level of cooperation (c/n) exceeds $1-(1-g/n)/r$, then it is preferable to defect. However, when the level of cooperation is less than $1-(1-g/n)/r$, then it is better to cooperate. Neither pure cooperation or pure defection is an equilibrium outcome and the natural outcome is based on choosing the strategy that gives the maximin outcome.

The maximin solution for this region is more complex than for the DIV region discussed earlier. The mixed strategy for the DIV region was found to occur when the frequency of cooperation (f) was equal to g/r . The same solution for the mixed strategy holds for the CIV region. However, a portion of the CIV region has values of $g/r > 1.0$. Since a mixed strategy must have a value of f between 0.0 and 1.0, the natural outcome for this area is a pure strategy. Figure 40 shows an inducement system ($r=1.5$, $g=2.0$) with $g/r > 1.0$ and Figure 41 shows the graphical solution for the same inducement system. The maximin payoff (0.55 utiles) occurs when each individual cooperates ($f=1.0$).

Games from the CIV region are preemption games. The most famous of these is "chicken" (Kahn, 1965). Figure 42 shows the payoff matrix for a 2-person game of chicken based on an inducement system using competitive rewards ($r=1.2$, $g=1.5$). Both CD and DC are Pareto optimal equilibrium. These games are called preemption games because the first person

Figure 39. Category IV inducement system with cooperation as the natural outcome and based on competitive rewards ($r=3.0$, $g=2.0$).

Figure 40. Category IV inducement system with cooperation as the natural outcome and based on competitive rewards ($r=1.5$, $g=2.0$).

Figure 41. Graphical solution of the mixed strategy for competitive rewards, ($r=1.5$, $g=2.0$).

to defect receives the best payoff. Note that the natural outcome CC is also Pareto optimal, but that it is not an equilibrium outcome. It is also interesting to note that CC is Pareto optimal when $g > r$.

		Player 2	
		C	D
Player 1	C	0.5	0.35
	D	0.75	0.0

Figure 42. Payoff matrix for a 2-person Category IV game based on competitive rewards ($r=1.2$ $g=1.5$).

Finding the boundaries of the Category IV regions (DIV & CIV) for the n-person case involves two steps. The first is to find the boundaries with the two regions with dominating strategies must be determined. The region where cooperation is the dominating strategy (CI) was found earlier to be $g > n$. The region where defection is a dominating strategy is found as follows:

$$C(c) < D(c-1) \text{ for } c=1 \text{ to } c=10$$

$$g(c/n) + r(1-c/n) - 1 < g(c-1)/n$$

$$gc + r(n-c) - n < gc - g$$

$$r(n-c) < n - g$$

$$r < (n-g)/(n-c)$$

Since $C(c) < D(c-1)$ must be true for all levels of cooperation ($c=1$ to $c=10$) and because $(n-c)$ is largest when $c=1$, then:

$$r < (n-g)/(n-1)$$

The second step is to determine when cooperation is the maximin strategy. For cooperation to be the maximin strategy, the minimum payoff for cooperation must be greater than the minimum payoff for defection. Because this inducement system has no penalties, the minimum payoff for defection occurs when $c=0$, $D(0)=g(0/n)=0.0$. For the minimum payoff for cooperation to exceed 0.0, then:

$$C(c) > 0.0$$

$$g(c/n) + r(1-c/n) - 1 > 0.0$$

$$g(c/n) + r(1-c/n) > 1$$

When $g > 1.0$, $C(c)$ will be greater than 0.0 for all values of c and, therefore, cooperation will be a dominating strategy. When the value of $g < 1.0$, then the minimum payoff for cooperation will occur when $c=n$. But when $c=n$, then $c/n=1.0$, and therefore:

$$g(1) + r(1-1) - 1 > 0.0$$

$$g > 1.0$$

Therefore, cooperation is the natural outcome when $g > 1.0$. In summary, the region with Category IV games has values of r and g such that, $1.0 < g < n$ and $r > (n-g)/(n-1)$. When $g < 1.0$ defection is the natural outcome (DIV), and when $g > 1.0$ cooperation is the natural outcome (CIV).

Competitive Penalties. The use of competitive penalties leads to inducement systems which fall within five regions as shown in Figure 43. The boundaries of these regions are identical to the boundaries of the regions that arise from

Figure 43. Map of natural outcome for the Individual motive based on competitive penalties.

the use of competitive rewards. The categories of games and natural outcomes are also the same for three of the regions 1) the DI region where $r < (10-g)/9$ and $g < 1.0$, 2) the DII region where $r < (10-g)/9$ and $g > 1.0$, and 3) the CI region where $g > 10$.

There are two regions (DIII & CIII) where the game categories for inducement systems using competitive rewards differ from those using competitive penalties. The first is the DIII region with values of g between 0 and 1.0 and values of r such that $r > (10-g)/9$. These are inducement systems where there is no dominating strategy, but where there is a Pareto optimal equilibrium ($d=10$). Figure 44 shows a typical inducement system from this region ($p=2.0$, $g=0.5$).

The point at which the payoff lines for cooperation and defection intersect in Figure 44 occurs when $C(c)=D(c-1)$.

The value of c/n is found as follows:

$$C(c)=D(c-1)$$

$$g(c/n)-1=g((c-1)/n)-p((c-1)/n)$$

$$-1+g/n=-p((c-1)/n)$$

$$c/n-1/n=(1-g/n)/p$$

$$c/n=1/n+(1-g/n)/p$$

Note that when the value of c/n is greater than $1/n+(1-g/n)/p$, then the payoffs for cooperation exceed the payoffs for defection. Defectors should, therefore, be expected to switch to cooperation. This causes the system to move towards the deficient equilibrium at $c=10$. Conversely,

Figure 44. Category III inducement system with defection as the natural outcome and based on competitive penalties ($p=2.0$, $g=0.5$).

when the level of cooperation is less than $1/n+(1-g/n)/p$, then defection is preferable to cooperation and the system should move towards the second equilibrium point at $d=10$.

For the Inducement system shown in Figure 44, the choice of defection as the natural outcome hinges on the fact that defection leads to a Pareto optimal equilibrium ($d=10$). It should be noted, however, that the argument for the Pareto optimal equilibrium as the natural outcome is weaker for the n -person case ($n>2$) than for the 2-person case. Consider as an example, the payoff matrix for a typical 2-person game from Category III as shown in Figure 45.

		Player 2	
		C	D
Player 1	C	-0.5	-0.75
	D	-0.75	0.0

Figure 45. Payoff matrix for a 2-person Category III game based on competitive penalties ($p=2.0$, $g=0.5$).

For this game, the Pareto equilibrium occurs when both players choose to defect. This outcome is easily reached in the 2-person case, since when either player defects the other player is reduced to choosing between the second best outcome (defect) and the worst outcome (cooperate). Unless the second player violates norms of rationality, the first player's defection should result in both players defecting.

Contrast this situation with what happens when only one player defects ($d=1$) in the inducement system shown in Figure 44. As can be seen, the remainder of the players will to do better by continuing to cooperate than by switching to defection. This will continue to be true until enough individuals defect to cause the level of cooperation to exceed $1/n+(1-g/n)/p$. At that point, any remaining cooperators will be better off by defecting. The Pareto optimal equilibrium will be reached as these cooperators switch to defection. While the choice of the Pareto optimal equilibrium as the natural outcome has strong appeal, the accessibility of this outcome in the n -person case for Category III games can be problematic. This is a situation where the presence of strong group norms might help the group to reach a better outcome than might be possible through individual actions.

The last region to be discussed for inducement systems based on competitive penalties is the CIII region. This region has values of g between 1.0 and n and values of r such that $r > (10-g)/9$. The boundary of this region for the n -person case can be found using the same steps used to find the boundaries of the Category IV region for inducement systems using competitive rewards. Using this approach, the CIII region has values of p and g such that $p > (n-g)/(n-1)$ and $1.0 < g < n$. Like the DIII region, the payoff lines for inducement systems from the CIII region have an intersection point at $1/n+(1-g/n)/p$. When $c/n < 1/n+(1-g/n)/p$ defection is

a dominating strategy. When $c/n > 1/n + (1-g/n)/p$ cooperation is a dominating strategy.

Competitive Rewards and Penalties. Competitive rewards and penalties can be used jointly as well as singly to create inducement systems. When considering inducement systems using both rewards and penalties, the relative values of the reward factor (r) and the penalty factor (p) must be established. For the purposes of this study, the reward factor is taken to be equal to the penalty factor ($r=p$). This results in inducement systems that are furthest from the two classes of inducements considered earlier. It also results in payoff lines for cooperation and defection which are parallel. As a result, there is always a dominating strategy (unless the payoff lines are equal) and all inducement systems are either Category I or Category II games.

Figure 46 shows the map of game categories that occur for the Individual motive for inducement systems with competitive rewards and penalties. Four regions occur, two of which have defection as the natural outcome (DI & DII). These regions have the same boundaries and game categories that occur when either rewards or penalties are used.

The remaining two regions (CI & CII) have cooperation as the natural outcome. When the value of g is greater than 1.0 ($g > 1.0$) and the values of r and p are such that $(r+p)/2 > (10-g)/9$, then cooperation is a dominating strategy and the equilibrium outcome ($c=10$) is Pareto optimal. This

Figure 46 . Map of natural outcomes for the Individual motive based on competitive rewards and penalties.

is a CI region. Figure 47 shows an inducement system from this region, $r=1.0$, $p=1.0$, $g=2.0$. For the n -person case, the CI region has values of r, p and g such that $(r+p)/2 > (n-g)/(n-1)$ and $g > 1.0$.

The remaining region (CII) also has a dominating strategy of cooperation. However, unlike the other region of cooperation (CI), the equilibrium outcome for this CII region is deficient rather than Pareto optimal. The boundaries of the CII region are $g < 1.0$ and $(r+p)/2 > (10-g)/9$. For the n -person case, the region has values of r, p and g such that $(r+p)/2 > (n-g)/(n-1)$ and $g < 1.0$.

The interesting result from this region is that the behavior labeled as "cooperation" is a dominating strategy that results in a deficient outcome. This is an apparent reversal of the normal prisoner's dilemma, where "defection" is the dominating strategy that leads to a deficient outcome. One explanation for this role reversal is the fact that "cooperation", as used in this study, means cooperation with the organization rather than cooperation with other individuals. To an extent, the reversal is an artifact of the way game theoreticians label choices in the prisoner's dilemma game. Nevertheless, there are few real-world examples of situations where the pursuit of group or organizational goals is individually rational but collectively irrational. Before adopting an inducement system from the CII region, organizations should consider the ethics and long-term practicality of using an inducement

Figure 47. Category I inducement system with cooperation as the natural outcome and based on competitive rewards and penalties ($r=1.0$, $p=1.0$, $g=2.0$).

system that sets organizational interests against the collective interests of individuals.

A summary of the regions where cooperation is the natural outcome for each of the six classes of inducement systems is shown in Table V. The game categories and boundaries for each region of cooperation are given based on the n-person case.

TABLE V
GAME CATEGORIES AND BOUNDARIES
FOR REGIONS WITH COOPERATION AS THE NATURAL OUTCOME
FOR THE INDIVIDUAL MOTIVE

Class

Absolute

Boundaries

Rewards

Category I

$$r+(g/n)>1.0$$

Penalties

Category I

$$p+(g/n)>1.0$$

Both

Category I

$$r+p+(g/n)>1.0$$

Competitive

Rewards

Category I

$$g>n$$

Category IV

$$1.0<g<n \text{ and } r>(g-n)/(n-1)$$

Penalties

Category I

$$g>n$$

Category III

$$1.0<g<n \text{ and } p>(g-n)/(n-1)$$

Both

Category I

$$g>1.0 \text{ and } (r+p)/2>(g-n)/(n-1)$$

Category II

$$g<1.0 \text{ and } (r+p)/2>(g-n)/(n-1)$$

Inducement System Costs. To apply the results from the preceding section to real-world organizations, it is

necessary to understand the costs of achieving a given level of cooperation for a specific inducement system.

Organizations are typically interested in increasing the level of individual cooperation with organizational goals at the minimum cost to the organization. It is assumed, therefore, that the organization will search for those inducement systems that result in cooperation as the natural outcome and which have the lowest costs to the organization.

Figures 48 & 49 show the cost isocurves for inducement systems based on 1) absolute rewards and/or penalties, and 2) competitive rewards and/or penalties. These cost curves assume that the natural outcome is cooperation and that each individual cooperates. Because each individual in the group is assumed to cooperate, penalties can be ignored. These curves represent the costs per cooperator and are valid for any group size (e.g. $n=2$, $n=10$, $n=135$).

For inducement systems that make use of absolute rewards and/or penalties (Figure 48), the costs per individual are equal to the sum of the reward factor (r) and the group incentive factor (g), $\text{costs}=r+g$. For those inducement systems utilizing competitive rewards and/or penalties (Figure 49), the costs depend only upon the group incentive factor (g), $\text{costs}=g$. This result is due to the fact that for inducement systems using competitive rewards, the size of the reward is equal to zero when all individuals cooperate, $\text{reward}=r(1-c/n)=0$ when $c=n$.

Figure 48. Cost isocurves for inducement systems based on absolute rewards and/or penalties.

Figure 49. Cost isocurves for inducement systems based on competitive rewards and/or penalties.

From these curves, the least cost inducement system for each region of cooperation can be identified. For inducement systems based on absolute rewards and/or penalties, the goal is to find the inducement system with the minimum value of $r+g$. For inducement systems based on competitive rewards and/or penalties, the goal is to find the inducement system with minimum value of g .

The cost curves shown in Figure 48 & 49 assume that each individual cooperates. As discussed in the previous section, for inducement systems based on competitive rewards, there is a CIV region where the maximin criterion leads to a mixed strategy over a portion of the region. As a result, the level of cooperation predicted by game theory is less than 1.0. Figure 50 shows the costs per cooperator based on the level of cooperation (g/r) that results from the mixed strategy. These cost curves are applicable to inducement systems using competitive rewards when the values of r and g are such that $0 < g < n$ and $r > g$.

The costs per cooperator for this region are calculated as follows:

$$\text{costs} = [f(g(c/n) + r(1 - c/n)) + (1 - f)g(c/n)] / (c/n)$$

$$\text{costs} = [g/r(g(g/r) + r(1 - g/r)) + (1 - g/r)g(g/r)] / (g/r)$$

$$\text{costs} = g(g/r) + r - g + g - g(g/r)$$

$$\text{costs} = r$$

For this region, the only factor affecting the costs per cooperator is the reward factor. Therefore, since the minimum costs (r) and the maximum level of cooperation (g/r)

Figure 50. Cost isocurves for regions having a mixed strategy.

both occur when $r=g=1.0$, this will be the preferred inducement system from this region.

The cost curves developed above for the CIV region are based on the concept of the mixed strategy. A different set of cost curves might also be developed using the equilibrium outcome to define the level of cooperation. This would result in a slightly different set of cost curves. The mixed strategy was chosen because of its close association with game theory and the maximin criterion.

The cost curves shown in Figures 48-50 assume no change in base pay. Organizations can adjust base pay in conjunction with changes in incentives to control the overall cost of inducements. While lowering base pay is often difficult, most organizations can move to a higher reward and group incentive factors by freezing cost-of-living increases over a period of several years. However, during periods of low inflation or financial emergency, it may be necessary to lower base pay to meet targeted base pay and incentive levels.

Implications for Organizations. With the goal in mind of achieving a high level of cooperation at a low cost, it is possible to identify specific inducement systems of interest to the organizational practitioner. These inducement systems can be identified by using the cost curves presented above to select the least cost inducement system for each region of cooperation.

As an example, consider the class of inducement systems based on competitive rewards and penalties which is shown in Figure 46. This class of inducement systems has two regions (CI & CII) where cooperation is the natural outcome. The CII region contains the least cost inducement system for this class of inducement systems. These costs are minimum when the group incentive factor (g) is zero and the reward factor is greater than $10/9$. In this case, the cost of gaining each cooperator's added contributions would be 0.0 utiles.

The CI region is also of interest because of the fact that Category I games have a Pareto optimal equilibrium, while Category II games have a deficient equilibrium. The least cost inducement system for this region occurs when the values of r and g both approach one. The costs of this inducement system would be 1.0 utiles.

The least cost inducement system for any region is the inducement system(s) having the lowest cost of any inducement system from the region. Finding the least cost inducement system for regions where cooperation is the natural outcome is an important starting point in choosing an inducement system for use in an organization. Table VI lists the costs per cooperator and design parameters for the least cost inducement system for each region where cooperation is the natural outcome for the six classes of inducement systems being studied. The level of cooperation for each of these regions is assumed to be 1.0. Note that the level of cooperation for the least cost inducement

system from the CIV region should also be 1.0, since c/n is equal to g/r .

TABLE VI
LEAST COST INDUCEMENT SYSTEMS
FOR THE INDIVIDUAL MOTIVE
AND N-PERSON GROUPS

<u>Class</u>				
<u>Absolute</u>	r	p	g	Cost
Rewards				
Category I	1.0	-	0.0	1.0
Penalties				
Category	-	1.0	0.0	0.0
Both				
Category I	0.5	0.5	0.0	0.5
<u>Competitive</u>				
Rewards				
Category I	0.0	-	n	n
Category IV	1.0	-	1.0	1.0
Penalties				
Category I	-	0.0	n	n
Category III	-	1.0	1.0	1.0
Both				
Category I	1.0	1.0	1.0	1.0
Category II	$n/(n-1)$	$n/(n-1)$	0.0	0.0

Table VI summarizes the least cost inducement system for the Individual motive. The most costly regions of cooperation are the CI regions for inducement systems based on competitive rewards or competitive penalties. The least cost inducement systems in these regions have a cost of n utiles, where n is the group size. For large groups, this level of costs will likely be prohibitively high. The least

costly inducement systems occur for the CI region based on absolute penalties ($p=1.0$, $g=0.0$) and the CII region for inducement systems based on competitive rewards and penalties ($r=n/(n-1)$, $p=n/(n-1)$, $g=0.0$). These inducement systems result in no additional costs over base salary.

The preceding analysis is based on what is rational for individuals within the organization. What the analysis does not indicate is how these outcomes compare with payoffs that might be available outside the organization. As an example, the least cost inducement system using absolute penalties results in a payoff of -1.0 utiles to cooperators. Unless the base pay is sufficiently high, individuals may be able to improve their payoff by moving to another organization. Even if individuals are unable or unwilling to move to another organization, the perception that they are not being compensated for their contributions can affect morale and lead to other problems in the organization.

Satisficing. As part of the work done in Phase I, an additional analysis of the Individual motive was made based on the theory of satisficing developed by Simon (1976). This analysis provides answers to two questions. First, "Is the outcome from cooperation satisfactory to the individual?". The answer to this question is important, because an individual may search for alternatives outside the organization if no satisfactory outcomes are available within the organization. The results of the analysis provide information that can be used to resolve the problem of

unsatisfactory outcomes noted above for inducement systems based on absolute penalties.

Second, "Will a defecting individual receive a satisfactory outcome?". This question is critical, since if a defector receives a satisfactory outcome, he may not engage in the search behavior needed to discover whether cooperation is preferable to defection. Such an individual might continue to defect, even though the principles of rationality would indicate that cooperation is the natural outcome.

Figures 51 & 52 show the results of the satisficing analysis of the Individual motive for inducement systems using competitive rewards and penalties. Results for the other classes of inducement systems are shown in Appendix A. This analysis makes use of the prior analysis of the natural outcomes for the Individual motive. For regions where cooperation is the natural outcome, the payoffs are reviewed to answer the two questions listed above. First, a review is made to see if cooperation results in a positive (satisfactory) outcome. This review is made assuming that all individuals are cooperators ($c=n$). Second, a review is made to see if defectors receive a positive payoff for any other level of cooperation (i.e. $c=0$ to $n-1$).

Figure 51 shows the results of the satisficing analysis for initial cooperators ($n=10$). The cross-hatched area (light background, dark cross-hatching) shows where the cooperation is the natural outcome and individuals receive a

Figure 51. Map of satisfying behavior of initial cooperators based on competitive rewards and penalties.

Figure 52. Map of satisfying behavior of initial defectors based on competitive rewards and penalties.

positive payoff from cooperation. This region (labeled "CSat.") has values of r , p and g such that $g > 1.0$ and $(r+p)/2 > (n-g)/(n-1)$. Examining Figure 51 shows that the CII region ($(r+p)/2 > (n-g)/(n-1)$ and $g < 1.0$) results in an unsatisfactory payoff to the individual, even though cooperation is the natural outcome. Recall that for this Category II region cooperation is individually rational but collectively irrational. The designer of organizational inducement systems should be sensitive to the problems that may arise from selecting an inducement system where the natural outcome results in an unsatisfactory payoff to the individual.

Figure 52 shows the results of the satisficing analysis for initial defectors. The cross-hatched area (dark background, light cross-hatching) shows the region where cooperation is the natural outcome and where defectors could receive a positive outcome. This region (labeled "DSat.") has values of r , p and g such that $(r+p)/2 > (n-g)/(n-1)$ and $(r+p)/2 < g$. As an example, consider the inducement system with $r=1.5$, $p=1.5$, $g=2.0$, $n=10$. The payoff for defection ($d=1$) is 0.45 utiles when all others cooperate ($c=9$). This payoff is positive, though it is less than the payoff for cooperation ($c=10$), 1.0 utiles. According to Simon's theory, individuals receiving satisfactory outcomes may fail to act in accordance with the accepted norms of rationality. If an individual is currently a defector, he may continue to defect even though the norms of rationality would predict

cooperation. This outcome is of importance to organizational practitioners. It illustrates how the presence of satisfactory outcomes for defection can undermine the effectiveness of an organization's inducement system.

Table VII summarizes the results from the satisficing analysis based on initial cooperation and initial defection.

TABLE VII
SATISFICING REGIONS
FOR INITIAL COOPERATORS AND DEFECTORS
BASED ON N-PERSON GROUPS

<u>Class</u>	<u>Satisficing Regions</u>	
<u>Absolute</u>	Initial Cooperators	Initial Defectors
Rewards	$g > 1.0$ $r + g/n > 1.0$	$g > 1.0$ $r + g/n > 1.0$
Penalties	$g > 1.0$ $p + g/n > 1.0$	$p < g(n-1)/n$ $p + g/n > 1.0$
Both	$(r+p)/2 + g/n > 1.0$ $r + p + g/n > 1.0$	$(r+p)/2 < g(n-1)/n$ $r + p + g/n > 1.0$
<u>Competitive</u>		
Rewards	$g > 1.0$ $r > g(n-g)/(n-1)$	$g > 1.0$ $r > g(n-g)/(n-1)$
Penalties	$g > 1.0$ $p > g(n-g)/(n-1)$	$g < p$ $p > g(n-g)/(n-1)$
Both	$g > 1.0$ $(r+p)/2 > g(n-g)/(n-1)$	$g < p$ $(r+p)/2 > g(n-g)/(n-1)$

The table shows the boundaries of the regions where

- 1) cooperators receive a positive payoff ($c=n$), and
- 2) defectors receive a positive payoff ($d=1$ to $d=n$). Results are listed for all six classes of inducement systems. The

analysis assumes no change in base pay. The regions would change if changes in base pay were considered.

This analysis makes it possible to utilize two additional criteria for selecting inducement systems. Namely, that 1) inducement systems should result in a satisfactory payoff for cooperators, and 2) inducement systems should result in an unsatisfactory payoff for defectors.

Of particular interest to organizational practitioners is the least cost inducement system meeting the two satisficing criteria. These two criteria are satisfied for those inducement systems that fall within the CSat. region but which lie outside the DSat. region. As an example, the region meeting the two satisficing criteria for inducement systems using competitive rewards and penalties has values of r and g such that $g > 1.0$ and $(r+p)/2 > g$. The least cost inducement system for this region occurs when $r=1.0$, $p=1.0$ and $g=1.0$. The cost of this system would be 1.0 utiles. Note that the cost of the least cost inducement system jumps from 0.0 utiles to 1.0 utiles when these criteria are added to the analysis of the Individual motive. Table VIII shows the boundaries of the regions where cooperation is the natural outcome and where the above two criteria are satisfied.

For inducement systems using competitive rewards only, there is no region that meets the two satisficing criteria. This is because defectors always receive a positive payoff when there are no penalties and because the competitive

TABLE VIII
REGIONS MEETING SATISFICING CRITERIA
FOR N-PERSON GROUPS

<u>Class</u>	<u>Regions</u>
<u>Absolute</u>	
Rewards	$r > 1.0$ $g = 1.0$
Penalties	$g > 1.0$ $p > g(n-1)/n$
Both	$(r+p)/2 + g > 1.0$ $(r+p)/2 > g(n-1)/n$
<u>Competitive</u>	
Rewards	none
Penalties	$g > 1.0$ $p > g$
Both	$g > 1.0$ $(r+p)/2 > g$

reward is equal to 0.0 when each individual cooperates. For inducement systems based on absolute rewards only, the inducement systems meeting both criteria have $g = 0.0$. When $g > 0.0$ defectors receive a positive payoff. This problem can be partially resolved by lowering base pay by $g(n-1)$ utiles and increasing the reward factor to $1 + g(n-1)/n$ utiles. Lowering base pay by $g(n-1)/n$ utiles ensures that defectors do not receive a positive payoff.

The results shown in Table VIII provide a useful summary of the work done in Phase I. Based on the Individual motive, six classes of inducement systems were investigated to identify those regions where cooperation is the natural

outcome. These regions were broken down into the four categories of symmetric games and the least cost inducement system identified for each region. These regions of interest were further reduced by applying two additional criteria based on the theory of satisficing.

Phase II Results

Phase I is based on the analysis of the Individual motive. In phase II, five additional social motives are considered 1) Collective, 2) Competitive, 3) Altruism, 4) Equity, and 5) Aggression. Each of these motives is based on the payoffs to others in comparison with payoffs to self (see Table III and Figure 8).

The analysis of these social motives uses the same methods used to analyze the Individual motive. For each class of inducement systems, the payoff functions are analyzed to determine whether cooperation or defection is the natural outcome for the motive being considered. Regions of cooperation and defection are further classified according to the category of game which represents inducement systems from those regions. A complete set of results showing the natural outcomes and game categories for the five social motives and the six classes of inducement systems is shown in Appendix B.

Collective Motive. The Collective motive reflects a preference for maximizing joint payoffs to the group. In most cases, joint maximization follows from individual

maximization. Regions with cooperation as the natural outcome for the Individual motive also have cooperation as the natural outcome for the Collective motive. The opposite is also true; namely, that regions where defection is the natural outcome for the Individual motive typically have defection as the natural outcome for the Collective motive. The only exception occurs for those regions that are represented by Category II games. These are the prisoner's dilemma games where what is rational for the individual is collectively irrational. Given the nature of these games, it is not surprising that games that fall into Category II for the Individual motive have the opposite natural outcome when the Collective motive is considered.

Figure 53 shows the results for the Collective motive and inducement systems based on competitive rewards and penalties. When these results are compared with the results for the Individual motive (see Figure 46), two changes are apparent, 1) the DII region for the Individual motive becomes part of the CI region for the Collective motive, and 2) the CII region for the Individual motive becomes part of the DI region for the Collective motive.

While the regions where cooperation is the natural outcome are similar for the Individual and Collective motives, the game categories that result are not necessarily the same. Regions that fall into Category I for the Individual motive will also fall into Category I for the

Figure 53. Map of natural outcomes for the Collective motive based on competitive rewards and penalties.

Collective motive. For other categories of games, no clear correspondence exists.

One important result from the analysis of the Collective motive is the difference that exist between the Individual and Collective motives for Category II regions. This is particularly true for the class of inducements based on competitive rewards and penalties. While it is possible to select a low cost inducement system with cooperation as the natural outcome for the Individual motive (e.g. $r=1.5$, $p=1.5$, $g=0.0$), this Category II inducement system will have defection as the natural outcome for the Collective motive. Conversely, an inducement system from region DII for the Individual motive would fall into region CI for the Collective motive. In this case, a strong Collective motive might lead to group cooperation, even though it is irrational for the individual.

The CI region for the Collective motive occurs for all six classes of inducement systems. This region does not require the use of any individual incentives. If there is a strong organizational culture that supports the Collective motive, it may be possible to fashion a low cost inducement system that results in a high level of organizational cooperation. This type of inducement system can be fashioned using group incentives only. Examples of this type of inducement system occur in employee-owned companies, where based pay is often supplemented by a major profit sharing plan. While these companies often have no individual bonuses

or merit pay, the strength of the Collective motive helps these companies to operate using group rewards tied to the overall performance of the company.

The use of group incentives only, may also make sense in organizations where there is a high level of intrinsic motivation or a critical need for cooperation between individuals or work groups. Deci (1971) has questioned the use of extrinsic rewards because of their adverse impact on intrinsic motivation. The underlying theory is that the use of extrinsic rewards shifts the locus of control from the individual to his environment. If intrinsic motivation is high, it may be preferable to use group incentives rather than individual incentives. While group incentives may also undermine intrinsic motivation, the fact that the choice is tied to the Collective motive and not to the Individual motive might reduce the shift in the locus of control away from the individual. Similarly, if group incentives are used exclusively, it may cause individuals to see their actions as being based on maximizing collective payoffs rather than payoffs to self. This could result in a general preference for cooperation over individualistic or competitive behaviors. More research is needed to understand the effects of group (versus individual) incentives on the level of intrinsic motivation and the individual's preferences for social outcomes.

Competitive Motive. The Competitive motive reflects a preference for doing better than others. This is an

important motive, particularly in the world of business. While competition can be a positive force in motivating individuals, it can also lead to dysfunctional behavior. This can occur when an individual puts his own interests ahead of those of the group.

For each of the six classes of inducement systems studied, the combined area where cooperation is the natural outcome for the Collective motive is slightly smaller than the regions of cooperation for the Individual motive. Figure 54 shows the results for the Competitive motive for inducement systems based on absolute rewards. Comparing this with the results for the Individual motive (see Figure 30) shows that the region of cooperation has changed from $r+g/10>1.0$ to $r>1.0$.

The differences between the Individual and Competitive motives reflect the problem mentioned above. An individual can improve his relative payoff by defecting, even though cooperation is rational for both the Individual and Collective motives. Figure 55 illustrates this problem for a 2-person inducement system using absolute rewards ($r=0.75$, $g=2.0$). Defection is a dominating strategy for the Competitive motive, while cooperation is a dominating strategy for the Individual and Collective motives. Designers of organizational inducement systems should be cautious when using inducement systems that fall into this region. Such inducement systems may cause dysfunctional behavior due to the presence of the Competitive motive.

Figure 54. Map of natural outcomes for the Competitive motive based on absolute rewards.

	C	D		C	D		C	D
C	0.0	-0.25	C	1.75	0.75	C	1.75	0.875
D	0.25	0.0	D	1.0	0.0	D	0.875	0.0
	Competitive			Individual			Collective	

Figure 55. Payoff matrices for the Individual, Collective and Competitive motives for a 2-person inducement system using absolute rewards ($r=0.75$ $g=2.0$)

One feature of the Competitive motive that should be noted is that the boundaries of regions do not depend on the value of the group incentive factor (g). This result is obvious, since group incentives apply to all parties equally and, therefore, do not result in a change in the difference between the payoffs to self and others. Because this motive is based on differences between self and others, the size of the group incentives does not affect the payoffs for this motive.

From a design standpoint, cooperation is the natural outcome for this motive for inducement systems based on absolute rewards and/or penalties whenever $(r+p)>1.0$. For inducement systems based on competitive rewards and/or penalties, cooperation is the natural outcome whenever $(r+p)>2.0$. Unless these minimum values of $r+p$ are reached, cooperation is never the natural outcome for this motive. Conversely, cooperation is always the natural outcome of

this motive when the value of $r+p$ exceeds these minimum values.

Altruism Motive. The Altruism motive is based on a preference for maximizing the payoffs to others, without consideration of the payoff to self. The rational basis for this motive is that others will engage in reciprocal acts of altruism (Trivers, 1964). While altruism based on kinship relations is common in nature, there is a question about the extent to which altruism operates in business organizations. The importance of this motive in organizational settings is, therefore, unknown.

The analysis of the Altruism motive for inducement systems based on absolute rewards and/or penalties is relatively straightforward. Cooperation is always the natural outcome, since cooperation increases the payoff to others whenever group incentive are used in conjunction with absolute rewards and/or penalties. The DII region for the Individual motive becomes a CI region for the Altruism motive. The DI regions for the Individual motive become CII regions for the Altruism motive. An interesting result occurs for the CII region for the Altruism motive. For the Individual motive, the corresponding region ($r+p+g<1.0$) has defection as a dominating strategy and the equilibrium outcome ($d=10$) is Pareto optimal (Category I). For the Altruism motive, this region falls into Category II and cooperation is the natural outcome. This is another example of a prisoner's dilemma. The presence of the group incentive

leads each individual to help the other group members, even though this results in an inferior outcome for each individual.

The analysis of the Altruism motive for inducement systems based on competitive rewards and/or penalties is somewhat more complex. For these inducement systems, the choice to cooperate or defect influences the size of the rewards and penalties that others receive. For inducement systems that use either competitive rewards or penalties, the regions of cooperation includes those areas which have cooperation as the natural outcome for the Individual motive plus the DII region and a portion ($r < g$ or $p < g$) of the DI region for the Individual motive. The only regions which do not have cooperation as the natural outcome for the Altruism motive are 1) the region with $r > g$ and $g < 1.0$ for inducement systems based on competitive rewards, and 2) the region with $p > g$ and $g < 1.0$ for inducement systems based on competitive penalties.

A still more interesting result occurs for the class of inducement systems based on competitive rewards and penalties as shown in Figure 56. Comparing these results with those for the Individual motive (see Figure 46) shows a new region of defection (DII) with values of r , p and g such that $(r+p)/2 > g$ and $g > 1.0$. Defection is rational for this region because the increases in the payoffs to others from the high reward and penalty factors outweigh the increases from group incentives that result from cooperation.

Figure 56. Map of natural outcomes for the Altruism motive based on competitive rewards and penalties.

The results from the Altruism motive show that while this motive leads to cooperation as the natural outcome in most cases, caution should be exercised when dealing with competitive rewards and/or penalties. When the reward factor is too high, individuals may engage in game playing (e.g. working on someone else's behalf) or self-sacrifice (e.g. defecting) based on a desire to increase the competitive rewards to others.

Equity Motive. The Equity motive is the social motive which has received the most attention in the literature on motivation. This motive is based on a preference for minimizing the difference between the payoff to self and the payoff to others. This motive differs from the other motives in several aspects.

First, all of the regions that occur for this motive fall within Category III. This is the only motive that has a single category of games. Figure 57 shows the results for inducement systems using absolute rewards.

Second, this motive always has at least two Pareto equilibria. This is true because the best possible outcome (no difference between self and other) occurs when either all of the players cooperate ($c=10$) or all of the players defect ($d=10$). This result is similar to the result predicted by Equity theory with regard to High-High and Low-Low outcomes (Adams, 1963).

Additionally, for inducement systems based on absolute rewards and/or penalties and inducement systems using

Figure 57. Map of natural outcomes for the Equity motive based on absolute rewards.

competitive rewards and penalties ($r=p$), the minimum payoffs for cooperation and defection are also equal. Consider as an example, the inducement system based on competitive rewards and penalties shown in Figure 58. This figure shows the payoffs for the Equity motive. Notice that the payoffs for both equilibria ($c=10$ and $d=10$) are equal. As a result, there is no basis for choosing between the two Pareto optimal equilibria and there is no unique maximin outcome. An individual with the Equity motive is, therefore, indifferent to cooperation and defection as the natural outcome for these classes of inducement systems. This result is noted on Figure 57 (i.e. "Defect=Cooperate").

Category III games with two Pareto equilibria do not occur in the taxonomy of Rappaport and Guyer (1966). Because those authors use ordinal outcomes (Best>Second Best>Third Best>Worst), two outcomes can never be equal to one another. This is another example of where the game categories developed by Rappaport and Guyer differ slightly from those developed in this study.

Another interesting feature of these classes of inducement systems is the equity line. The equity line includes all inducement systems that result in equal payoffs to cooperators and defectors for all levels of cooperation. For these inducement systems the payoff curves for cooperation and defection are identical. As a result, individual receives their best possible outcome (Equity motive) regardless of the level of cooperation.

Figure 58. Payoffs for the equity motive based on competitive rewards and penalties ($r=1.0$, $g=1.0$).

In this study, the comparison between self and others used to formulate the Equity motive is based on the average payoff to others. The group, as opposed to any specific individual, is used as the referent for determining equity. As such, the Equity motive leads to cooperation whenever the majority of the group chooses to cooperate. However, when a single individual is the referent, the group will adopt this referent individual's level of contributions. In such cases, equity might lead to defection even though it would not be predicted on the basis of this analysis.

Aggression Motive. The Aggression motive reflects the preference for outcomes that minimize the payoff to others. This payoff is the opposite of the Altruism motive. Wherever the Altruism motive has a natural outcome of cooperation, the Aggression motive has a natural outcome of defection. The game categories are also the same except that Category III games become Category IV games and Category IV games become Category III games.

As might be expected, the Aggression motive tends to run counter to the other social motives. For inducement systems based on absolute rewards and/or penalties, there is no region where cooperation is the natural outcome for the Aggression motive. For inducement systems based on competitive rewards or penalties, the Aggression motive generally leads to cooperation only when the other social motives do not. However, for inducement systems based on competitive rewards and penalties, there are two large

regions (CI & CII) where cooperation is the natural outcome and where the Individual motive and the Competitive motive also have cooperation as the natural outcome. Figure 59 shows the results for the Aggression motive for inducement systems based on competitive rewards and penalties. This class of inducement systems may be of interest in organizations desiring aggressive behavior by selected employees. Competitive rewards are sometimes used in sales organizations (O'Dell, 1987). Aggressive sales-related behavior may be beneficial in these organizations, since there is often a limited need for cooperation between individual sales representatives. In general, however, the Aggression motive runs counter to the organization's need for coordinated actions and common goals. As such, most organizations will prefer to select inducement systems where the Altruism motive (versus Aggression motive) has cooperation as the natural outcome.

Implications for Organizations. The results of phases I & II define the regions where cooperation is the natural outcome for the Individual motive and the five social motives. In an empirical study by McClintock, Messick, Kuhlman and Campos (1974) the frequency of cooperation was found to increase as the number of social motives satisfied by cooperation increased. Their work considered four motives: 1) Individual, 2) Collective, 3) Competitive, and 4) Aggression. The fact that behavior was influenced by the degree to which social motives were satisfied has important

Figure 59. Map of natural outcomes for the Aggression motive based on competitive rewards and penalties.

implications for organizations. Namely, that inducement systems should be selected that have cooperation as the natural outcome for as many motives as possible.

One way to apply the results of phases I & II is to map the regions where cooperation is the natural outcome for each of the motives being considered. Figures 60 thru 65 are summary maps showing the overlapping regions of cooperation for the Individual motive and the five social motives. These figures can be used to select inducement systems from regions where cooperation is the natural outcome for several motives. These inducement systems can be expected to result in cooperation over the widest range of social motives. This should lead to an increased level of cooperation when compared with regions where fewer motives have cooperation as the natural outcome.

The regions shown in Figures 60-65 do not differentiate between game categories. Because some game categories are preferable to others (e.g. Category I), it is important to look at the actual game categories for each social motive before selecting an inducement system. As an example, an organizational practitioner might want to select an inducement system from a CI region for the Individual motive to ensure that cooperation is as stable as possible for this important motive.

To illustrate the use of these figures, consider the results shown in Figure 60 for inducement systems using absolute rewards. When the value of the reward factor is

Figure 60. Map of the overlapping regions of cooperation for inducement systems using absolute rewards.

Figure 61. Map of the overlapping regions of cooperation for inducement systems using absolute penalties.

Figure 62. Map of the overlapping regions of cooperation for inducement systems based on absolute rewards and penalties.

Figure 63. Map of the overlapping regions of cooperation for inducement systems using competitive rewards.

Figure 64. Map of the overlapping regions of cooperation for inducement systems using competitive penalties.

Figure 65 . Map of the overlapping regions of cooperation for inducement systems using competitive rewards and penalties.

greater than 1.0, four motives (Individual, Collective, Competitive and Altruism) have cooperation as the natural outcome. Recall that neither cooperation or defection can be the natural outcome for the Equity motive for this class of inducement systems, and that the Altruism and Aggression motives can not both have cooperation as the natural outcome. As a result, the region with $r > 1.0$ has cooperation as the natural outcome for the maximum number of social motives. Since altruism is likely to be preferred over aggression in an organization, this region is probably optimal for this class of inducement systems.

A number of real-world inducement systems are based on absolute rewards. Sales commissions or piece rates are examples of absolute reward systems. Provided that the size of the reward is sufficient to compensate for the added effort, these inducement systems should be effective for the Individual, Collective, Competitive and Altruism motives.

Another application of the results of phase II is in aligning the inducement system with the business strategy or culture of the organization. Lawler (1983), in particular, has argued for designing inducement systems based on the goals of the organization. Consider, as an example, a business that wants an aggressive and competitive sales force for gaining market share in a new area. Reviewing Figure 65 shows that for the class of inducement systems based on competitive rewards and penalties, there is a region ($g < 1.0$, $r > (10-g)/9$) where cooperation is the natural

outcome for the Individual, Competitive, and Aggression motives. An inducement system from this region has the potential for rewarding and reinforcing the behaviors that the business wishes to see in its sales force. This result is consistent with the finding that outside sales organizations often make use of special cash incentive and noncash incentive and recognition programs based on competition (Colletti, 1988).

Another organization may require a high degree of cooperation and an absence of internal competition to succeed. Such an organization might chose to use group incentives alone in or in combination with a low level of rewards and/or penalties to form an inducement system that results in cooperation for the Collective and Altruism motives. One such region is shown in Figure 63 ($1.0 < g < 10.0$, $r < (10-g)/9$) for inducement systems based on competitive rewards. This type of inducement system could be formed using a special cash incentive program for exceptional performance in combination with a gainsharing plan. This combination of incentives might be acceptable even in a unionized setting, where it is normally difficult to have any significant amount of employee compensation tied to individual performance.

The results from phases I and II should be viewed as a starting point in the selection of an inducement system for a real-world organization. The results are valuable from a heuristic standpoint in identifying the classes of

inducement systems that should be examined in greater detail. Of course, many other factors need to be considered before selecting an inducement system for real-world application (e.g. external job market, administration, senior management approval, degree of unionization, employee attitudes, etc.)

Phase III Results

The analysis performed in phases I and II is a static analysis. The natural outcomes that are given are based on the analysis of a single motive. Phase III extends the analysis by considering how the populations or frequencies of the six motives might evolve and how this evolution would affect the overall level of cooperation.

An analysis of the evolution of social motives requires that specific inducement systems be selected for modeling. The results of phases I and II were used to select the inducement systems to be modeled. These inducement systems were chosen based on costs and the number of social motives with cooperation as the natural outcome. Table IX shows the inducement systems selected for modelling, the motives that had cooperation as the natural outcome and the costs of the inducement system.

Fitness versus Satisfaction. Two models were developed for studying the evolution of social motives. One model takes the view that social motives evolve based on their

success in gaining material payoffs that increase the fitness of the individual. These are the payoffs which are

TABLE IX
INDUCEMENT SYSTEMS SELECTED
FOR MODELING IN PHASE III

<u>Class</u>			<u>Motives</u>	<u>Costs</u> (utiles)
<u>r</u>	<u>p</u>	<u>g</u>		
<u>Absolute</u>				
0	1.5	0	1,2,3,4	0.0
0.5	0	1.0	2,4	1.5
1.25	0	0.25	1,2,3,4	1.5
<u>Competitive</u>				
2.5	0	0	3,6	0.0
0	2.5	0	3,5,6	0.0
1.25	1.25	0	1,3,6	0.0
2.5	0	0.5	3,6	0.5
0	2.5	0.5	3,5,6	0.5
1.25	1.25	0.5	1,3,6	0.5
1.5	0	1.5	1,2,4,5	1.5
0	1.5	1.5	1,2,4	1.5
0.75	0.75	1.5	2,4	1.5
2.5	0	1.5	1,2,3,4	1.5
0	2.5	1.5	1 thru 5	1.5
1.25	1.25	1.5	1,2,3,4	1.5
2.5	2.5	1.5	1,2,3,6	1.5
<u>Group Incentives Only</u>				
0	0	0	none	0.0
0	0	0.5	4	0.5
0	0	1.5	2,4	1.5

1) Individual, 2) Collective, 3) Competitive, 4) Altruism, 5) Equity, 6) Aggression

reflected in the Individual motive. This model is labeled the "Fitness" model.

The second model treats the outcome preferences reflected by the motive as ends in themselves. The success of a motive is viewed in terms of its ability to gain

payoffs that satisfy the preferences of the motive. Preferences are assumed to be satisfied when the best possible (maximum available) outcome is achieved. Satisfying this preference is considered to be intrinsically rewarding. This model is labeled the "Satisfaction" model.

These models reflect two alternative explanations of how learning occurs within an organizational setting. The first model reflects the traditional approach of evolutionary game theory. The second is an attempt to fashion an alternative model that breaks from the normal assumptions of game theory, that individuals act to maximize their self-interests. The purpose of this portion of the study is to explore a new form of analysis made possible by the use of game theory. These models and their results should be viewed as a speculative attempt to widen our conceptual knowledge of motivation.

Results of Modeling. The two models (Fitness and Satisfaction) were used to analyze each of the inducement systems shown in Table IX. All of the analysis in phase III was made using a 10-person group. The initial frequencies (f) of each social motive were set equal ($f=0.167$) and the simulation models were run until the equilibrium frequency for each social motive was reached. The results from the simulations were plotted to show the evolution of the frequencies of the social motives and the level of cooperation. These graphs were prepared for each of the inducement systems shown in Table IX and are included in

Appendix C. The results from this phase of analysis are quite diverse. While it is not possible to review the results for each inducement system in detail, general observations can be made regarding the results for the various classes of inducement systems.

It is useful to begin with the three inducement systems based on group incentives only. As discussed earlier, these inducement systems are the limiting case ($r=0$, $p=0$) for the other classes of inducement systems. When the group incentive factor is also equal to zero, we have the base case inducement system. The only compensation to the individual is that which comes from base pay. This motive does not have cooperation as the natural outcome for any of the six social motives. For both the Fitness model and the Satisfaction model, the level of cooperation is zero throughout the simulation. Note that the frequencies of the motives change in the Satisfaction mode, but not in the Fitness model. In the Fitness model, the payoffs for the Individual motive are used to adjust the frequencies of all six motives. Because each motive defects, each motive receives the same payoff and the frequencies are unchanged from round to round. For the Satisfaction model, each motive uses the payoffs from its own motive (see Table III) to define its satisfaction relative to the other social motives (i.e. $(P_C(i) - P_{\max}(i)) / (P_{\max}(i) - P_{\min}(i))$). Since the degree of satisfaction is different for each motive, the

frequencies evolve from round to round even though each motive defects.

The other two inducement systems using group incentives are somewhat more interesting. While neither of these inducement systems result in cooperation for the Fitness model, the inducement system with $g=0.5$ does result in a partial level of cooperation ($c/n=0.28$) for the Satisfaction model. The results for the Satisfaction model ($r=0.0$, $p=0.0$, $g=0.5$) are shown in Figure 66. Note that the Individual and Altruism motives displace the other motives, even though one motive cooperates and the other motive defects. The steady-state level of cooperation is based on cooperation by the Altruism motive. The reason that this motive cooperates is that cooperation increases the payoff to others. The same rationale does not lead to cooperation, however, when the group incentive factor is increased to 1.5. The reason for this apparently contradictory result is that the payoff for altruism becomes relatively less satisfying than the payoff for aggression when g is increased to 1.5. As a result, the Aggression motive displaces the Altruism motive for this inducement system.

Three inducement systems using absolute rewards and penalties were also considered. Only three inducement systems were considered because the results for any two inducement systems are equivalent when the value of g and the sum of r and p are equal (e.g. $r=0.0$, $p=1.5$, $g=0.5$ is equivalent to $r=1.25$, $p=0.25$, $g=0.5$). Two of the inducement

Figure 66. Evolution of social motives for the satisfaction model based on group incentives ($r=0.0$, $p=0.0$, $g=0.5$).

systems have cooperation as the natural outcome for the Individual, Collective, Competitive and Altruism motives. For these inducement systems, both the Fitness and Satisfaction models lead to total cooperation ($c/n=1.0$) as the steady-state outcome.

A number of inducement systems based on competitive rewards and/or penalties were modeled. The four inducement systems using competitive rewards each resulted in an intermediate level of cooperation for both the Fitness model and the Satisfaction model. For the Fitness model, the steady-state level of cooperation was reached when $c/n=1-1/r$. This is the point where the payoffs for cooperation and defection are equal. When the simulation reaches this point, no further evolution of motives occurs. How quickly the model evolves to this point determines what motives remain. Figure 67 shows the results for $r=2.5$, $p=0.0$, $g=0.5$. Note how the level of cooperation fluctuates before settling down at the equilibrium frequencies. For the inducement system with $r=2.5$, $p=0.0$, $g=1.5$, the dynamics of the system are such that no steady-state was reached, even though several hundred rounds were eventually ran.

For the Satisfaction model, the steady-state outcome for three of the four inducement systems based on competitive rewards and penalties involved a cycle between two levels of cooperation. Figure 68 shows the results for the Satisfaction model and an inducement system based on competitive rewards ($r=2.5$, $p=0.0$, $g=0.0$). For this

Figure 67. Evolution of social motives for the fitness model based on competitive rewards ($r=2.5$, $p=0.0$, $g=0.5$).

Figure 68. Evolution of social motives for the satisfaction model based on competitive rewards ($r=2.5$, $p=0.0$, $g=0.0$).

inducement system, the level of cooperation jumps between 0.0 and 0.5 in successive rounds. The motive associated with this cyclic behavior is the Altruism motive. When the level of cooperation is low ($c/n=0.0$), the altruist increases the payoff the others by cooperating. When the level of cooperation is higher ($c/n=0.5$), the altruist improves the payoff to others by defecting. This cyclic behavior is unlikely in a real organization, since it is improbable that the actions of a large portion of the group would be synchronized.

Four inducement systems using competitive penalties were also analyzed. For these inducement systems, the steady-state levels of cooperation were found to vary depending upon the starting levels of cooperation. Recall that the payoffs for cooperation and defection for the Individual motive are equal when $c/n=1/p$. When the level of cooperation is less than $1/p$, then the payoffs for defection are greater than the payoffs for cooperation. This causes the frequencies of defecting motives to increase and ultimately results in complete defection ($c/n=0.0$) as the steady-state outcome. The converse occurs when the level of cooperation is greater than $1/p$. The frequencies of motives that cooperate increase and the steady-state outcome is total cooperation ($c/n=1.0$).

Figures 69 & 70 show the results for the Fitness model when $r=0.0$, $p=1.5$, $g=1.5$. Figure 69 has an initial level of cooperation of $c/n=0.5$, based on the natural outcomes for

Figure 69. Evolution of social motives for the fitness model based on competitive rewards ($r=0.0$, $p=1.5$, $g=1.5$) and an initial level of cooperation of $c/n=0.5$.

Figure 70. Evolution of social motives for the fitness model based on competitive rewards ($r=0.0$, $p=1.5$, $g=1.5$) and an initial level of cooperation of $c/n=0.83$.

the six social motives. In Figure 70, the initial level of cooperation was increased to 0.83 by making two additional motives first round cooperators. These motive would normally begin as defectors, since they have defection as the natural outcome. Observe how the change in the initial level of cooperation affects the steady-state level of cooperation. The use of the natural outcome to define the initial level of cooperation follows from the analysis done in phases I and II. Organizational practitioners should be sensitive to the fact that the success of a particular inducement system might depend on the starting level of cooperation in the organization. When the existing level of cooperation is low, it may not be practical to use competitive penalties to increase contributions.

Five inducement systems using competitive rewards and penalties were modeled. Each of these inducement systems had cooperation ($c=10$) as the steady-state outcome for the Fitness model. All but one of the inducement systems also had cooperation as the steady-state outcome for the Satisfaction model. Figures 71 & 72 show the results for an inducement system using competitive rewards and penalties ($r=2.5$, $p=2.5$, $g=1.5$). Figure 71 is based on the Fitness model and Figure 72 on the Satisfaction model. This inducement system is from a region where cooperation is the natural outcome for the Individual, Collective, Competitive and Aggression motives. Note that the Altruism motive has defection as the natural outcome for this region.

Figure 71. Evolution of social motives for the fitness model based on competitive rewards and penalties ($r=2.5$, $p=2.5$, $g=1.5$).

Figure 72. Evolution of social motives for the satisfaction model based on competitive rewards and penalties ($r=2.5$, $p=2.5$, $g=1.5$).

In Figure 71 (Fitness model), the level of cooperation quickly rises to 1.0. As discussed earlier (phase II), the high reward and penalty factors of this inducement system lead the Altruism motive to defect so that others will receive these rewards. This causes the frequency of this motive to rapidly diminish as the penalties decrease its payoffs. By contrast, the Equity motive immediately begins to mimic the behavior of the other motives in order to minimize the difference between its payoff and the payoffs others. This is an example of the tendency of this motive to follow the group norm.

In Figure 72 (Satisfaction model), the level of cooperation initially fluctuates and then returns to its starting level of 0.667. In the process, the frequency of the Altruism motive jumps to $f=0.33$. Over an extended period of time, the increased level of satisfaction for the Individual, Equity and Altruism motives displace the other motives entirely. In this example, the Equity and Altruism motives both succeed in establishing themselves in the final equilibrium populations. The fact that one defects while the other cooperates results in a partial level of cooperation as the steady-state outcome. Similar results occur whenever the reward and penalty factors exceed the group incentive factors. When this happens, the Altruism motive has defection as the natural outcome and this results in less than total cooperation as the steady-state outcome. As a result, it may be inadvisable to use competitive rewards and

penalties unless the group incentive factor is equal to or larger than the reward (and/or penalty) factor.

Implications to Organizations. The inducement systems analyzed in phase III show how the two models of organizational learning (Fitness and Satisfaction) can lead to different predictions about the stability of social motives. One way in which this study is useful is in identifying inducement systems where both models predict a high (or acceptable) level of cooperation as the steady-state. This is an additional criteria which can be used when selecting an inducement system. Inducement systems which lead to high levels of cooperation for both learning models should be more successful in gaining the cooperation of individuals within an organization. Table X shows the steady-state levels of cooperation for the Fitness model and the Satisfaction model for each of the inducement systems being studied. The most desirable inducement systems are those where the steady-state level of cooperation results in total cooperation ($c/n=1.0$) for both models. As an example, for inducement systems based on absolute rewards and/or penalties, the inducement system with $r=0.0$, $p=1.5$ and $g=0.0$ is preferred over the inducement system with $r=0.5$, $p=0.0$ and $g=1.0$, since only the former has steady-state values of c/n equal to 1.0 for both models.

TABLE X

EQUILIBRIUM LEVEL OF COOPERATION
FOR FITNESS AND SATISFACTION MODELS

<u>Class</u>			<u>Fitness</u>	<u>Satisfaction</u>
<u>r</u>	<u>p</u>	<u>g</u>	(c/n)	(c/n)
<u>Absolute</u>				
0	1.5	0	1.0	1.0
0.5	0	1.0	0.0	0.0
1.25	0	0.25	1.0	1.0
<u>Competitive</u>				
2.5	0	0	0.6	0.25
0	2.5	0	0.0	1.0
1.25	1.25	0	1.0	1.0
2.5	0	0.5	0.6	0.33
0	2.5	0.5	1.0	1.0
1.25	1.25	0.5	1.0	1.0
1.5	0	1.5	0.33	0.75
0	1.5	1.5	0.0	0.0
0.75	0.75	1.5	0.0	0.0
2.5	0	1.5		0.45
0	2.5	1.5	1.0	1.0
1.25	1.25	1.5	1.0	1.0
2.5	2.5	1.5	1.0	0.68
<u>Group Incentives Only</u>				
0	0	0	0.0	0.0
0	0	0.5	0.0	0.28
0	0	1.5	0.0	0.0

CHAPTER V

DISCUSSION AND CONCLUSIONS

This chapter summarizes the practical implications and theoretical significance of the results and methods and provides recommendations regarding further empirical and theoretical work. The results from the preceding analysis (see Chapter IV) are used to develop criteria for selecting inducement systems which should be effective in motivating individuals to make discretionary contributions towards the goals of the organization. Inducement systems meeting these criteria are identified for each of the six classes of inducement systems being studied. The most efficient inducement systems from these regions are identified based on the costs of the inducement system to the organization. Suggestions are made for applying the results to real-world organizations. The limitations of the study are discussed and suggestions are given for future empirical and analytical work.

This chapter also discusses the theoretical significance of the application of game theory to the study of inducement systems and social motives. The relationship of this work to expectancy theory and other theories based on social motives is presented and recommendations are given regarding further work needed to build an integrated theory

of motivation - one capable of incorporating a range of social motives.

Inducement System Design

Organizations are concerned with designing inducement systems which are both effective and efficient (Barnard, 1938). Inducement systems are effective when they motivate individuals to contribute their efforts towards the goals of the organization. Inducement systems are efficient when they use a minimum of organizational resources.

The results of the three phases of analysis given in Chapter IV can be used as selection criteria for designing inducement systems which motivate individuals to contribute to the organization. Many inducement systems will not meet all of these criteria. Those that do meet these criteria should be good candidates for consideration by organizational practitioners. They should not be used blindly, however. Inducement systems that meet all of the criteria may not fit a given organization, while other inducement systems might work very well. As noted by Lawler (1983), inducement systems should be designed so that they are congruent with the organization's structure, management philosophy, and decision making and communications styles.

The first phase of analysis was based on the Individual motive and the belief that individuals will seek to maximize their self-interest. Self-interest is one of the core assumptions of most theories of motivation. The importance

of the Individual motive leads to a selection criterion that requires inducement systems to have cooperation as the natural outcome for the Individual motive. The results from phase I give the regions where cooperation is the natural outcome for the six classes of inducement systems being considered. These results are summarized in Table V (see Chapter IV) and shown graphically in Appendix A. Inducement systems from these regions meet the criterion being discussed - that cooperation is the natural outcome for the Individual motive.

Two additional criteria from phase I can also be used to screen inducement systems. These are the satisficing criteria that: 1) cooperators receive satisfactory outcomes, and 2) defectors receive unsatisfactory outcomes. When these criteria are met, satisficing behavior (Simon, 1976) should not interfere with the natural outcome. The regions where these two criteria are met depend upon the level at which base pay is set. As such, organizational practitioners should be open to modifying base pay to meet these satisficing criteria. Table VIII shows the regions where both satisficing criteria are met, assuming no change in base pay. These regions are graphically depicted in Appendix A.

In phase II, five additional social motives were considered: 1) Collective, 2) Competitive, 3) Altruism, 4) Equity, and 5) Aggression. While the business goals of an organization may dictate a preference for some motives over

others (e.g. Collective vs. Competitive) in shaping the culture of the organization, most organizations would prefer an inducement system that promotes cooperation across as many social motives as possible. The general exception is the Aggression motive, which can be dysfunctional in many organizations. This is partly because a motive based on minimizing the payoffs to others is likely to have negative impacts that effect other areas of the business (e.g. customer relations, interpersonal communications, team-orientation). Additionally, inducement systems that have cooperation as the natural outcome for the Aggression motive typically have defection as the natural outcome for the other motives.

Given the potential problems with the Aggression motive, an appropriate criterion for selecting inducement systems is the number of social motives (excluding Aggression) that have cooperation as the natural outcome. Figures 60-65 summarize the natural outcomes for the social motives for the six classes of inducement systems being considered (see Chapter IV). These figures present the major results from phase II of the analysis. Other factors being equal, inducement systems from regions where cooperation is the natural outcome for the largest number of motives (excluding Aggression) are preferred.

In phase III, selected inducement systems were analyzed to determine the possible evolution of social motives. Two learning models were used to model candidate inducement

systems. One model (Fitness Model) interprets social motives as strategies for maximizing material payoffs. The other (Satisfaction Model) treats social motives as reflecting genuine preferences for social motives. Where both models lead to cooperation as the steady-state outcome, this outcome can be thought of as robust (i.e. a high level of cooperation would continue over many payoffs). The criterion that both models evolve to cooperation as the steady-state outcome is the final effectiveness criterion used in this study. A summary of the results from phase III for selected inducement systems are shown in Table X (see Chapter IV).

Each of the three phases of analysis provide possible selection criteria for choosing an organizational inducement system. These criteria are concerned with the potential effectiveness of inducement systems in gaining the cooperation of individuals with the goals of the organization. Each of these criteria can be used to screen inducement systems based on the ability of the inducement system to promote individual cooperation with the goals of the organization. The effectiveness criteria that were developed from each phase of the analysis are summarized in Table XI. Inducement systems that meet each of these criteria have the potential to be effective in promoting individual cooperation with the goals of the organization.

While primarily concerned with the issue of effectiveness, this study also examines the issue of efficiency. Efficiency is viewed in terms of the costs of

the inducement system to the organization. From the perspective of the organization, an inducement system is efficient if it promotes cooperation at the lowest cost to the organization. Cost curves for each of the classes of

TABLE XI

SUMMARY OF RECOMMENDED CRITERIA
FOR SELECTING ORGANIZATIONAL INDUCEMENT SYSTEMS

Phase I

Inducement systems should have cooperation as the natural outcome for the Individual motive.

The payoffs to cooperators for the Individual motive should be satisfactory when every individual cooperates.

The payoffs to defectors for the Individual motive should be unsatisfactory for all levels of cooperation by others.

Phase II

Inducement systems are preferred which have cooperation as the natural outcome for the largest number of social motives (excluding the Aggression motive).

Phase III

Inducement systems should evolve to total cooperation as the steady-state outcome for both the Fitness and Satisfaction models.

inducement system were developed earlier and are shown in Figures 48-50 (see Chapter IV). These cost curves can be used to find the least cost inducement system meeting the effectiveness criteria shown in Table XI. The inducement system meeting each of the effectiveness criteria and having the lowest cost should be of interest to organizations.

The least cost inducement system is, of course, not necessarily the best inducement system. The methods used in this study depend on an accurate measure of the costs that the individual assigns to their discretionary contributions and the utility of various inducements to the individual. Additionally, this study makes no allowances for differences among individuals. As a result, the organization is faced with significant uncertainties when setting the optimum values of the group and individual incentive factors. Organizations may, therefore, wish to select inducement systems with somewhat higher costs to ensure the cooperation of the majority of individuals in the face of these uncertainties.

The cost curves given in Figure 48 & 49 represent the costs of incentives given by the organization to cooperators. The units are based on the utility of those incentives to the cooperating individuals. In determining the costs that the organization is willing to pay to gain the cooperation of individuals, the organization must determine 1) the value of the discretionary contributions these incentives gain, and 2) the ability of the organization to pay those incentives. Organizations may be willing to pay a great deal for highly valued or scarce contributions. On the other hand, the organization may look to restructure its inducement systems to lower costs during times of financial emergency. These decisions depend on the specific conditions facing the organization.

The effectiveness and efficiency criteria described above can be applied to each of the six classes of inducement systems to select candidate inducement systems for use in an organization. Table XII summarizes the recommendations of this study regarding the selection of organizational inducement systems. This table indicates 1) the regions where each of the effectiveness criteria are met, 2) the parameters of the least cost inducement system, and 3) the costs of the least cost inducement system. The results for each class of inducement systems are discussed below.

Absolute Rewards. For inducement systems based on absolute rewards, the only inducement systems where each of the selection criteria is satisfied occur when the values of the reward factor (r) and the group incentive factor (g) are $r > 1.0$ and $g = 0.0$ (assuming no change in base pay). When $g > 0.0$ this class of inducement systems fails to meet the satisficing criteria which requires that defectors receive an unsatisfactory payoff. Fortunately, there is a relatively simple solution to this problem. By reducing base pay by g utiles, defectors will always receive an unsatisfactory payoff. The value of the reward factor (r) can then be adjusted to ensure that cooperators always receive a satisfactory payoff. This value is determined as follows:

$$C(n) = g(n/n) + r - 1 - g > 0.0$$

$$r > 1$$

TABLE XII
SUMMARY OF RECOMMENDATIONS
FOR SELECTING INDUCEMENT SYSTEMS
BASED ON EFFECTIVENESS AND EFFICIENCY CRITERIA

<u>Class</u>	<u>Effectiveness</u>	<u>Efficiency</u>			<u>Cost</u>
		r	p	g	
Absolute					
Rewards	$r > 1.0$ $g = 0.0$ or $g > 0.0$	1.0	-	0.0	1.0
(assuming base pay is lowered by g utiles)		1.0	-	g	1.0
Penalties	$p > 1.0$ $g > 1.0$ $p > g(n-1)/n$	-	1.0	0.0	1.0
Both	$(r+p) > 1.0$ $r+g > 1.0$ $(r+p)/2 > g(n-1)/n$	1.0 or 0.5	1.0 0.5	0.0 0.5	1.0 1.0
Competitive					
Rewards	none	N/A	N/A	N/A	N/A
Penalties	$p > 2.0$ $g > 1.0$ $p > g$	-	1.0	1.0	1.0
Both	$(r+p)/2 = g$ $g > 1.0$	1.0	1.0	1.0	1.0
r=rewards factor g=group incentive factor		p=penalty factor n=group size			

Figure 73 shows the regions where the effectiveness criteria are met for inducement systems based on absolute rewards. The cross-hatched area ($r > 1.0$) includes systems meeting each of effectiveness criterion listed in Table XI. These results are based on reducing base pay by g utiles. Inducement systems based on absolute rewards fall into this

Region meeting effectiveness criteria
(assuming base pay is reduced by g utiles).

Figure 73. Map of the region meeting effectiveness criteria for absolute rewards.

region when $r > 1.0$. When this condition is met four social motives have cooperation as the natural outcome, 1) Individual, 2) Collective, 3) Competitive, and 4) Altruism. Recall that the Equity motive has no unique solution for the natural outcome for this class for inducement systems. However, when $r = 1.0$ the inducement system falls on the equity line and payoffs will be equitable for all levels of cooperation. Also note that cooperators always receive a satisfactory outcome when $r > 1.0$.

The two inducement systems from this region which were analyzed in phase III resulted in cooperation ($c/n = 1.0$) as the steady-state outcome for both the Fitness and the Satisfaction models. These two inducement systems had design parameters of $p = 1.5$, $g = 0.0$ and $r = 1.25$, $g = 0.25$. As discussed in Chapter IV, the inducement system with $p = 1.5$, $g = 0.0$ is equivalent to an inducement system with $r = 1.5$, $g = 0.0$ for inducement systems based on absolute rewards and/or penalties.

Two types of absolute rewards used in organizations are sales commissions and piece rates. These incentives can be used with or without group incentives. A recent survey of sales and marketing organizations found that 65% of organizations with outside sales personnel used sales commissions to reward individuals (O'Dell, 1987). The median reward was 25% of base compensation. Incentive pay has also been used successfully in manufacturing businesses. Lincoln Electric has paid its employees on a piecework basis for

decades (Perry, 1988). In addition employees receive a year-end bonus based on their dependability, quality and output. Employee bonuses average 97.6% of regular earnings and Lincoln has not had a losing quarter in 54 years.

Commissions and piece rates benefit from the fact that they both have objective and measurable outputs. Because commissions and piece rates are generally set in advance, individuals have a high degree of certainty that their performance will result in known outcomes. This results in clearly defined goals and high performance-outcome expectancies ($P \rightarrow O$).

Another common form of individual rewards is merit pay. In many organizations, employees receive merit increases based on meeting established goals and objectives. These goals and objectives are often tailored to the specific tasks and responsibilities of the individual and can include both objective and subjective measures. A problem with merit pay incentive systems is that merit pay tends to become viewed as a part of base compensation. As a result, pay is rarely reduced, even when performance falls. Employees often receive annual merit increases until they reach the top of their salary range. "Topping out", as it is known, leads to morale and motivation problems for long-term employees in a given pay classification.

Lawler (1983) has recommended that organizations consider using lump sum merit increases to help preserve the effectiveness of incentive rewards. Lump sum merit increases

reward individuals based on their individual performance. Unlike most merit pay systems, these rewards do not add to the individual's base pay but are paid as a separate bonus. By requiring that individuals earn their bonus each performance period, lump sum merit increases help preserve the effectiveness of the reward.

If base pay is not reduced, the addition of group incentives increases the cost of the inducement system over the least cost inducement system. However, when no group incentives are used, individuals are indifferent between defection and cooperation for the Altruism motive. As a result, individuals may be more likely to sacrifice group interests for individual interests. Organizations using absolute rewards may wish to include group incentives in order to reinforce cooperation by this motive. This can be done without increasing costs if base pay is reduced by g utiles. One of the gainsharing type group incentives could be effective for this purpose (e.g. Rucker, Improshare, Scanlon). The use of group incentives would also increase the salience of the Collective motive. When group incentives are built around an employee participation process, they can be very effective in promoting teamwork and cooperation (Doyle, 1983).

Absolute Penalties. The region where each of the selection criteria are satisfied for inducement systems using absolute penalties has values of p and g such that $p > 1.0$, $p > g(n-1)/n$ and $g > 1.0$ (see Table XII). The penalty

factor must be greater than 1.0 to ensure cooperation by the Individual, Collective, Competitive and Altruism motives. The penalty factor must also be greater than $g(n-1)/n$ to ensure that defectors receive an unsatisfactory payoff. Because there are no rewards for cooperation, the group incentive factor must be greater than 1.0 to ensure that the natural outcome results in a satisfactory payoff for cooperators.

Figure 74 shows the region where the effectiveness criteria are met for inducement systems based on absolute penalties. The higher group factor ($g > 1.0$) for this class of inducement systems causes the least cost inducement system to have the same costs per cooperator that were found for inducement systems using absolute rewards. In general, the minimum cost per cooperator must be at least 1.0 utiles to offset the costs to the individual from cooperating.

Inducement systems meeting the above criteria have cooperation as the natural outcome for the Individual, Collective, Competitive and Altruism motives. The higher level of group incentives needed for this class of inducement systems should be beneficial to organizations trying to promote the Collective and Altruism motives. Note that the high penalty factors would also act to eliminate defectors from the organization due to the unsatisfactory outcomes that they would receive.

One important observation about this class on inducement systems is that unless the group incentive factor

Figure 74. Map of the region meeting effectiveness criteria for absolute penalties.

is greater than one ($g > 1.0$), cooperators will be dissatisfied. This dissatisfaction might affect overall performance, even though the individual cooperates with respect to the parameter used to measure contributions.

Another difficulty with the use of penalties is that many supervisors are unable to use them effectively. Confronting an employee and taking away compensation is a difficult supervisory task. Too little attention has been given to the communication, interpersonal and psycho-social skills needed to effectively implement various inducement systems, particularly those involving penalties. The use of any monetary penalties (absolute or competitive) should only be considered if their use is consistent with the level of training and skills of supervisors.

The problems associated with lowering pay may lead some organizations to consider using noncash penalties. For example, posting production or sales records or using a progressive discipline procedure are penalties that could be used in lieu of monetary penalties. These types of incentives might be particularly effective in eliminating low performers from the organization while preserving a major portion of total compensation for group incentives.

Absolute Rewards and Penalties. The region of interest for inducement systems using absolute rewards and penalties has values of r , p and g such that $(r+p) > 1.0$, $(r+p)/2 > g(n-1)/n$ and $(r+p)/2 + g > 1.0$ (see Table XII). This region is shown in Figure 75. A number of least cost

Region meeting effectiveness criteria.

Figure 75. Map of the region meeting effectiveness criteria for absolute rewards and penalties.

inducement systems can be selected from this region. This is because inducement systems along the boundary where $(r+p)/2+g=1.0$ all have costs of 1.0 utiles per cooperator. The practitioner can, therefore, choose whether or not to include group incentives without increasing the costs to the organization. As an example, the inducement systems $r=1.0$, $p=1.0$, $g=0.0$ and $r=0.5$, $p=0.5$, $g=0.5$ each have a cost of 1.0 utiles.

Organizations should give consideration to basing their inducement systems on absolute rewards and penalties. This class of inducement systems has many of the best features on inducement systems based on absolute rewards or penalties. As an example, lump sum merit increases could be combined with noncash penalty systems (e.g. discipline) and a gainsharing program. This type of inducement system would encourage defectors to improve their performance or leave the organization while providing strong motivation for individual and group performance.

Competitive Rewards. Inducement systems using competitive rewards have no region where each of the selection criteria are met. This result occurs because there are no penalties to defectors and because there are no rewards to cooperators when each individual cooperates. For inducement systems using absolute rewards, this problem was corrected by decreasing base pay by $g(n-1)/n$ utiles. Because there are no competitive rewards when each individual cooperates (i.e. $\text{reward}=r(1-c/n)=0$), a positive payoff for

cooperators can only be achieved by increasing the group incentive such that $g > 1.0$. For this category of games, it is impossible to meet both of the satisficing criteria, since g must be greater than 1.0 ($g > 1.0$) for cooperators to receive a satisfactory payoff and g must be 0.0 ($g = 0.0$) for defectors to receive an unsatisfactory payoff.

This class of inducement systems also fails to meet the criterion that both learning models lead to cooperation ($c=n$) as the equilibrium outcome. None of the four inducement systems modeled ($g < n$) resulted in cooperation as the equilibrium outcome for either the Fitness Model or the Satisfaction Model.

The use of competitive rewards should not be discarded entirely. These types of rewards can be particularly effective because of their high visibility within an organization. Public awards based on outstanding performance have symbolic as well as motivational impacts on the organization. Competitive rewards can also be used in conjunction with absolute rewards and/or penalties to form hybrid inducement systems. In general, it may be preferable to use competitive rewards on an unannounced basis to reward past performance, rather than using them as the basis of contests for future rewards. While this would lower the motivational value of these rewards, it would increase their symbolic value and avoid situations where competition between individuals damages group performance.

Despite the problems with competitive rewards noted by others (Kohn, 1987), this type of incentives has gained some acceptance in sales organizations (O'Dell, 1987; Colletti, 1988). These inducement systems take the form of special cash incentives, noncash incentives and recognition programs. The basis of the payment can be competing against others or competing against the past performance level of the individual. These incentives are often based on subjective measures such as supervisory or peer rankings. In general, only 5-10% of individuals receive rewards under these programs (O'Dell, 1987). It should be noted that sales organizations often have limited need for cooperation between outside sales representatives.

One problem with competition based on management discretion is that individuals may have a low expectation that a given level of performance will result in the payment of the rewards. This reduces the performance-outcome expectancy and may limit the effectiveness of this type of reward (O'Dell, 1987). Peer rankings generally have a higher degree of accuracy and reliability (Latham & Wexley, 1981) and should improve the $[P \rightarrow O]$ expectancy. One such inducement system would be a merit pool where payoffs are based on peer rankings and where the size of the merit pool is tied to group performance. This is a hybrid type of system including elements of group and individual incentives.

The use of internal competition to improve productivity has been quite controversial. Kohn (1987) has argued strongly against all forms of internal competition and has stressed the importance of cooperation and coordination in improving performance. Based on the research reviewed by Kohn (1987), he states that competition: 1) increases anxiety, 2) decreases innovation, 3) restricts the flow of information, and 4) limits the sharing of resources. Other management authors (Kanter, 1987; and Peters, 1988) see competition as potentially useful in certain situations, particularly those involving competing work groups. Peters cites the excellent results achieved by General Motors at their New Unified Motor Manufacturing Inc. (NUMMI) auto plant, based in part on competing work groups.

The results from this study indicate partial support for Kohn's position. By themselves, competitive rewards did not result in cooperation as the natural outcome for the Individual, Collective or Altruism motives. Instead, the only motives with cooperation as the natural outcome were the Competitive and Aggression motives. When no group incentives are used, this class of inducement systems is ineffective in promoting cooperation. With the exception of sales organizations, where cooperation between individuals is not required, the use of competitive rewards is likely to lead to dissatisfied workers and at best a partial level of group cooperation. In fairness to Peters, this study did not consider inducement systems based on group competition. The

results do, in fact, point to the need for group incentives when competitive rewards and penalties are used. Further work is needed to determine the effectiveness of incentives based on group competition.

Competitive Penalties. For inducement systems based on competitive penalties, the region meeting the two satisficing criteria has values of p and g such that $g > 1.0$, $p > 2.0$, and $p > g$. This region is shown in Figure 76. Because costs depend only upon the size of the group incentive factor, the practitioner can choose differing levels of penalties without incurring any added costs. This is important in selecting an inducement system that has cooperation as the natural outcome for the largest number of social motives. Figure 64 (see Chapter IV) shows the summary map of social motives for inducement systems using competitive penalties. When $p > 2.0$ all of the motives, except the Aggression motive, have cooperation as the natural outcome. However, when $p < 2.0$ then only three motives have cooperation as the natural outcome, 1) Individual, 2) Collective, and 3) Altruism.

Some caution should be given regarding the use of high competitive penalty factors. First, managers are often reluctant to administer penalties. The effectiveness of the inducement system will be severely undercut if managers fail to deliver these penalties. Second, errors in determining cooperators from defectors might result in cooperators being unfairly penalized. This could have undesirable consequences

Figure 76. Map of the region meeting effectiveness criteria for competitive penalties.

on future motivation. The need for well-trained managers and accurate evaluation systems cannot be overemphasized when penalties are used as part of the inducement system. In general, the problems noted for inducement systems using absolute penalties are also applicable to inducement systems using competitive penalties.

Another point which should be made about these inducement systems is that when $g < n$ the equilibrium outcome (cooperation or defection) depends on the initial level of cooperation. When the level of cooperation is less than $1/n + (1-g/n)/p$, defection is the natural outcome. This result is consistent with the results for the two simulation models used in phase III. Complete cooperation ($c/n=1.0$) was the steady-state outcome only when the initial level of cooperation was greater than $1/n + (1-g/n)/p$. Note that when the level of group cooperation is less than $1/n + (1-g/n)/p$, it may be inadvisable to introduce competitive penalties.

Competitive penalties are not generally included as a formal part of inducement systems. Instead, they tend to be part of the informal inducement system of the organization and take the form of discipline, demotion and layoffs. A novel program for improving attendance is based on providing attendance coaching to the workers with the worst attendance each month. Attendance records are posted each month and the employees with the worst attendance sent to the manager's office for a discussion of how the employee can improve his

attendance. Failure to improve can result in discipline and eventual termination.

Competitive penalties also operate in consulting organizations and universities where low performers are often forced to leave the organization. Advancement or tenure are often based on competing against others in similar positions. These informal penalty systems are reflected in sayings like "up or out" and "publish or perish".

Competitive Rewards and Penalties. The inducement systems meeting the two satisficing criteria for the class of inducement systems based on competitive rewards and penalties have values of r , p and g such that $(r+p)/2 > g$ and $g > 1.0$ (see Table XII). Because costs are independent of the size of the reward and penalty factors when $c/n = 1.0$, the practitioner can set these values without being overly concerned about costs.

Unfortunately, when $(r+p)/2 > g$ the Satisfaction model has a steady-state level of cooperation of less than 1.0 ($c/n < 1.0$). Additionally, when $(r+p)/2 > g$ the motives that have cooperation as the natural outcome include the Aggression motive. If the inducement system designer wishes to avoid the Aggression motive, then he needs to set the value of $(r+p)/2$ less than g . The Altruism motive then becomes one of the motives with cooperation as the natural outcome. However, when $(r+p)/2 < g$ the payoff to defectors is positive. The compromise is to set $(r+p)/2 = g$. Inducement

systems meeting these criteria are shown in Figure 77. These inducement systems then are indifferent to both the Aggression and Altruism motives. In practice, the use of competitive rewards and penalties requires that the organization abandon either the criterion that defectors receive an unsatisfactory outcome or the criterion that both simulation models lead to total cooperation as the steady-state outcome.

One interesting feature of this class of inducement systems is that even when $g < 1.0$ the natural outcome is cooperation, provided that $(r+p)/2 > (n-g)/(n-1)$. Reducing g to less than 1.0 results in negative payoffs to cooperators, but cooperation remains the natural outcome for this Category II region. These are reverse prisoner's dilemma games. While this region does not meet the criterion that cooperators receive a satisfactory outcome, these inducement systems have cooperation as the natural outcome for the Individual, Competitive and Aggression motives and have costs of less than 1.0 utiles. This region may be of interest to organizations that can tolerate a high degree of turnover or wish to promote the Competitive and Aggression motives. Another potential use of these types of rewards and penalties is to combine them with absolute rewards and penalties. More work is needed to investigate these hybrid classes of inducement systems.

In general, the problems which were noted for competitive rewards or competitive penalties also hold for

— Region meeting effectiveness criteria.

Figure 77. Map of the region meeting effectiveness criteria for competitive rewards and penalties.

inducements systems based on competitive rewards and penalties. The use of penalties is problematic in most organizations. Penalties, particularly monetary penalties, require a high level of supervisory training and skills. As noted by Kohn (1987), competition has serious side-effects which can cause performance problems in organizations.

Organizational Implications. Based on the results for the six classes of inducement systems, the use of absolute rewards and/or penalties is recommended over the use of competitive rewards and/or penalties. No inducement systems were found which met all of the selection criteria for inducement systems based on competitive rewards. For inducement systems based on competitive rewards and penalties, the organization must choose between a partial level of cooperation and allowing defectors to receive a satisfactory outcome. While inducement systems based on competitive penalties met each of the selection criteria when $p > 2.0$, $g > 1.0$ and $p > g$, there are problems in administering penalties and general concerns over the side-effects of competition. While competitive rewards and penalties can be effective in cases where high turnover is acceptable and where there is little need for the coordination of activities (e.g. outside sales representatives), the general use of competitive rewards and penalties is not recommended. More work is needed to look at hybrid systems of absolute and competitive rewards and

penalties and other form of competition, particularly group competition.

Inducement systems based on absolute rewards and/or penalties were found to be quite effective in gaining the contributions of individuals. A broad range of inducement systems were found that meet each of the selection criteria, although some adjustment in base pay was required for inducement systems based on absolute rewards. This class of inducement systems allow the designer a great deal of discretion in balancing individual and group incentives.

One attractive option would be to lower base pay by g utiles and use gainsharing plus lump sum merit increases as the basis of the group and individual incentives. Base pay would need to be lowered by g utiles and the reward opportunity set at greater than 1.0 utiles. In sales or piece work organizations, where a high degree of coordination is not required, the group incentive factor could be dropped and lump sum merit increases replaced by a sales commission or piece rate. If penalties are desired, they could be noncash penalties, such as coaching and discipline, rather than monetary penalties.

Motivation Theory

The work done in this study has applicability beyond the analysis of organizational inducement systems. The addition of game theoretic methods represents a potentially powerful expansion of motivation theory. These methods make

possible an analysis of the motivation of groups of individuals rather than being restricted to dealing only with single individuals. These methods also provide a framework for integrating expectancy theory, equity theory and other theories of motivation based on social motives.

The approaches of expectancy theory and game theory are closely related. Both approaches assume that individuals will make choices that maximize their self-interest. In expectancy theory, the expected value or payoff from actions are based on the conditional probabilities (i.e. expectancies) that a chosen level of effort will result in outcomes of differing preferences (i.e. valences). Two sets of probabilities are involved: 1) the probability that a level of effort will result in a specified level of performance ($E \rightarrow P$), and 2) the probability that the level of performance will result in certain outcomes ($P \rightarrow O$). The general formulation of expectancy theory is that the motivational force is equal to $[E \rightarrow P][P \rightarrow O]V$, where V is the valence of the outcomes to the individual (Vroom, 1964).

This study has assumed that the individual's choice to contribute discretionary effort results in the outcomes specified by the inducement system. This implies means that the motivational force depends only upon the valence of the outcomes and that $[E \rightarrow P]=1.0$ and $[P \rightarrow O]=1.0$. The simplified approach used in this study can be modified to incorporate the $[E \rightarrow P]$ and $[P \rightarrow O]$ probabilities of

expectancy theory. The payoffs for cooperation and defection become:

$$C(c)=[E_C \rightarrow P_C][P_C \rightarrow O_C]V_C$$

$$D(c)=[E_D \rightarrow P_D][P_D \rightarrow O_D]V_D$$

The term $[E_C \rightarrow P_C]$ is the expectancy or probability that cooperation (an effort of 1.0 utiles) will result in the level of contributions (i.e. performance) defined as cooperation. Since there is no discretionary effort associated with defection, $[E_D \rightarrow P_D]$ is equal to 1.0. The term $[P_C \rightarrow O_C]$ is the expectancy that the level of performance defined as cooperation will result in the specified payoffs for cooperation. The term $[P_D \rightarrow O_D]$ is the expectancy that the level of performance defined as defection will result in the specified payoffs for defection. The terms V_C and V_D are the valences or utilities of the outcomes from cooperation (including the cost of the effort to cooperate) and defection. These are the payoffs shown in Table II for the six classes of inducement systems. While this study considers only two levels of effort, a more complete analysis would consider a number levels of effort and contributions. With these additions, the game theoretic approach used in this study is consistent with expectancy theory.

As noted by Pfeffer (1982), expectancy theory takes the individual as the unit of analysis. A criticism of expectancy theory is that it ignores the organizational and social environment. Defenders of expectancy theory might

argue that these influences are reflected in the expectancies and valences that individuals assign to actions and outcomes. However, absent a theoretical basis for predicting how the social and organizational environment influences expectancies and valences, expectancy theory will have limited applicability in real-world organizations. This is an important and fundamental criticism of expectancy theory.

The application of game theory to the study of organizational inducements provides a framework for expanding expectancy theory to incorporate elements of the social and organizational environment. The approach outlined in this study does this in two ways. First, it incorporates the choices of others into the decision making model. By including the effects of choices by others on the payoffs to self, the individual is able to make choices that reflect the interdependencies present in organizations. Game theory provides a richer and more realistic framework for understanding individual choice within organizations.

Second, game theory expands expectancy theory by incorporating additional social motives that can arise in organizations. Expectancy theory is unable to provide an explanation for the socially motivated behaviors that occur in organizations. The development of equity theory is an attempt to incorporate social motives into motivation theory. The application of game theory to the study of organizational inducements provides a common framework for

integrating a variety of social motives into the general approach of expectancy theory. Identifying a framework for integrating two of the important cognitive theories of motivation is an important outcome from this study.

It should be noted that the use of payoff matrices and curves does not change the assumption that motivation is a within-person process. Individuals still make choices between alternative actions based on their personal analysis of the payoffs to self and others.

Future Research

The work done in this study breaks new ground in the areas of inducement system design and motivation theory. The results of this study also point out the need for further empirical and theoretical research.

Empirical work is needed to 1) test the recommendations on inducement system design, and 2) determine whether the use of game theory and incorporation of social motives increase the predictive ability of expectancy theory. Before adopting the inducement systems recommended earlier, it would be appropriate to determine whether existing data support those recommendations. A broad survey of the relative success of companies and the type of inducement systems being used in those companies is needed.

The application of this study to the design of inducement systems will also require that a common utility scale for measuring both contributions and efforts be

developed. Initially, it may be expedient to equate a percentage increase in contributions with a percentage increase in total compensation (e.g. a 10% increase in contributions is just offset by a 10% increase in total compensation). This approach will probably be satisfactory when the contributions equate to added hours of work or a higher piece rate. Problems are likely to be encountered when the discretionary effort involves issues like quality, customer interaction, or innovation. In the long run, more information about the relative value of contributions to various inducements is needed. Additionally, the work of Deci (1971) makes it clear that further work is needed to deal with the potential effect of extrinsic rewards (e.g. pay) on the individual's level of intrinsic motivation. While these problems are common to any theory of organizational inducements, they limit the application of the results from this study in designing organizational inducement systems.

Another needed piece of empirical work is to determine whether the incorporation of social motives increases the predictive ability of expectancy theory. This work will require that instruments be developed to measure the relative weights of the various social motives within individuals. The use of before and after tests might also shed some light on the evolution of social motives. Like past research on motivation, this research should begin with laboratory testing to refine instruments and methods.

Research could then be expanded to experiments outside of the laboratory.

In addition to empirical research, further theoretical research is needed. Several simplifying assumptions were used in this study. In particular, only two level of contributions were considered in the analysis. Expanding the analysis to include additional levels of cooperation would show whether the results are affected when individuals are free to contribute at a variety of performance levels.

A second simplifying assumption used in phases I & II was to treat each individual as having identical preferences. A more realistic but less tractable assumption would be to treat individuals as having differing preferences. Such an analysis can become quite complicated when more than two individuals are considered. It may be the case, however, that individuals assign one set of preferences to themselves while attributing another set to others. If a single set of preferences could be attributed to others, the analysis of the n-person case would be manageable. The attribution of different motives to others is consistent with attribution theory, and might be significant in organizational settings.

Further analysis is also needed to look into other forms of inducements. In particular, additional analysis is needed to investigate hybrid inducement systems using both competitive and absolute rewards and/or penalties.

Inducement systems based on competition between group rather than individuals should also be investigated.

Additional work is also needed to integrate the various social motives into a single theory of motivation. The work done in this study provides a common framework for analyzing social motives. The results of phase II indicate the number of social motives with cooperation as the natural outcome. Further work is needed to integrate these motives into a common scale representing the motivational force on the individual.

One approach would be to treat the motives as separate attributes of the possible outcomes. If the relative importance of each of the motives to an individual was known, then the relative motivational force of the various outcomes could be developed using an approaches like multiutility attribute theory or multiple criteria decision making (Zelany, 1982). Both of these approaches would treat the social motives as attributes of the decision to cooperate or defect. In multiutility attribute theory, the utility of each attribute (i.e. social motive) is treated separately. The attributes are assumed to be independent, so that the utility of any outcome is equal to the sum of the utilities from the individual attributes. The utility functions for cooperation and defection for each attribute are given by the payoff functions for each social motive, $C_i(c)$ and $D_i(c)$ (see Table III). Following the approach of expectancy theory, the motivational force for cooperation

and defection would be represented by the combined utility functions $\text{Sum}(w_i C_i(c))$ and $\text{Sum}(w_i D_i(c))$, where:

w_i =relative weight of motive i .

In multiple criteria decision making, the best values of each attribute (i.e. $P_{\max}$) are determined from the set of possible outcomes. These best or ideal values are used to construct the hypothetical displaced ideal or bliss point. Each outcome is then evaluated based on its distance from the displaced ideal. These distances are weighted for the importance of the social motives to the individual. The motivational force for an outcome could then be based on the weighted distance of the available outcomes from the displaced ideal. The closer the outcome, the greater its motivational force. Additionally, it might be possible to use this approach to include attributes associated with intrinsic motivation. This could shed light on the problem of the interaction of extrinsic and intrinsic motivation (Deci, 1971).

The portion of this study that could most benefit by additional theoretical research is the work done in Phase III on the evolution of social motives. This exploratory work only begins to scratch the surface of the work that might be done in developing a dynamic model of motivation and social motives. One extension would be to incorporate a memory factor into the simulation models. This would allow individuals to make predictions about the future based on a more complete history of prior outcomes. This might

eliminate some of the cycling behavior noted in the simulation models. The inclusion of a memory factor would also make the model consistent with the relative payoff sum model developed by Harley (1981).

Another logical extension of the work done in phase II would be to integrate the two learning models (Fitness and Satisfaction) into a single model. This integration could be accomplished by assigning weighting factors to each of the social motives. The strength of the weighting factors for the Individual motive would represent the importance of the material payoffs (Fitness model) to the individual. The weights of the other social motives would represent the individual's genuine preferences for the other social outcomes (Satisfaction model). These weights could then be assumed to evolve based on how well the motives preferences are satisfied. The measure of "satisfaction" could be defined using an interval scale based on the maximum and minimum values of the attribute for the set of possible outcomes. Such an approach would allow individuals to adjust the importance they assign to motives based on a need to reduce the dissonance between actual and desired outcomes. This approach would mesh nicely with methods and assumptions used in multiple criteria decision making. It would also be consistent with the individual's need to reduce their cognitive dissonance (Festinger, 1957).

Summary

The methods of game theory have been used in this study to analyze organizational inducement systems and social motives. Starting with the concept of the inducements-contributions contract, six classes of inducement systems were formulated into mathematical terms. These inducement systems cover a broad range of individual and group incentives that organizations might use to gain the cooperation of individuals with the goals of the organization.

The classification scheme developed by Rappaport and Guyer (1966) for 2-person games was modified for use in determining the natural outcome for uniform n-person games. Beginning with the Individual motive, based on maximizing self-interest, the classification scheme was used to analyze the six classes of inducement systems and determine the values of the individual reward and penalty and group incentive factors that would result in cooperation as the natural outcome. An additional analysis of this motive was done based on the satisficing theory of Simon (1976).

This game theoretic analysis was repeated for five additional social motives, 1) Collective, 2) Competitive, 3) Altruism, 4) Equity, and 5) Aggression. The combined results indicate the values of the individual reward, penalty and group incentive factors needed to achieve cooperation as the natural outcome for these social motives. For the idealized inducement systems treated in this study,

these results allow the determination of the inducement systems parameters that will promote cooperation with the organization over a range of social motives.

Two dynamic learning models were developed to determine whether cooperation would be stable and to explore the possible evolution of social motives within a given inducement system. One model assumes that social motives are strategies for maximizing material payoffs. The other model treats social motives as genuine preferences for social outcomes. These two simulation models were run until equilibrium conditions were reached. Together with the earlier results from the study, these simulations were used to recommend inducement systems of potential interest to organizational practitioners.

The work described above was used to develop a set of selection criteria (see Table XI) for choosing inducement systems which should be effective in promoting individual cooperation with the goals of the organization. These criteria were applied to the six classes of inducement systems to determine the values of the reward, penalty and group incentive factors required for an inducement system to meet each of the effectiveness criteria. These results are shown in Table XII, along with the least cost inducement system. The practical implications of the results were discussed for each class of inducement systems. In general, inducement systems based on absolute rewards and/or penalties were found to be more effective than were

inducement systems based on competitive rewards and/or penalties. Suggestions were given for applying the results to the design of organizational inducement systems.

In addition to providing insights into the design of organization inducement systems, this study makes contributions to the theory of motivation. The application of game theory allows the general approach of expectancy theory to be expanded to include the outcomes and decisions of others in the organization. This extends the unit of analysis beyond the individual to include others in the organization.

A second theoretical contribution of the study is the incorporation of social motives into a framework consistent with expectancy theory. The expansion of expectancy theory to include social motives is a potentially powerful expansion of the theory. The analytical framework provided by this study should allow for a common scale of motivational force to be developed which incorporates a range of social motives. Multiple criteria decision making (Zelany, 1982) is suggested as a method for building this integrated theory of motivation.

A third theoretical contribution of the study is the application of methods from evolutionary game theory to the development of two learning models of motivation. These models are dynamic models of motivation that allow the level of cooperation and frequencies of social motives to evolve.

These models should be viewed as a speculative effort towards developing a dynamic model of motivation.

Lastly, this study illustrates how game theory can be used to integrate ideas from organization theory, social psychology and theoretical biology to explore questions about social motives and the design of organizational inducements. This illustrates the ability of general systems theory to contribute to the knowledge base at the levels of both theory and practice.

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APPENDIX A

PHASE I RESULTS

This appendix contains maps showing the natural outcome and game category for six classes of inducement systems based on the Individual motive. These are followed by maps showing the results of the satisficing analysis for initial cooperators and initial defectors.

Cooperate

Natural Outcome

Defect

Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Individual Motive - Absolute Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Individual Motive - Absolute Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Individual Motive - Absolute Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Individual Motive - Competitive Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Individual Motive - Competitive Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Individual Motive - Competitive Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

**Satisficing - Initial Cooperators
Absolute Rewards**

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

**Satisficing - Initial Defectors
Absolute Rewards**

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

Satisficing - Initial Cooperators
Absolute Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

Satisficing - Initial Defectors
Absolute Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

**Satisficing - Initial Cooperators
Absolute Rewards & Penalties**

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

Satisficing - Initial Defectors
Absolute Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

**Satisficing - Initial Cooperators
Competitive Rewards**

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

**Satisficing - Initial Defectors
Competitive Rewards**

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

**Satisficing - Initial Cooperators
Competitive Penalties**

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

**Satisficing - Initial Defectors
Competitive Penalties**

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

Satisficing - Initial Cooperators
Competitive Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Satisficing Behavior based on initial cooperation/defection

**Satisficing - Initial Defectors
Competitive Rewards & Penalties**

APPENDIX B

PHASE II RESULTS

This appendix contains maps showing the natural outcome and game category for six classes of inducement systems based of five social motives: 1) Collective, 2) Competitive, 3) Altruism, 4) Equity, and 5) Aggression.

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Collective Motive - Absolute Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Competitive Motive - Absolute Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Altruism Motive - Absolute Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Equity Line		

Equity Motive - Absolute Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Aggression Motive - Absolute Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Collective Motive - Absolute Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Competitive Motive - Absolute Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Altruism Motive - Absolute Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Equity Line		

Equity Motive - Absolute Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Aggression Motive - Absolute Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Collective Motive - Absolute Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Competitive Motive - Absolute Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Altruism Motive - Absolute Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Equity Line		

Equity Motive - Absolute Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Aggression Motive - Absolute Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Collective Motive - Competitive Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Competitive Motive - Competitive Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Altruism Motive - Competitive Rewards

Cooperate

Natural Outcome

Defect

Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Equity Motive - Competitive Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Aggression Motive - Competitive Rewards

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Collective Motive - Competitive Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Competitive Motive - Competitive Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Altruism Motive - Competitive Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Equity Motive - Competitive Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Aggression Motive - Competitive Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Collective Motive - Competitive Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Competitive Motive - Competitive Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Altruism Motive - Competitive Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Equity Line		

Equity Motive - Competitive Rewards & Penalties

Cooperate	Natural Outcome	Defect
Dominating Strategy - Pareto Equilibrium (Category I)

Dominating Strategy - Deficient Equilibrium (Category II)

No Dominating Strategy - Pareto Equilibrium (Category III)

No Dominating Strategy - Non-equilibrium (Category IV)

Aggression Motive - Competitive Rewards & Penalties

APPENDIX C

PHASE III RESULTS

This appendix contains graphs showing the evolution of social motives for selected inducement systems based on the results from two simulation models: 1) Fitness model, and 2) Satisfaction model.

Evolution of Motives - Fitness Model
Absolute Penalties ($p=1.5$, $g=0.0$)

Evolution of Motives - Satisfaction Model
Absolute Penalties ($p=1.5$, $g=0.0$)

Evolution of Motives - Fitness Model
Absolute Rewards ($r=0.5$, $g=1.0$)

Evolution of Motives - Satisfaction Model
Absolute Rewards ($r=0.5$, $g=1.0$)

Evolution of Motives - Fitness Model
Absolute Rewards and Penalties ($r=1.25$, $p=0.0$, $g=0.25$)

Evolution of Motives - Satisfaction Model
 Absolute Rewards and Penalties ($r=1.25$, $p=0.0$, $g=0.25$)

Evolution of Motives - Fitness Model
Competitive Rewards ($r=2.5$, $g=0.0$)

Evolution of Motives - Satisfaction Model
Competitive Rewards ($r=2.5$, $g=0.0$)

Evolution of Motives - Fitness Model
Competitive Penalties ($p=2.5$, $g=0.0$)

Evolution of Motives - Satisfaction Model
Competitive Penalties ($p=2.5$, $g=0.0$)

Evolution of Motives - Fitness Model
 Competitive Rewards and Penalties ($r=1.25$, $p=1.25$, $g=0.0$)

Evolution of Motives - Satisfaction Model
 Competitive Rewards and Penalties ($r=1.25$, $p=1.25$, $g=0.0$)

Evolution of Motives - Fitness Model
Competitive Rewards ($r=2.5$, $g=0.5$)

Evolution of Motives - Satisfaction Model
Competitive Rewards ($r=2.5$, $g=0.5$)

Evolution of Motives - Fitness Model
Competitive Penalties ($p=2.5$, $g=0.5$)

Evolution of Motives - Satisfaction Model
Competitive Penalties ($p=2.5$, $g=0.5$)

Evolution of Motives - Fitness Model
 Competitive Rewards and Penalties ($r=1.25$, $p=1.25$, $g=0.5$)

Evolution of Motives - Satisfaction Model
 Competitive Rewards and Penalties ($r=1.25$, $p=1.25$, $g=0.5$)

Evolution of Motives - Fitness Model
Competitive Rewards ($r=1.5$, $g=1.5$)

Evolution of Motives - Satisfaction Model
Competitive Rewards ($r=1.5$, $g=1.5$)

Evolution of Motives - Fitness Model
Competitive Penalties ($p=1.5$, $g=1.5$)

Evolution of Motives - Satisfaction Model
Competitive Penalties ($p=1.5$, $g=1.5$)

Evolution of Motives - Fitness Model
 Competitive Rewards and Penalties ($r=0.75$, $p=0.75$, $g=1.5$)

Evolution of Motives - Satisfaction Model
 Competitive Rewards and Penalties ($r=0.75$, $p=0.75$, $g=1.5$)

Evolution of Motives - Fitness Model
Competitive Rewards ($r=2.5$, $g=1.5$)

Evolution of Motives - Satisfaction Model
Competitive Rewards ($r=2.5$, $g=1.5$)

Evolution of Motives - Fitness Model
Competitive Penalties ($p=2.5$, $g=1.5$)

Evolution of Motives - Satisfaction Model
Competitive Penalties ($p=2.5$, $g=1.5$)

Evolution of Motives - Fitness Model
Competitive Rewards and Penalties ($r=1.25$, $p=1.25$, $g=1.5$)

Evolution of Motives - Satisfaction Model
 Competitive Rewards and Penalties ($r=1.25$, $p=1.25$, $g=1.5$)

Evolution of Motives - Fitness Model
Competitive Rewards and Penalties ($r=2.5$, $p=2.5$, $g=1.5$)

Evolution of Motives - Satisfaction Model
Competitive Rewards and Penalties ($r=2.5$, $p=2.5$, $g=1.5$)

Evolution of Motives - Fitness Model
Group Incentive Only ($g=0.0$)

Evolution of Motives - Satisfaction Model
Group Incentive Only ($g=0.0$)

Evolution of Motives - Fitness Model
Group Incentive Only ($g=0.5$)

Evolution of Motives - Satisfaction Model
Group Incentive Only ($g=0.5$)

Evolution of Motives - Fitness Model
Group Incentive Only ($g=1.5$)

Evolution of Motives - Satisfaction Model
Group Incentive Only ($g=1.5$)