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INCENTIVE PLANS AND MULTI-AGENT INFORMATION SHARING

BY

Susan Pickard Ravenscroft

A DISSERTATION

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

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Department of Accounting

ABSTRACT

INCENTIVE PLANS AND MULTI-AGENT INFORMATION SHARING

By

Susan Pickard Ravenscroft

Managerial control systems have effects on behavior beyond those predicted within micro-economic models. Incentive plans, which are one aspect of management controls -- are the focus of this study. Several conditions typical of actual work environments were manipulated across two incentive plans in a laboratory experiment to explore the interactive effects on employee performance and employee attitudes.

Expectancy theory provided the general framework for hypotheses formulation. In addition, the theory of contests (a multi-agent approach to agency theory) and organizational theory were valuable sources of prior relevant research and served to enrich and refine the research hypotheses. This study examined the effects of incentive plans, the opportunity for direct inter-agent communication, and feedback upon performance levels, information exchange among workers, self assessments of abilities, and beliefs regarding the relationship between performance and payoffs. The two incentive plans were a cooperative group pooling and a rank ordering, or contest.

Generally, the hypothesized results were obtained. While prior research comparing performance under cooperative versus competitive

incentive plans has yielded mixed results, in this study communication clearly interacted with the incentive plan. Performance was significantly higher under the cooperative reward with communication than in any other condition. Feedback positively affected workers' expected performance in all conditions, which was contrary to expectations. Information sharing and beliefs regarding the performance-payoff relationship were significantly affected by the incentive plan. Finally, the latter two attitudes were significantly related to performance, which supports validity of expectancy theory. The performance results also suggest that a single agent, single principal model may be inadequate in studies comparing the effectiveness of various incentive programs.

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INTRODUCTION

In a recent review of research on managerial control systems Birnberg and Sadhu [1986] point out that a "model of the process by which accounting budgets and reports are utilized in organizations," [p. 124] is emerging. The general objective of such research is "to understand better the effects of accounting information and techniques on behavior beyond those predicted by micro-economics in order to identify the functional and dysfunctional effects of managerial accounting systems" [p. 123]. In this study, several theoretical sources are relied upon to formulate and test hypotheses regarding the behavioral effects of incentive plans, which are one facet of management control systems. According to Hopwood, "One of the principal means by which senior managers attempt to motivate their managers and employees towards effective performance is by linking organizational rewards to the level of their performance" [1975, p. 95]. While that linkage can take many forms the most obvious one is employee incentive plans.

The elements of any incentive plan include:

1. an agent(s) or employee(s) who provides effort or goods,
2. a principal or employer who provides a reward for the effort or goods,
3. an agreement between the parties such that rewards are allocated to

- the agent in accordance with certain defined levels of output,
4. a management accounting system which provides information that is used in designing and implementing the plan.

This study explores the effect of incentive plans, feedback and the opportunity for communication among employees on performance, information exchange among workers, self assessments of ability, and on beliefs regarding the performance-reward relationship. The questions addressed in this study are significant because "information from the management accounting system provides the basis for determining and enforcing contracts among economic agents" [Kaplan, 1982, p. 4]. This study differs from most prior accounting research on incentives in that direct communication among workers is manipulated. In many studies, "communication" is severely restricted both in format and content [e. g. Waller and Payes, 1988]. The results of this study indicate that the ability to communicate interacts significantly with incentives.

Incentive plans can differ along several dimensions. First, the locus of the reward can differ, i.e., whether incentive plans are distributed based on group or individual output. A second major distinction among incentive schemes is whether rewards are structured cooperatively or competitively. A reward scheme is cooperative if attainment of one's goals is positively correlated with other workers' goal attainment. A reward scheme is competitive if attainment of one's goal is negatively correlated with other individuals' attainment of their goals. For instance, a reward scheme which rewards group members equally on the basis of total group output would be defined as cooperative. On the other hand, a reward scheme which rewards group

members on a rank-order basis and results in differential payment is a competitive scheme. A third criterion which distinguishes incentive programs is the relationship between output (or performance) and reward. The most common plan in practice is a piece-rate approach, which involves a one-to-one relationship between output and reward. For instance, a tax preparer might be paid \$25.00 for each tax form completed. However, many variants exist in practice.

Groups often play a role in incentive plans. The most obvious instance is a competitive or rank order scheme in which an agent's rank within a group determines his compensation or bonus. The question of how group behavior is affected by incentive plans is unresolved. In addition, the possible interactive effects of the incentive plans and feedback or communication among group members have not been examined. In designing incentive plans management accountants should consider both the effect that the plan may have on the efficacy of feedback and the effect that inter-agent communication may have under varying incentive structures. The more general question of the relative efficacy of various types of incentive plans has been explored under several distinct theoretical approaches. Lines of research relevant to the current study are the experimental approach in the psychological literature comparing cooperative and competitive rewards, the work done on expectancy theory, which includes both laboratory studies and field studies, and, finally, the analytic approach of agency theory.

Within psychology and organizational behavior, a great deal of research has been conducted on the question of whether cooperative or competitive rewards result in higher performance or output levels. A

meta-analysis of over 100 studies [Johnson et al., 1981] emphasizes the inconclusive results that can be inferred from this body of work. The failure to reach definitive conclusions indicates that intervening or mediating variables must be included in future studies. Possible mediating variables include individual differences such as skills and goals, as well as social behaviors leading to differential performance levels. Inconclusive results may also indicate that the dependent measure being studied is not sufficiently refined. Instead of looking simply at the effect of incentive plans on performance, researchers should study the effect of incentive plans on motivation, beliefs and/or attitudes that correlate to performance.

Expectancy theory allows for that refinement by providing a general model of motivation as a function of three theoretical constructs:

- valence -- defined as the subjective utility of an outcome;
- expectancy -- the subjective probability of attaining a certain level of performance given a certain level of effort;
- instrumentality -- the subjective probability of receiving a particular reward given a certain level of performance.

According to expectancy theory, motivation and performance levels increase when the subjective likelihoods of highly valued outcomes increase. A major premise of this study is that both inter-agent behavior and instrumentality are affected by incentive plans. Under a cooperative incentive plan an increase in performance leads to an increase in reward. Under a competitive incentive plan, an increase in performance leads to an increase in reward only if one's rank in the group changes. Thus, the connection between performance and reward

(instrumentality) is lower under a competitive reward. A second premise is that feedback and incentive plans interactively affect expectancy. To the extent negative feedback impairs performance, a decrease in the expectancies of those subjects who are doing poorly relative to others in the competitive condition is predicted. In summary, expectancy theory variables provide a more refined measure of incentive plan effects than simple performance comparisons by examining some of the factors that drive performance.

A third line of research on the question of the relative efficacy of incentive schemes appears within agency theory. In this paradigm, organizations are defined as a nexus of contracts among the factors of production. Relying on strict assumptions of rationality and utility maximization, these theorists construct an analytic model which provides the framework for the rational choice of compensation alternatives. Within a line of agency research called the theory of contests, researchers are investigating what theoretical circumstances render competitive incentive plans superior to individual incentive plans. While this approach has yielded some fruitful insights, it has explicitly excluded consideration of the non-pecuniary aspects of motivation [Demske and Feltham, 1978]. In addition, because this field is fairly new, complexities which are common in the work world, but are not easily modelled, are explicitly excluded. Thus, the agency model has tended to focus on single period, single agent settings. The result is that the possible incentive plan effects on behavior, such as information exchange among agents, has not yet been addressed by the theory of contests. Although agency research is not explicitly relied

upon to formulate hypotheses in this study, it does enrich the empirical work and provides useful insights into the problems.

Two additional aspects of employment are controlled and studied in this research - feedback and the effect of allowing inter-agent communication. Feedback has been generally shown to have a positive effect on performance, but the overall feedback effect differs depending upon the context and content of the feedback. In this study, feedback in a competitive reward scheme is predicted to have a negative effect on the expectancy of those subjects who are performing poorly relative to their group.

The second additional aspect of employment studied is that of inter-agent communication. This manipulation proved to be very significant in driving the obtained results. If these results prove to be generalizable they have significant implications for management control systems. Usually, employees do not work in isolation. While the focus of agency work has been on the communication of privileged information from the agent to the principal, another potentially more important form of information is that of task-related expertise exchanged among agents. When agents are rewarded cooperatively their reward increases directly with increases in group performance. In the competitive condition, agents are paid on a rank-order basis and receive a greater reward only if their performance exceeds that of the other group members. Thus information sharing among agents is expected to be much more frequent under the cooperative reward plan than the competitive reward. In this study information sharing proved to be an important determinant of performance.

Over 300 students participated in this study by performing the same task -- six sets of progressive matrices -- under varying incentive, feedback, and communication conditions. The research design was a 2^4 factorial with one repeated measure. Four dependent variables were directly measured and one was constructed statistically.

Briefly, the results of this study indicate that cooperative incentive schemes result in significantly higher performance levels if communication is allowed. If communication is not allowed, performance under the cooperative incentive plan does not differ significantly from performance levels under the competitive incentive plan. The expected negative effect of feedback in the competitive condition did not occur. Because predictability of performance can be an important factor in management planning and control, the variance of performance was tested and found to be significantly lower in the cooperative reward with communication than in any other experimental condition. Both the performance and performance variance results were highly significant and suggest that incentive schemes should be designed to foster and, perhaps, even reward information sharing among workers. If these results are shown to be generalizable over a wide range of tasks and settings, communication may be beneficial in the process of collecting data as input to the management accounting system. Information compiled by workers or managers who share ideas, cooperate in the gathering of data, and provide feedback to one another at the input stage may be superior to data gathered by managers who are not rewarded for such cooperative behaviors.

Expectancy was hypothesized to improve with feedback in the

cooperative reward and to decrease in the competitive reward condition. Instead, it improved with feedback in both incentive conditions, but the improvement was greatest in the cooperative reward with communication condition. These results parallel those found in analyzing the performance measure. Information exchange was found to be significantly higher in the cooperative incentive condition. Finally, the subjects' perception of the relationship of their performance to reward (instrumentality) was significantly affected by the reward condition. The instrumentality of subjects paid under the cooperative incentive scheme was significantly higher than the instrumentality of subjects paid under the competitive incentive plan. In general, the results were supportive of expectancy theory and also of the assertion that comparisons of incentive plans must include consideration of possible mediating environmental factors.

This study improves upon past research in several ways. First, it explicitly includes the measure of a social process -- information exchange -- that is affected by incentives and in turn affects performance levels. Research based on a single agent working in isolation provides a beginning to model development, but social interaction is a reality in most work settings and the effects of incentives on that interaction must be researched. Second, it applies expectancy theory to the comparison of two incentive plans. Most prior research on expectancy theory has compared hourly pay, which is not performance based, to piece-rate or other performance-based plans. These earlier results relate to the general question of the efficacy of any performance related incentive and yield little insight into the more

difficult problem of which incentive plan to apply in a given work setting. Third, it explores the application of expectancy theory in a group setting. Fourth, in the statistical analysis the method of contrast coding, a more powerful method of analysis than the traditional ANOVA, is described and applied. Fifth, a multi-period setting is used because single-period results are not always generalizable to multi-period applications [e.g. Axelrod, 1984] and social processes may not develop in a single period.

In the next chapter, previous literature relevant to this study is reviewed. The following chapter describes the research hypotheses and the administration of the experiment. This is followed by the results chapter. Finally, the concluding chapter presents the implications, limitations, and strengths of this study, as well as suggestions for future research.

LITERATURE REVIEW

Motivation

Managerial accounting systems generate much of the information used in executing both the control system and the planning function of firms. "Control system design encompasses choosing both the performance standard and compensation scheme" [Chow, 1983, p. 667]. Belkaoui [1980] asserts that the behavioral challenge facing management accountants is the matching of the internal reporting system to those factors such as the individual worker's perception of the firm's objective function, the decision-making models used by the individual, and environmental conditions that motivate the individual. In a similar vein, Dopuch et al. [1974] observe that control systems may have dysfunctional behavioral effects and that these effects comprise one of the criteria by which such control systems should be evaluated. Experimental evidence shows that subjects are highly responsive to differences in reward systems [Luzi and Mackenzie, 1982] and that these responses are not always predictable [Farr, 1976; Bull et al., 1987].

An important behavioral question then emerges. How can incentive or compensation schemes be structured so as to promote goal congruence between the firm and the agent?¹ Particular emphasis is placed on the

¹ In the literature the terms "incentive scheme" and "compensation scheme" are not clearly distinguished. In general usage, "compensation scheme" tends to be a generic term for any pay schedule, while incentive plans tend to indicate a link between pay and performance. This rather loose distinction is relied upon herein. E.g. straight hourly pay would not be an incentive scheme. Both of the pay schedules used in this

problems of moral hazard and adverse selection, both of which arise because of information asymmetry between workers and employers. Employees possess superior information regarding their own abilities, the state of nature, and the effort they must expend to perform at certain levels. Since agents are not expected to voluntarily provide this information to principals, a key element in designing incentive schemes is the inducement of either information from agents (e.g., for reducing slack in budgets or for allocating resources between divisions) or actions by agents from which principals can infer information [O'Keefe et al., 1984; Green & Stokey, 1983; Holmstrom, 1982].

Another important type of information, but one which has received little attention, is task related information that can be transferred among agents. In agency theory the parties considered significant in the exchange of information have traditionally been a single principal and a single agent [Baiman, 1982]. A basic premise of this paper is that task-related information exchange among agents is an important factor in the performance of work groups. Examples of such information include the suggestions of a production seamstress on how to most quickly set a sleeve, to loan officers sharing financial information about a loan applicant or a program to predict bankruptcies. Within audit firms such information sharing could prove beneficial by increasing productivity. In many firms audit staff are currently ranked in annual ratings meetings, where promotions and raises are determined. It is not clear that such ratings foster appropriate

study link pay and performance and are therefore, incentive schemes. Finally, it should be noted that the following terms are used interchangeably: incentive scheme, incentive plan, and reward structure.

behaviors. Despite high academic achievement, many junior auditors would benefit from sharing basic information that could least threateningly be conveyed by peers. The inclusion of a well-designed peer rating on relevant information sharing behaviors could be incorporated into performance appraisals. (Ilgen and Feldman [1983] describe the effectiveness of peer review.) The benefits of information sharing would have to be compared to the value of the performance information derivable in existing evaluation systems to see whether such a shift would be profitable. The extent to which incentive plans determine group processes, such as information exchange, has not been thoroughly studied. To the extent such group processes affect performance, the relationship warrants investigation.

Prior Research

Incentive plans can be differentiated along several dimensions. A major dimension is the locus of rewards [Chow & Shields, 1986] where locus is defined as the unit (usually an individual, a group, or a team) whose output is being evaluated for purposes of reward distribution. The effect of incentive plan locus has not been rigorously studied. Instead, the comparison of group versus individual incentive plans is usually discussed in field studies of incentive programs, in which many variables are altered simultaneously, creating confounded variables and allowing researchers to draw few conclusions.

Another dimension of incentive plans is whether rewards are structured cooperatively or competitively. Cooperative plans are defined as those in which attainment of reward is positively related

among workers; an example is paying group members equally based on the entire group's output. Competitive plans are defined as those in which the attainment of rewards by one person is negatively correlated to the attainment of rewards by another person, as it is in a rank order contest [Rosenbaum, 1980].

A third dimension which distinguishes plans is the relationship between performance and reward. The most commonly used piece-rate approach involves a one-to-one relationship between performance and reward. In rank-order tournaments performance and rewards are not directly related because one's reward is contingent on output or performance relative to that of others who are being ranked [Nalebuff & Stiglitz, 1983]. The perception of the relationship of performance and reward is addressed in the section on expectancy theory research. While very little research has been done on the social processes invoked by various incentive schemes, the comparison of performance levels under various incentive plans -- notably the contrast of cooperative versus competitive rewards -- has been extensive. That research is discussed in the next section.

Cooperative vs. Competitive Rewards

A major line of research relating to payoff patterns or reward structures is the comparison of performance under cooperative and competitive reward conditions. This includes studies in which rewards are manipulated and others in which groups are encouraged or structured so as to have cooperative or competitive working relations but are not necessarily rewarded on those bases. It is only the former line of

research that has bearing on the issue being investigated herein and the following literature review shall be mainly restricted to that category.

A major purpose of the current study is to examine the effect of different reward structures on the group process of sharing task-related information. In this study designated experts were subjects randomly selected to receive information on how to complete the task which other subjects did not receive. The experimental task was chosen to facilitate monitoring of the relative frequency of information sharing under the different incentive plans. Information sharing by the experts was expected to be demonstrated by improvement in performance and was probed directly in a final questionnaire.

Deutsch [1949] did the seminal work on performance differences under varying reward schemes. He hypothesized and found support for greater productivity when cooperative incentive plans were in force. Blau [1954] obtained similar results in a field study. Employees in a public employment agency were divided into two groups -- a cooperative one in which employees were encouraged to share information and to help one another place job applicants, and a competitive group in which workers were evaluated based on individual performance relative to their co-workers. In the competitive group the employees tended to hoard information and consequently, productivity declined. The productivity difference observed by Blau lends support to the hypothesis that for those subjects allowed to communicate in this study, productivity will be greater under the cooperative incentive plan.

Miller and Hamblin [1963] reviewed 24 studies comparing productivity under cooperative and competitive conditions and found that the results

were fairly evenly divided. Miller and Hamblin hypothesized that task interdependence was an orthogonally related trait that could account for the divergent results. Task interdependence is the degree to which a task can or cannot be executed without contact, assistance, or information provided by others. They manipulated task interdependence and found that in the high interdependence condition competitive rewards were inversely related to productivity. In the low task interdependence (hence called independent) condition the reward structure had no effect.

Weinstein and Holzbach [1972] argued that Miller and Hamblin's independent group members may have felt so remotely connected that they were simply individuals working on similar tasks, rather than identifying as group members. They devised a task in which it was clear that the output was a group output, even though individuals were assigned different steps in the process. Groups were rewarded on a rank order basis (one-half, one-third, and one-sixth of the total based on group output) or on a cooperative basis - an equal share of a total based on a group output. They found that productivity was greater when the task was structured independently and was greater under the rank order reward. Weinstein and Holzbach used a rank order scheme which had the interesting feature that the group's total pay was a linear function of the group productivity. This is not the competitive reward scheme used by experimenters. In fact, for less productive employees this particular reward structure could possibly counteract the disincentive of a fixed total bonus plan. The effectiveness of the Weinstein and Holzbach incentive plan should be further investigated.

Scott and Cherrington [1974] repeated the independent portion of the

Weinstein and Holzbach experiment, and added an individual reward condition. Productivity was again found to be greatest in the competitive condition. In another extension of Weinstein and Holzbach, Farr [1976] used an independent task, the sorting of computer cards. He had two time-periods and manipulated the existence of a performance based incentive plan and the locus of the reward scheme (either group or individual). Output was greatest in the contest, lowest in the hourly pay and equal in the group and individual piece-rate conditions. Thus, the very existence of an incentive plan increased productivity. Contrary to Farr's hypotheses, however, the subjects considered the rank order contest significantly less equitable than the other incentive schemes. The subjects' perception of unfairness suggests that workers paid under such a plan might try to subvert the plan. As is the norm in studies of incentives, subjects in Farr's research did not communicate with one another; instead the groups existed only as comparison units for computing rewards. Thus, the effect of the pay schemes on group interaction was not addressed.

In French et al. [1977] children built towers out of building blocks, a highly interdependent task. French found that productivity was inversely related to the extent of differentiation in rewards, i.e. cooperative rewards yielded the greatest productivity. Rosenbaum et al. [1977] had adult subjects perform the same task and added an independent task condition in which individuals worked alone. In that condition productivity was not affected by reward structures. However, with an interdependent task, productivity was highest in the cooperative reward condition and lowest in the competitive condition. In addition, a

measure of efficiency of work procedures showed that the competitive condition was less efficient than the other two conditions.

In a replication of that study Rosenbaum et al. [1980] measured turn-taking and found that it was significantly higher in the cooperative condition than in the other two conditions, thus indicating that subjects may use efficient production strategies when they serve the group's interest. These last two studies are exceptional because they did address issues of group process. Their results lend support to the hypothesis that information sharing can increase productivity and will occur more frequently in cooperative reward conditions.

Johnson et al. [1981] did a meta-analysis of 122 studies on the effect of reward structure on performance. The results of three different meta-analytic procedures showed that cooperative rewards promote achievement more than competitive rewards or individualistic rewards. In addition, competitive and individualistic rewards did not correlate with significantly different levels of productivity. Johnson et al. [1982] responded to criticisms of their approach by providing additional analyses, iterating their position that the number of studies in which the same mediating variables are manipulated is generally too small to allow for interpretable results. They concurred with their critics on the importance of mediating circumstances and processes, but said that "the social interaction processes mediating or moderating the relation between cooperation and productivity have yet to be clarified and consistently demonstrated" [p. 191-192].

Since interdependent tasks require cooperation it is not surprising that cooperative reward structures generally lead to higher performance

levels on such tasks. Because the matrix task used in the current study can be done individually, it is an independent task. However, the results of a pilot study indicated that when subjects were provided a brief, written explanation of the task, their performance improved significantly. To some extent, therefore, the progressive matrix task has characteristics of an interdependent task. All but the very simplest independent tasks are also interdependent to some extent. In this study the cooperative reward was expected to increase information sharing, so higher performance was predicted in the cooperative incentive than in the competitive condition.

As Rosenbaum [1980] points out, in studies of incentive plans the usual dependent variable is productivity, with occasional measures of error rates. Research does not usually address the effect of group processes on productivity or the effects of incentive schemes on group processes. Some research has been conducted, however, that relates indirectly to the information sharing hypothesis.

Hackman et al. [1976] manipulated the extent to which groups interacted to discuss strategy for completing a task. In the strategy condition groups were told to take about five minutes to discuss methods for completing the task. By contrast, in the non-strategy condition subjects were told to not waste time talking about the task. This condition was crossed with a manipulation of task interdependence. Using a performance rate calculated by dividing the value of nondefective output by the time actually spent assembling, the results for the high interdependence task were that the strategy group significantly outperformed the non-strategy group and the results for

the independent task group were insignificant. In other words, with an interdependent task the group process improved performance; in the independent task, it had no effect.

Rosenbaum [1980] reports on an unpublished study in which subjects collated parts of a booklet. An intermediate process required each subject to complete a data card before proceeding to collate the next set of pages. Subjects were told that they could process the data card for the next person on the assembly line if they chose to. Even though subjects were prohibited from communicating, the number of cards processed for others in the cooperative reward condition was over twice that in the individualistic and competitive conditions. This led to significantly higher productivity. When the experiment was repeated with the data card step removed, there was no reward effect on productivity. Thus, the increase in productivity resulted from the adoption of facilitative procedures by the cooperatively rewarded subjects when such procedures were allowed.

Thomas [1957] had subjects construct cardboard houses. In some groups each subject completed entire houses, while in other groups each person did a portion of the house. This manipulation was crossed with a reward manipulation, subjects were rewarded on either an individual or a group condition. The groups which worked on sub-tasks and were scored as groups performed better than the groups in which each individual completed the entire task. However, the difference was not statistically significant. Subjects working on subtasks reported greater feelings of responsibility to other group members; and subjects rewarded as a group were more willing to help others. Thomas's results

indicate that cooperative incentives motivate facilitative group processes which can improve productivity. One of the purposes of the current study is to test the possibility that reward structures affect information sharing, which is one such behavior.

The possible effect of incentive structures on group processes has significance because frequently individual employees in a group have higher skills or more experience than other members of the group. Such relative expertise enables them to work more efficiently or to produce fewer errors than their colleagues. If these employees could be motivated through incentive structures to share that information, higher performance levels should result. Using the managerial problem of negotiating transfer prices as their experimental task, Ackelsberg and Yukl [1979] found that communication arose spontaneously among subjects assigned the role of division managers who were paid on a corporate wide basis but not among those paid on a divisional basis. In this study, the corporate reward scheme corresponds to a cooperative plan, while the divisional reward scheme correlates to a competitive plan.

Waller [1988] discusses the possibility of cases in which it is desirable for production levels to be at or near those budgeted or predicted. Problems could arise, for instance, if an intermediate product was overproduced and created an excessive work-in-process inventory. To the extent it is desirable to be able to predict work levels or to be able to obtain approximately equal work output, variance in output may be problematic. Bull et al. [1987] described variance in output as a cost to the principal in that it reduces the principal's certainty regarding the agents' responses to a compensation plan.

Gruneberg and Osborne [1981] describe an incentive plan in an industrial setting that was overly successful; parts were produced and loaded onto a conveyor belt so quickly that they could not be used by the other departments and caused storage and warehousing problems. Thus, it is useful to look at the effect of the experimental variables upon performance variance.

Predictability and consistency in productivity levels are important management concerns, particularly in settings where standard costs are used. Rambo et al. [1982] studied consistency of output levels over time. In a study of several work settings, Rothe [1978] found that consistency was higher when an incentive system was in effect than when pay was hourly. He says that "consistency of output, as measured by week-to-week correlations, permits a statement about the effectiveness of incentives," [p. 44]. An additional aspect of predictability is important in setting standards -- uniformity of performance among workers. Work standards will be perceived as more feasible if individual output levels cover a narrower range, since smaller variances imply that there would be fewer outliers, people producing much higher or much lower than the standard. Varying levels of output can be detrimental to motivation, depending upon the pay scheme or incentives in place. Also, in some settings high variance of output causes problems such as disruption in work flow, storage problems, and so forth.

Consistent with Bull et al. [1987] this writer considers consistency a between subject variable. Other researchers such as Brewer and Kascier [1963] and Rothe [1978] discuss consistency as an intra-individual

behavior over time. This is in line with attribution theory, where an individual's performance history determines consistency and invariance across individuals is called consensus. Rothe argues that consistency over time is a necessary condition for an effective incentive plan.

It should be noted that the distinction between cooperative and competitive rewards is not absolute, and is, in fact, dependent upon the identification of a relevant group. For instance, while individual professional baseball players may compete for the Most Valuable Player award, they are rewarded cooperatively (as a team) for winning their league playoffs. However, as a team they form a unit that is rewarded competitively vis a vis other teams in the league. Thus, the identification of the appropriate group is an important element of determining whether incentive schemes are competitive or cooperative.

Overall, research results comparing cooperative to competitive incentive schemes have been mixed. If tasks are interdependent, then cooperative reward structures result in higher performance levels; while if tasks are independent, competitive reward structures yield higher performance. A weakness of this line of research is that a general theoretical framework has not been formulated. Both Rosenbaum et al. [1980] and Johnson et al. [1981] point out the lack of research on the effect of incentive schemes when tasks are independent. Therefore, the task used in this study is one which can be completed independently.

Expectancy Theory

General background. Expectancy theory provides a model of individual motivation which accounting researchers have used to investigate a wide

range of work-related behavior, including job choice, selection of method of pay, goal setting, and effort levels. According to expectancy theory, behavioral choices are based on outcome attractiveness and the perceived likelihood that a given act will lead to desired outcomes. Within this framework some hypotheses about incentive structures emerge [Ronen and Livingstone, 1975]. Incentive plans are expected to affect instrumentality (defined below) and feedback is expected to affect expectancy (also defined below). These two constructs, in turn, have been shown to correlate to performance. Expectancy theory enables researchers to begin to study the process by which incentive plans cause differing performance levels.

The theoretical model in the seminal work on expectancy theory [Vroom, 1964] includes three basic elements. Valences are the expected utility of a particular outcome or event.² Expectancy is the subjective belief concerning the likelihood that effort will result in a certain level of performance [Mitchell, 1982]. Instrumentality is the subjective belief that a certain level of performance will lead to a particular reward. In general terms the model has been presented as:

$$\text{Force to perform} = f[E \cdot \Sigma (I \cdot V)]$$

where E = Expectancy = Subjective $\text{Pr}(\text{Performance} \mid \text{Effort})$

I = Instrumentality = Subjective $\text{Pr}(\text{Reward} \mid \text{Performance})$

V = Valence = Subjective expected utility of Reward

[Vroom, 1964]. More complex formulations have been introduced [Ronen &

² Vroom also defines valence as the anticipated satisfaction of an outcome (1964).

Livingstone, 1975; Ferris, 1977], but Schwab et al. [1979] raise concerns that elaborate formulae may "overintellectualize" the cognitive processes people carry out in making choices.

In his discussion of expectancy theories, Belkaoui [1980] enumerates some implications this theory has for management accounting. He said that expectancy theory variables should be considered by managers in determining how extrinsic rewards should be related to work performance, in using feedback to increase the individual's expectancy, and in rewarding individual effort in order to influence instrumentalities [p. 68]. Research on expectancy theory has shown that within the employment setting workers select effort levels or engage in activities that maximize their expected benefit. Jiambalvo [1979] successfully applied the expectancy model to predict which job responsibilities auditors would direct the greatest effort toward, contingent upon their perception of the duties most highly valued by their superiors. Magee and Dickhaut [1978] found that subjects used different decision rules when faced with different compensation plans, as was predicted within the expectancy paradigm. Dillard [1979] found that expectancy model variables predicted junior auditors' occupational and position goals.

Incentives and Instrumentality. While the concept of instrumentality has received less attention than either valence or expectancy, it is recognized as a key link in the employee motivation- performance link. Sims et al. [1976] say, "The prevailing opinion is that perceptions of performance-reward probabilities are an important factor in motivating employees to improved performance" [p. 556]. Several studies have been done on instrumentality and its relationship to performance. Wofford

[1971] found a biserial correlation between performance and expectancy-instrumentality of .433. Harrell and Stahl [1984] provide evidence that the weight given to the combined valence-instrumentality variable is approximately four times that given to the expectancy variable, indicating the importance attached to extrinsic rewards for performance.

Since incentive plans link performance levels to rewards, they are expected to affect instrumentality. Schwab [1973] found that pay schemes accounted for approximately 40% of the variance in instrumentality ratings. Ilgen et al. [1981] found that instrumentality was highly dependent upon the pay structure in effect. It should be stressed that the usual comparison in the studies cited is between instrumentality in hourly or flat-rate incentives versus piece-rate plans. Because there is virtually no connection between performance and reward in a flat-rate pay scheme it is not surprising that instrumentality is lower under such a scheme than it is in a piece-rate plan. In the present study, the comparison will be between instrumentality in two performance based plans -- one cooperative and one competitive. This is a more subtle distinction and therefore provides a more powerful test of the concept of instrumentality.

The strong link between instrumentality and performance has been demonstrated. Campbell [1984] found that the instrumentality of the pay scheme significantly affected performance. Cammann and Lawler [1973] describe an incentive plan which failed because the relationship between performance and rewards (instrumentality) was extremely complex and was not understood by the employees. In that case a low instrumentality was related to a low level of performance. These results reinforce the

conjecture made by Davis [1969] regarding the importance of reward schemes in social settings.

It should be noted that Davis was commenting on group effort; while expectancy theory is a theory of individual motivation. The effect of aggregating expectancy theory concepts in a group setting is not entirely clear. However, the general model is expected to apply in the group setting of this experiment. The voluminous prisoner dilemma literature, and other research [e.g., Becker, 1978; Chung & Vickery, 1976], provide strong support for the importance of extrinsic rewards. In addition, Ronen and Livingston [1975] argue that groups enhance the extrinsic valences of a worker and that workers are highly motivated to comply with group norms. In summary, the group setting is expected to enhance the validity of expectancy theory, which predicts that incentive plans significantly determine instrumentality, which, in turn, affects performance³ and/or effort.

Feedback and Expectancy. The beneficial effect of the knowledge of results (one form of feedback) upon performance is one of the best established findings in organizational behavior [Becker, 1978; Kim and Hamner, 1976]. Within expectancy theory "feedback should play a vital role in establishing a recipient's belief in the effort-performance relationships (expectancies), which in turn should influence his or her

³In many experiments, including this one, performance is used as a surrogate for effort. While this is far from ideal, it has proven extremely difficult to construct meaningful tasks which do not involve some measures of abilities. Researchers have been forced to use fairly trivial tasks such as pushing a button or blowing air into a bellows in order to eliminate the effect of ability.

desire to respond to the feedback" [Ilgen et al., 1979, p. 362].⁴ The same researchers indicate, however, that there are many mediating factors which affect the positive connection between feedback and performance. Chung and Vickery [1976] provide some evidence that feedback and incentive plans affect performance interactively. The relationship between feedback and incentive plans is being explored in this study.

Feedback has two basic functions: it can "direct action by offering informational cues...and/or it can influence motivational state" [Strang et al. 1978, p. 446]. In their research Strang et al. provide evidence that feedback may be necessary to the efficacy of assigned goals. Chung and Vickery [1976] explored the possible interaction of the effect of feedback and incentives schemes (either piece-rate or an hourly rate) and obtained marginally significant results, indicating that feedback provided under a piece-rate incentive plan had a positive effect on performance. Chung and Vickery's findings suggest the need for additional study of how other incentive structures might interact with feedback.

One response to feedback is a change in effort level, which is a main variable of interest in expectancy theory. The sign of feedback (i.e. whether it is positive or negative) can be significant. In an early study negative feedback caused performance to worsen [Meyer et al., 1965]. The favorability of feedback has been found to affect

⁴The same researchers assert that feedback plays, "a major role in the establishment and maintenance of beliefs about behavior-reward contingencies," i. e. instrumentalities [Ilgen et al., 1979, p. 363]. They do not explicitly test this assertion, however.

subjects' perceived task competence, which is related to expectancy [Stone & Stone, 1985]. Consistent with that result, Earley [1986] showed that the sign of feedback has a significant effect on self-efficacy or expectancy, which in turn, operates on performance. He says, "The importance of sign is to provide an individual with information relevant to the estimations of capacity to perform." Because the agent's pay is based on relative performance in the competitive incentive plan, some agents will receive negative messages that they are the low performer in their group. If negative feedback impairs performance, this effect is expected in the competitive condition but not in the cooperative condition. In the contest, a low performer receives feedback indicating that he is the worst in the group and this is hypothesized to carry negative connotations. In the cooperative condition a low performer receives a low score, but is not told additionally that he is doing worse than the other people in his group.

Bandura [1982] discusses the concept of self-efficacy, which is a more general sense of abilities than expectancies, but which can be measured in specific instances and is considered analogous to expectancy. He found that past performance was the key determinant of self-efficacy. Similarly, Locke et al. [1984] found that self-efficacy had a significant, positive effect on performance. Self-efficacy is measured more directly than the conditional probabilities involved in expectancy measures. For instance, Locke et al. asked subjects whether they could perform at various levels and how certain they were of that prediction, as opposed to asking what performance levels people would

expect if they expended differing levels of effort. (See Appendix C). Locke et al. [1984] showed the tie between self-efficacy and expectancy theory. Self-efficacy was shown to be strongly linked to goal level, task performance, and goal commitment, even when controlling for ability and past performance. Locke et al. [1984] argue that their scale, which is based on confidence ratings rather than the usual estimates of the probability of success, is more valid than most other scales used in this type of research.

While a change in effort is one response to feedback, an alternative reaction is suggested within the theory of contests, which is discussed more fully in the next section. According to the theory of contests, a Stackelberg equilibrium is likely to emerge when feedback is provided and abilities are widely variant. Such equilibria emerge in settings or industries with a limited number of players, who are aware of each other's power or abilities [Nicholson, 1978]. In a rank-ordering, feedback will indicate to a low performer that he is not likely to excel, so he will not work to his full abilities. At the same time a high performer will assume that a low performer is reasoning precisely that way, and will consequently also expend low effort [Dye, 1984; O'Keefe et al., 1984]. This result is predicated upon an assumption of agents' effort aversion. In this scenario, the effect of feedback upon performance is negative due to reduced effort by all group members.

In summary, prior research and expectancy theory would predict generally beneficial effects from feedback. However, to the extent the lowest performers in the competitive condition consider their feedback negative, their performance is expected to decrease. This contrasts

with the theory of contests, which suggests that if abilities are unequal the effect of feedback on all agents may be negative. The resulting Stackelberg solution results in low effort levels by all agents in a rank order incentive scheme. The interactive relationship of feedback and incentives will be explicitly tested in this study.

Theory of Contests

The main analytic research approach investigating incentive schemes is agency theory, in which an analytic model provides the framework for the rational choice of compensation alternatives. In contrast to the standard neoclassical position which models the firm as a production function responding to market demands, the agency theorists focus on the contractual relations among economic actors and view the firm as a nexus of contracts among the factors of production. As Fama [1980] has pointed out the agency theory literature has moved away from the neoclassical model while it still includes the basic assumptions of the model. Although it was not the original intention of the neoclassical economists to derive a descriptive or normative theory of individual managerial behavior, some managerial accounting researchers use this theory to describe optimal individual behavior [Namazi, 1985].

An additional limitation of this line of research is that due to the intractability of the model in multi-period and multi-agent settings, researchers have generally focussed on single period, single principal, and single agent settings [Namazi, 1985, Baiman, 1982]. Recently, however, some researchers have explored the single principal, multiple-agent setting. This line of research is called the theory of contests.

The purpose is to compare rank-order contests to other incentive plans, usually piece-rate plans. Results are generally supportive of the use of rank order contests. This theory is very recent and not fully developed. Several of the researchers informally address some of the consequences of agent interaction and communication; no formal model allows for such interaction. However, the existing results shed some light on the relative merits of the two types of incentive schemes and are reviewed briefly below.

Lazear and Rosen [1981] assume a single period, two players (agents) of identical skills, and no communication between agents. Output is dependent on both individual characteristics such as worker effort or skill, and on a random environmental shock. If agents are risk averse, the superiority of an incentive depends on the relative variance of the common shock and the individual random element of output. As the common shock increases in importance, rank order tournaments become superior to individual incentive plans.

Holmstrom [1982] urges the use of rank order incentive schemes, not because of any benefit from competition per se, but because the effort or performance level of one agent provides the principal with information regarding other agents. Holmstrom says that rank order tournaments do not necessarily imply an efficient use of information and suggests using an aggregate statistic, such as the mean of the agents' performance to measure individual agent's output. In the absence of a random shock, the theory predicts tournaments will be less productive than individual incentive plans. One should note that Holmstrom's model does not allow for communication between agents.

Green and Stokey [1983] conclude that in the absence of a common shock, independent contracts dominate tournaments. However, if the diffusion of the environmental shock is sufficient then the tournament is more productive. O'Keefe et al. consider the problems of differential abilities and concede that "for many distributions of workers' abilities, there may be no contest that induces efficient effort." Despite these limitations to tournaments O'Keefe et al. [1984] conclude that contests are an ingenious solution to market imperfections such as indivisible rewards and asymmetric information. It is important to note that the above researchers do not address the issue of worker communication.

By way of contrast, Dye [1984] points out several weaknesses of tournaments, including the possible consequences for inter-agent communication. He discusses the potential for collusion, counterproductive behavior, and the motivational problems which arise if the abilities of the agents are unequal and are known by the agents. He feels the most likely of these is the Stackelberg strategy or equilibrium, which he describes as follows. Assume that two workers are paid on their relative rank and that both worker A and worker B know that A is twice as productive as B.

...Then B might reason as follows: regardless of what effort level I select, if A selects the same effort level then I will be very unlikely to win the tournament, so the best I can do (given that effort is distasteful) is to apply no effort. A would in turn exert no effort if he believed that B reasons as above, with the net undesirable effect (from the principal's point of view) that no effort would be exerted by either participant [Dye, 1984, p. 147].

The occurrence of collusion or actively counterproductive behavior is not studied in the current research. However, the possible consequences

of negative feedback are explicitly hypothesized and tested in the current study.

Nalebuff and Stiglitz [1983] also address some of the possible effects of contests on agent behavior. In an informal discussion of some of the limitations of contests, they suggest that eliciting cooperative behavior among agents may significantly affect productivity.

In situations where contests are frequently observed, such as a patent race, there may be technological returns to cooperation, as in sharing information. In the competitive system, there are no incentives for cooperation. There are even rewards from engaging in destructive activity if it can hurt one's rival more than oneself. The piece rate system will encourage agents to cooperate when it is mutually beneficial, and this potentially may be very important.
[p.40]

The effect of information sharing is being investigated in this study because, for this task, information transfer can lead to increased productivity.

Very little empirical work has been done in support of the theory of contests. In Bull et al. [1987] subjects were involved in a tournament, with payoffs determined partly randomly and partly by subjects' effort level. Bull et al. found that whether subjects were rewarded on a piece-rate plan or a rank-ordering, they reached the same equilibrium effort level. However, the contest condition resulted in significantly greater variance of effort than did the piece-rate plan. This result was not predicted by the theory and has serious practical implications. Bull et al. conclude, "It appears that a cost to choosing a tournament system over a piece rate system is that the principal must bear uncertainty as to how the agents will react to the tournament" [1983, p. 29]. The researchers conjecture that the cause of this variance might

be a result of the game nature of tournaments, rather than the information structure. Because predictability of performance is sometimes desirable in management planning, the effect of incentive plans on variance in performance is explicitly tested in the current study. Bull et al. also manipulated abilities and found that the theory of contests yielded better predictions when abilities were equal than when abilities were divergent.

Greenberg [1986] addressed some of the issues in the theory of contests. Greenberg's independent variables were the incentive plan and the environment; the environment manipulation was an operationalization of the random shock in Holmstrom's model. Half the subjects faced a common random shock and the other half operated in environments separate from the other subjects. In half the groups the bonus pool was distributed cooperatively (equally). In the other half the pool was distributed competitively such that the agent choosing the highest effort level received the greatest percentage of the bonus pool. Greenberg found that the competitive compensation scheme was most beneficial to the owner in both environments. In addition, for either incentive scheme, the owner's payoff was higher when agents operated in a separate environment. These results conflict with Holmstrom's hypothesis that competition is useful only if it provides information about common environments. Greenberg gives no indication that subjects communicated with one another, so the possibility of cooperative processes was not explored.

In summary, analytic research provides arguments and a limited amount of empirical evidence which demonstrate that competitive rewards

dominate piece-rate incentives plans when environmental shock is great and the abilities of workers are equal. Rank-order incentives schemes may be problematic for some as yet unspecified distributions of ability, in the absence of environmental shock, and, most importantly, if agents can communicate. Researchers in the theory of contests contrast a rank-order pay scheme (which has a group as its locus) and individual piece-rate incentives plans. Thus, two variables are being manipulated and compared -- the cooperative or competitive aspect of the incentive plan and the group or individual locus of the plan.

In this study a rank-order incentive scheme is compared instead to a group-based piece-rate incentive plan. This avoids the confounding effect of changing two dimensions of incentive plans. While the theory of contests assumes multiple agents it does not specify or allow for inter-agent interaction, thus precluding consideration of the behavioral consequences arising from working in groups and from group norms [Young, 1985, 1983]. Because the focus of this research is on non-mechanistic responses that incentive plans may invoke, and because the existence of a group does affect behavior, it is important to maintain a group locus when comparing cooperative and competitive reward plans. Therefore, the theory of contests is not explicitly tested in this study, but is relied upon because of the insights it offers to certain relevant aspects of the comparative study of incentive plans.

Furthermore, while the agency model has yielded many valuable insights, its applicability to questions of individual behavior has been questioned. Scapens and Arnold [1986] argue that agency theory is not suitable for the study of individual behavior because it is founded in

neoclassical economics. Two basic assumptions of that branch of economics are the economic rationality of economic agents, and the economic allocation of resources through a market reflecting marginalist utilities. When applied to individuals rather than to firms, both of those assumptions have been questioned.

Theory Linking Independent Variables

According to Mitchell [1982] expectancy theory suggests "that reward contingencies would be a major determinant of expectancies and instrumentalities" [p. 308]. However, this hypothesized relationship has not been thoroughly researched. Since incentive plans indicate the objective relationship between performance and reward, they are used to affect instrumentality, the perceived connection between performance and reward. According to expectancy theory, incentive plans which are perceived as directly relating a given output level to a certain reward have higher instrumentalities and are expected to result in higher effort or performance than incentive plans which connect performance and reward less directly. The cooperative incentive scheme used in this research consists of a variable bonus pool which is based on total group production and is shared equally among group members.

Because the reward is determined using a piece rate, pay is a simple linear function of the group's output. In other words, the relationship of reward and output is a monotonic function. For any subject an increase in his output will lead to an increase in payoff, regardless of what other members of his group do. Since his output is pooled, he receives only $1/3$ of the \$.25 paid for each correct response. Of

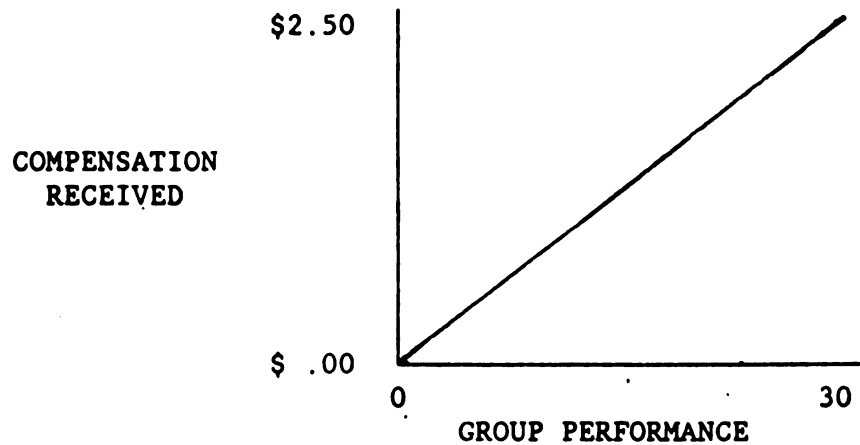
course, he shares equally in the output of his group members' production as well. The crucial point is that he is aware that if he has more correct responses, he receives a higher level of pay. Figure 2.1 illustrates the connection between the group performance and the amount an individual would be paid for a single problem set. As the performance of the group increases, the individual's compensation increases.

By contrast, the competitive incentive scheme will consist of a fixed bonus pool which is to be split unequally among group members depending upon their relative ranking within the group. Thus, the reward received is not linearly related to performance; instead, the reward function is a step function. In addition, pay is not a function of absolute level of performance, but of one's performance level relative to that of other group members. Green and Stokey [1983, p.351] say that, "Competing in a tournament is like being judged against a standard that is a random variable (the opponent's output)". (See Figure 2.1.) As Bull et al. [1987] point out, piece-rate schemes present workers with a simple maximization problem, while tournaments present workers with the less easily solved situation of a game. An individual cannot assume that if his performance improves he will necessarily receive higher compensation. The key to higher rewards is surpassing the performance of another group member. The absolute level necessary to do so is not known in advance of performing the task. That is why question marks appear on the X-axis of the lower panel of Figure 2.1. These characteristics of contests imply that the instrumentality of a contest is lower than that of a piece-rate incentive.

INSTRUMENTALITY: THE LINK BETWEEN PERFORMANCE AND REWARD

Cooperative Reward

As the pooled performance of the group improves, the compensation received by each member of the group increases.



Competitive Reward

As an individual's performance improves, his compensation increases IF and ONLY IF his performance exceeds that of someone else in the group. The individual performer does not know what level he must attain in order to receive a higher level of compensation.



Figure 2.1
Diagram of Instrumentality

A graphic representation of the expected relationships among the dependent and independent variables is presented in Figure 2.2. The independent variables are shown in the left column outlined with double scoring and the dependent variables are outlined in single scoring. According to the model, feedback affects expectancy, which, in turn, affects performance. The presence of an expert is manipulated primarily to provide the experimenter with some controls on information sharing. That variable is predicted to interact with incentives to affect information sharing. In addition, the presence of an expert in a group is expected to have some effect on expectancy. Incentives are the primary independent variable and are expected to have an impact on expectancy, instrumentality, and information sharing. By definition, the opportunity to communicate is a necessary, though not sufficient, condition for information sharing. It is hypothesized that information sharing will be more frequent in the cooperative condition and in cells in which "experts" have been given additional information on how to perform the task. Expectancy, instrumentality and information sharing all, in turn, affect performance. The research hypotheses are developed and explained in the next chapter.

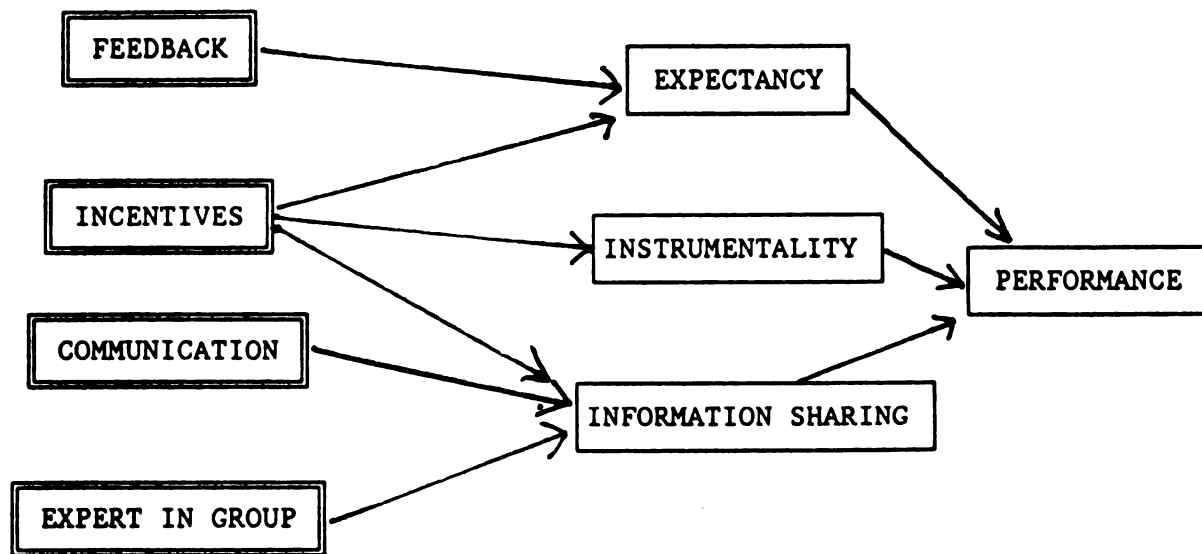


Figure 2.2
Linkage of Theoretical Variables

HYPOTHESES AND RESEARCH METHODS

The purpose of this study is to explore the effects of performance incentive plans, the opportunity of workers to communicate, feedback, and expertise, on performance, information sharing, and on two expectancy theory constructs -- expectancy and instrumentality. The hypothesized relationships are tested in a laboratory study. This experiment is a 2⁴ factorial with three between subject variables and one within subject variable as follows:

Between subject variables:

- 1) reward structure - cooperative versus contest
- 2) presence of an expert in the group - yes or no
- 3) opportunity to communicate - yes or no

Within subject variable:

- 4) feedback given to the subjects - no for the first three periods and yes for the second three periods.

A brief narrative form of the hypotheses is presented below (the dependent variables are underscored). The full development of the hypotheses in explicit, testable form is provided in the following section of this chapter.

Hypothesis 1: Performance will generally be higher in the cooperative reward and when communication is allowed. In the

competitive reward only, feedback is expected to have a negative effect on performance.

Hypothesis 2: The variance of performance in work groups will be higher in the competitive reward.

Hypothesis 3: Among subjects allowed to communicate, those working under the cooperative reward will have higher rates of information sharing than those rewarded competitively.

Hypothesis 4: Reward and feedback will have an interactive effect on expectancy. Feedback will increase expectancy in the cooperative reward condition and decrease expectancy in the competitive condition.

Hypothesis 5: Instrumentality will be higher in the cooperative reward condition than in the competitive reward.

Research Design

The design of the experiment is presented in Figure 3.1.

		<u>Reward Structure</u>			
		<u>Cooperative</u>		<u>Competitive</u>	
		<u>Communication Allowed?</u>			
		Yes	No	Yes	No
WITHOUT FEEDBACK	<u>Expert in</u> Yes	1	2	3	4
	<u>Group?</u> No	5	6	7	8
WITH FEEDBACK	<u>Expert in</u> Yes	1F	2F	3F	4F
	<u>Group?</u> No	5F	6F	7F	8F

Figure 3.1
Research Design

In later discussions of the hypotheses, experimental cells are referred to by the numbers assigned in Figure 3.1. For instance, "1F" represents the following experimental condition: cooperative reward scheme, with communication allowed, an expert in the group and with feedback provided. This cell represents the last three periods of the experimental session that corresponds to cell 1, and has the identical manipulations except that feedback is provided in cell 1F and not in cell 1.

The reward structures to be used are a cooperative group piece-rate scheme and a rank-order contest. In the cooperative plan each member receives an equal share of a total determined linearly on the total number of correct responses by the three group members. In the contest the most productive member of the group receives one-half of the total fixed "bonus," the second most productive member gets one-third, while the least productive member receives one-sixth of the bonus.

The second manipulated factor is the existence of an expert, i.e. one member who is given a brief introduction to the construction and logic of the experimental task, and some heuristics on how to quickly perform the task. Half of the groups will not have expert members, i.e. all the subjects in those groups will be naive. This factor is introduced to allow some independent evidence of the extent of communication within groups.

The third manipulated variable is the opportunity for group members to communicate with one another. The hypothesized effect on productivity is based on an interaction of communication and reward

structures. While it may seem perverse to manipulate the possibility of communication in a study focussing on information transfer, it is necessary to have the full factorial experiment in order to test the interactive effects of cooperative versus competitive rewards with and without communication.

Administration

Before any work could be initiated and in accordance with university procedures governing the use of human subjects, an application was made and approved by the University Committee on the Use of Research Involving Human Subjects.

The research was conducted using volunteer, student subjects at the facilities of Michigan State University. Volunteers were solicited in beginning and intermediate accounting classes, and in introductory management classes. The management students received course credit as well as being excused from writing a paper in return for their participation in an experiment. The group size at various experimental sessions varied because some intact classes were used, while at other sessions, the experiment was conducted outside of the normal classroom meeting time. The size varied from nine subjects to forty-five subjects.

The experiment began with the distribution of an informed consent form to the subjects. See Appendix A. Subjects were asked to refrain from discussing the experiment with other subjects outside of the experimental setting. They were also told they were free to leave at any time during the experiment with the only penalty being forfeiture of

the right to any payment. At that time subjects were also given a card with their subject number on it and asked to use this number on all forms they received and subsequently completed. This provided anonymity and eased the job of identifying subjects in data compilation and analysis.

The next step in the experiment was to describe the subjects' incentive plan for reimbursement. The cooperative incentive plan was based on pooled group effort. A work group consisted of three people, and subjects were paid \$.25 for each problem correctly solved in three randomly selected problem sets. That amount was put into a group pool and the three group members were each paid one-third of the group pool. In the competitive condition, students were paid on a rank-order basis. The highest performer received \$2.50 for that set, the middle performer received \$1.50 and the lowest scorer received \$.50. In both conditions subjects were told they would be asked to complete more than three sets, but that they would not know which three sets were reimbursable until a lottery was conducted at the end of the experimental session.

For the expert cells (cells 1 - 4) the subjects were told that a pre-test would be administered, and that there were three different pre-tests. They were divided into three groups based on the last digit of their subject number. Subjects were told that because of scheduling problems, we had access to only two rooms. Expert subjects were taken to the second room. The remaining two groups were separated but stayed in the test room. Non-experts were given a test containing various story problems and I.Q. test type problems (See Appendix F), none of which were the type used in the experimental instrument. Although the

tests were the same for all subjects, they were printed on different color paper and passed out separately and subjects were told that the tests were different.

Experts were given a written explanation of progressive matrices, the type of problem used in the experiment. The logic used in designing such matrices was explained; and examples of the two types of matrices in the actual test were provided. In addition, a heuristic for solving them quickly was provided. See Appendix G. Questions were solicited and answered. Two subjects were asked to explain the examples to the experimenter to verify their comprehension.

Experts were told they were the only members of their group receiving task information and that other subjects were completing unrelated problems. In the communication condition, emphasis was placed on the subjects' freedom to share information with other members of their group at any time during the experiment. When subjects had no further questions about the task, they were moved back to the original room. At that time communication cell subjects were seated in close proximity. If communication was not allowed, group members were seated apart from each other.

Subjects were informed of their communication condition. When communication was allowed, the experimenter stressed the possibility of communicating at any time throughout the experiment. Subjects were asked to talk -- if at all -- only with their own group. After returning the experts to the original classroom, the experimenter left the room temporarily in the communication cells. Leaving the room provided subjects time to freely discuss task procedures with their

group and to lessen the possibility of demand characteristics regarding sharing or hoarding of information. It was crucial to allow subjects unconstrained decisions regarding information sharing.

The subjects were told they would be working for several periods, but the exact number of periods was not specified in order to avoid end-game strategies. Informed subjects could decide to share information for one period only, or at a certain point in the sequence if they knew in advance exactly how long the experiment would continue.

Subjects used a standardized test answer sheet to indicate responses. They were also given a brief explanation of the nature of the problem. The experimenter explained that they were to complete a multiple-choice task involving the completion of a visual matrix of abstract symbols. The sample matrix used had no particular pattern or method, and was not an example of the sort of matrix used in the actual instrument. No explanation of matrix logic or heuristic for solving matrices was provided. This task was described as one drawing on visual skills such as those involved in reading graphs, maps, three-dimensional schematics. Subjects then indicated their initial expectancy on the expectancy form (See Appendix B). This was a simple measure of how adept they felt they were at such tasks as compared to the average person.

Once the consent and expectancy forms were collected, the actual task began. The experimental session comprised six problem sets of ten problems each. Set One was distributed face down. Each set lasted three minutes. When time was called the test booklet was collected and the second set was distributed. See Appendix H for test instrument. After Set Two, subjects were asked to indicate their expectancy, i.e.

expected level of performance. See Appendix C.

The experiment continued with the administration of Set Three. Starting with the third problem set, the researcher provided outcome feedback (the number correct) to all subjects. This was simple outcome feedback; no instructions or advice on how to solve the problems was given. Only Set Three was evaluated; no information was given on Sets One or Two. For all subjects the experimenter wrote the number correct on the subject's number card which was turned in at the end of the experiment. Additionally, in the competitive condition the subject's relative rank in the group was provided since this was the sole basis on which pay was determined. The ranking was not given in the cooperative condition as that had less effect on an individual's pay. The researcher gave only that feedback necessary to establish the link between performance and compensation.

The researcher had a deck of cards and if there was a tie in the competitive condition, subjects drew cards to determine who would receive the higher pay. The experimenter did not formalize or discuss the possibility of any side payments. While these may have occurred after subjects were paid, no such arrangements were ever discussed in the presence of the experimenters. It was stressed that a drawing at the end of the experiment would determine exactly which problem sets would be paid. In the cooperative condition the experimenters stressed that a subject's pay would be pooled with his group members and then divided equally. Thus, the amount on the card represented the amount the person was earning for the group pool. After receiving feedback for the first time, subjects were again asked to provide their expectancy.

This was done to determine whether feedback affected expectancy.

Set Four was distributed, completed, and evaluated. The same process was followed for Set Five. After Set Five, however, expectancy was measured again. Finally, Set Six was administered, with no additional measures and no feedback. Students at that time completed a final questionnaire. See Appendix D and E. The purpose of the questionnaire was to gather data on information sharing behavior and instrumentality. At that time, a lottery was held to determine which three of the six problem sets were to be used to determine reimbursement. The experimenter and her assistants calculated reimbursement while subjects completed the questionnaire.

A second smaller set of subjects in the four cells of the communication condition did the same experiment but completed a final questionnaire which included a much more extensive instrumentality measure. See Appendix D. This second administration of the experiment was necessary because the instrument used in the first round was not appropriately designed and had not been properly tested. The more complete instrument was more time-consuming and an initial concern had been to avoid taking more than 90 minutes because of the difficulty of enlisting subjects.

The task items were taken from Ravens Progressive Matrices, problems requiring the completion of a visual sequence of abstract shapes or symbols. Such items are found in typical intelligence tests, including the Stanford-Binet. See Appendix H. This particular type of problem was chosen because while it can be done adequately without any instruction, the pilot test showed that provision of some rudimentary

explanations of the matrices significantly improved performance. This sort of problem is also a convenient one since it is a pencil and paper task, lending itself to some privacy in a classroom setting. If learning occurs, it should result from information provided by a subject's own group members, not from observing the action of other groups. A major purpose of the current study was to examine the effect of different reward structures on a group process -- the sharing of task-related information. The matrix task was chosen to facilitate the determination that "experts" were more likely to share that information with other subjects under one reward plan than they were under another plan. Experts were the subjects who were briefed on how to complete the matrices. The experiment was terminated when the subjects turned in the final questionnaire and were reimbursed by the experimenter.

Hypotheses

The hypotheses will be presented according to which dependent variable is being discussed. In all cases the alternative, or research, hypothesis is presented without the null hypothesis, which is simply that no differences exist among the relevant cells.

Performance

The first hypothesis summarizes the interactive effect of communication, incentive scheme, and feedback on performance. Since the predicted model is complex, it is presented in two steps. First, the reasoning underlying the relationships among sub-sets of cells is

presented. Then these sub-hypotheses are combined into a single model.

The first sub-hypothesis relates to the effect of communication. The cooperative incentive plan is expected to induce information sharing; therefore subjects with the opportunity to communicate are expected to have higher output than subjects in the cooperative incentive without communication. This would imply the following relationship for performance:

$$\text{Cells } 1, 1F, 5, 5F > 2, 2F, 6, 6F.$$

In the contest, however, communication -- if it occurs at all -- is expected to have a negative effect. The possibility that group members are not equally talented suggests that a Stackelberg equilibrium would emerge [Nicholson, 1978] due to differential abilities. Such equilibria arise in oligopolistic situations in which one firm is a clear price leader and other firms are clear price followers. The Stackelberg equilibrium in this study would occur if one group member is clearly more capable of performing this task than other group members. The less talented group members realize this and consequently do not strive to outperform the high achiever. The following relationship is then predicted:

$$\text{Cells } 4, 4F, 8, 8F > 3, 3F, 7, 7F.$$

Because the results on previous research comparing cooperative and competitive rewards have been mixed, researchers must consider the effect of intervening or additional variables in formulating hypotheses. The major prediction of this research is that in conjunction with the opportunity to communicate, cooperative rewards will result in significantly higher performance than competitive rewards do. In terms

of cell means this is represented as follows:

Cells 1, 1F, 5, 5F > 3, 3F, 7, 7F

Prior results have been mixed, but generally, for independent tasks without feedback and without communication output in contests has been equal to or greater than output in cooperative rewards.

Cells 4, 8 > 2, 6

Despite general support for the positive effect of feedback on output, the theory of contests predicts a negative effect of feedback in the competitive incentive plan. Thus, the expected effect of feedback is to reverse the pattern of the preceeding sub-hypothesis. In the competitive incentive plan learning one's rank through feedback is expected to be discouraging to the low producers and to indicate to the high producers that with relatively low output levels they can be the highest performer, which is the Stackelberg scenario. The resulting relationship follows:

Cells 2F, 6F > 4F, 8F

When multiple comparisons of means are performed the likelihood of an inappropriate finding of significance increases [Keppel, 1982].

Therefore, the above relationships are combined into a single model, based on the method of contrast coding.¹ The advantages of this method are threefold. First, the model does not use as many degrees of freedom

¹ This method is also called orthogonal polynomials or trend analysis [Keppel, 1982]. However, since all the independent variables in this study are dichotomous, the only pattern possible is a linear one. Therefore, it seems more appropriate to use "contrast coding," the phrase that Cohen and Cohen [1975] use for this type of coding, as it avoids the implication of quadratic or higher powered interactions, which do not apply in this study.

so the statistical power of the test is not decreased as it is when multiple tests are performed. Secondly, power, the likelihood of finding a significant effect when it does exist, is increased. Thirdly, this method enables the researcher to test for interactive relationships other than the crossover interaction, which is the interaction that the traditional ANOVA detects most powerfully. Using contrast coding, the relationships shown above are aggregated into a single hypothesis, which models the expected patterns of performance level among subjects in all sixteen experimental cells. Again, the numbers below refer to experimental cells:

HYPOTHESIS 1: Performance is the dependent variable.

1, 1F, 5, 5F > 2F, 4, 6F, 8 > 2, 4F, 6, 8F > 3, 3F, 7, 7F

This prediction says that generally performance is higher in cooperative rewards and the effect is increased by the opportunity to communicate. In addition, if subjects are not allowed to communicate, the effect of feedback is expected to be positive only in the cooperative condition. Under the competitive incentive plan, feedback is expected to impair performance.

The above hypothesis provides a tentative empirical test of one of the conclusions within the theory of contests. In this experiment there were six problem sets. However, subjects were monitored and paid for only three of those problem sets. Since these were randomly determined at the end of the experiment, subjects did not know which sets they would be paid for until after they have completed all six rounds. This random choice of problem sets is, according to O'Keefe et al. [1984], a type of random environmental shock in the monitoring system. O'Keefe

et al. describe various ways to increase randomness in the monitoring process -- the timing of spot checks, the use of more impressionistic evaluations, or paying differing amounts of attention to performance [p. 32-33]. In the current experiment the random shock is uncertainty about the monitoring system and it is present in all experimental conditions.

By contrast the expert member is an individual abilities manipulation and is present in only half the groups. This allows a preliminary test of the two incentives' relative effectiveness when the individual element dominates and when the environmental element dominates. According to the theory of contests, when the environmental shock dominates, contests are superior, which would imply that performance in cells 7 and 8 is higher than in cells 5 and 6, which is contrary to the model above. Alternatively, in those groups with an expert it is hypothesized that the individual differences will outweigh the environmental shock and, cells 1 and 2 would have higher performance than cells 3 and 4. If the data indicate that cells 7 and 8 exceed cells 5 and 6 and cells 1 and 2 exceed cells 3 and 4, the theory of contests could provide an alternative explanation. If the data do not indicate this pattern, then they provide some empirical results in conflict with the theory of contests. However, any results related to the theory of contests are at best suggestive, since the strict assumptions of the models are not met in this experiment.

Performance Variance

In addition to performance levels, managerial accountants must also consider the incentive plan's effect on the variability in performance

levels. Variation in performance is explored here both because it can cause practical problems and because research has shown that it may increase under certain types of incentive plans [Bull et al., 1987]. Consistent with the evidence found by Bull et al. [1987] performance variance is expected to be higher in the competitive condition than in the cooperative condition. Bull et al. did not have an explanation for the effect they found, but conjectured that it was due to the game nature of contests. The unit of analysis for this hypothesis is the three person work group. Variance is defined as the variance across the three group members as opposed to variance over time. While both types of performance variance are important management concerns, the consistency over time approach to variance is not being pursued here because a change over time is expected due to learning and to the provision of feedback during the last half of the experiment.

In this study, the piece-rate or cooperative scheme is expected to induce information transfer when communication is allowed and thus yield fairly consistent output across subjects in groups. Even in those cells in which communication is not allowed the hypothesized effect is expected because of the likelihood of a Stackelberg pattern in the competitive condition. So the hypothesis is across feedback and communication conditions, and is simply a prediction that variance of performance will be higher under the competitive incentive than under the cooperative incentive.

HYPOTHESIS 2: Variance of Performance

With or without feedback: 3, 4, 7, 8 > 1, 2, 5, 6

Information Transfer

Information transfer or sharing among subjects is the group process expected to drive the above results. The occurrence of such transfer will be measured in two ways. Subjects' output levels will provide indirect evidence of whether the expert subject shared information with his group members. In addition, subjects will be asked about that process in a final questionnaire. It is expected that information sharing will be greater in the cooperative condition than in the contest with communication. The reasoning is straightforward and is based on the notion of maximizing utility. Because the individuals in the cooperative incentive benefit if others in their group perform better, they will be motivated to share information and to work to develop rules for performing the task. Conversely, in the competitive condition, a group member earns less if other members perform better so there is a disincentive to share information.

HYPOTHESIS 3: Information Transfer 1, 5, 1F, 5F > 3, 7, 3F, 7F

Hypothesis 3 says that information sharing will be more frequent in the cooperative incentive than under the competitive incentive.

Expectancy

The two elements of expectancy theory which are measured in this study are expectancy and instrumentality. Expectancy is measured at four times during the experiment. At the beginning, a very general question is asked regarding the subjects' assessment of their ability on spatial tasks involving pattern recognition. During the actual problem sets expectancy is assessed at three separate times. The self-efficacy

measure is administered after the second set, the third set, and the fifth set. Subjects are asked to estimate what they believe their performance on the next set will be and to give the certainty with which they hold those expectations. This provides a measure of self-efficacy, a more relevant measure of expectancy in this situation, [Locke et al. 1984]. In this setting subjects are not allowed to decide how much time they wish to expend completing the project, which means their effort choices are severely restricted. Thus, it is difficult for subjects to hypothesize about different effort levels. See Appendix C for a copy of the instruments used. Subjects received feedback information on sets three, four, and five. So, the first general self-assessment of skill and the first self-efficacy measure are completed in the absence of feedback, while the second and third measure of self-efficacy are completed after receiving feedback.

Subjects are expected to have essentially equal expectancies on the general assessment and the first self-efficacy measure. Once feedback is provided to them, however, the effect of feedback and incentive scheme is expected to be interactive. Thus, in the competitive condition, feedback is expected to reduce expectancy, while in the cooperative condition, feedback is expected to have a positive effect on expectancy. Generally, in prior feedback experimentation the difficulty of goals was manipulated rather than the incentives or reward structures.

HYPOTHESIS 4.A: Expectancy Cells 1F, 2F, 5F, 6F > 1, 2, 5, 6

Hypothesis 4.A says that in the cooperative incentive feedback is expected to increase expectancy.

HYPOTHESIS 4.B: Expectancy Cells 3, 4, 7, 8 > 3F, 4F, 7F, 8F

Hypothesis 4.B. says that in the competitive incentive condition feedback is expected to lower expectancy.

Instrumentality

In the final questionnaire subjects were asked for information on their perceived instrumentality of the reward structures. It was expected that generally the instrumentality would be greater for the cooperative reward scheme than for the contest. The relationship of performance to reward is presented graphically in Figure 2.1. It is anticipated that subjects' perceptions will reflect the objective relationship and that instrumentality will be higher under the cooperative incentive than under the competitive incentive.

HYPOTHESIS 5: Instrumentality Cells 1, 2, 5, 6 > 3, 4, 7, 8

Table 3.1 - Summary of Research Hypotheses

<u>Dependent Variable</u>	<u>Expected Relationship</u>
1. Performance: 1, 1F, 5, 5F > 2F, 4, 6F, 8 > 2, 4F, 6, 8F > 3, 3F, 7, 7F	
2. Performance Variance: 3, 4, 7, 8 > 1, 2, 5, 6	
3. Information Transfer: 1, 1F, 5, 5F > 3, 3F, 7, 7F	
4.A. Expectancy: 1F, 2F, 5F, 6F > 1, 2, 5, 6	
4.B. Expectancy: 3, 4, 7, 8 > 3F, 4F, 7F, 8F	
5. Instrumentality: 1, 2, 5, 6, > 3, 4, 7, 8	

RESULTS AND DISCUSSION

The purpose of this chapter is to present the experimental results of the study. Each hypothesis is restated and followed by a description of the statistics used for testing that hypothesis, the results and the implications of the results. Statistical analysis was performed using the SAS program [SAS Institute, 1987].

To begin, a brief review of the experimental design is presented for expository clarity. The independent variables and their levels are:

- 1) Type of reward -
 - a) Cooperative
 - b) Competitive
- 2) Communication -
 - a) Allowed
 - b) Not allowed
- 3) Expert in group
 - a) Present
 - b) Not present
- 4) Outcome feedback
 - a) Provided
 - b) Not provided.

The first three variables are between subject variables, while the fourth independent variable is a within subject variable. For ease of reference the experimental design is graphically displayed below with numerical referents for experimental cells. The three between subject variables are included below. The within subject variable -- feedback -- is not displayed graphically. Each of the eight cells shown has a related cell number with an F suffix indicating that feedback was

provided. Thus, there are sixteen experimental cells in total.

Table 4.0 - Experimental Design

		<u>Incentive Plan</u>			
		<u>Cooperative</u>		<u>Competitive</u>	
		<u>Communication?</u>			
		Yes	No	Yes	No
Expert in Group?	Yes	1	2	3	4
	No	5	6	7	8

Results and Discussion of Hypothesis One

Performance 1, 1F, 5, 5F > 2F, 4, 6F, 8 > 2, 4F, 6, 8F > 3, 3F, 7, 7F

The prediction was that performance is higher in the cooperative reward with communication. In the competitive reward condition, feedback and communication are expected to have a negative effect. This hypothesis was tested using orthogonal contrasts [Keppel, 1982], a statistical method which is also called contrast coding [Cohen & Cohen, 1975]. This technique is particularly appropriate when research hypotheses involve interactions. Contrast coding allows a researcher to specify in advance the exact nature of the expected interactions and avoids the usual difficulties of increased Type 1 error caused by multiple planned comparisons. The specification of an overall model relating all the cells uses only one degree of freedom and results in a very powerful and efficient test. The procedure requires only cell means, the determination of suitable coefficients, and an overall mean

squared error term from a traditional analysis of variance. Because of the complexity of a model with sixteen cells the analysis is given first for the overall model, followed by the results for the important sub-hypotheses developed in chapter III.

The general formula for computing the sum of squares of a contrast coding model is:

$$SS_{\text{Comparison}} = \frac{s(\Phi)^2}{\sum (c_i)^2}$$

Where s = number of subjects in a cell

c = coefficient

i = a particular treatment, or cell

$\Phi = \sum (c_i) \cdot (A_i)$

A = treatment mean for cell i .

Keppel [1982, pp. 134-142] outlines the procedures necessary to obtain orthogonality in one's model, which is achieved by using the appropriate coefficients. Table 4.1.1 displays the performance cell means of the experimental design of Table 4.0.

Table 4.1.1 - Cell Means - Performance

		<u>Incentive Plan</u>				
		<u>Cooperative</u>		<u>Competitive</u>		
		<u>Communication?</u>				
		Yes	No	Yes	No	
<u>Without Feedback</u>	Expert in Group?	Yes	18.617	16.333	16.217	16.200
		No	20.127	15.545	15.431	16.045
		<u>With Feedback</u>				
		<u>Communication?</u>				
		Yes	No	Yes	No	
	Expert in Group?	Yes	21.900	19.056	17.600	18.700
		No	19.857	17.909	16.902	17.614

Table 4.1.2 includes the cell means, the appropriate coefficients for the contrast coding computation, and the cell sizes.

Table 4.1.2 - Contrast Coding Coefficients

<u>Cell #</u>	<u>Cell Means</u>	<u>Coeff</u>	<u>N</u>	<u>Coeff x Means</u>
1	18.617	3	60	55.851
1F	21.900	3	60	65.700
2	16.333	-1	36	-16.333
2F	19.056	1	36	19.056
3	16.217	-3	60	-48.999
3F	17.600	-3	60	-52.800
4	16.200	1	30	16.200
4F	18.700	-1	30	-18.700
5	20.127	3	63	60.381
5F	19.857	3	63	59.571
6	15.545	-1	33	-15.545
6F	17.909	1	33	17.909
7	15.431	-3	51	-46.293
7F	16.902	-3	51	-50.706
8	16.045	1	44	16.045
8F	17.614	-1	44	-17.614
				<u>43.723</u>

An examination of the cell size (N) column in Table 4.1.2 reveals that cell sizes are not equal. This arose from two causes. In some cases intact classroom groups were used as subjects. Also, a second instrument was designed to test instrumentality, as will be discussed in the section on Hypothesis Five. This instrument was used on an additional, smaller group of subjects in the odd-numbered cells only. The resulting disparity in cell sizes requires the use of a harmonic mean [Keppel, 1982, p. 347-350]. When using contrast coding a mean square term is calculated according to the formula above and compared to the mean square error term of a traditional ANOVA to obtain an F statistic. The traditional ANOVA is presented in Table 4.1.3. Since this is a repeated measures design, performance for each subject is measured both with and without feedback. The traditional ANOVA indicates a significant four-way interaction. However, it does not provide any evidence on the pattern of the interaction, which renders interpretation difficult. When the hypothesized model is tested using contrast coding, the results are altered as shown in Table 4.1.4.

Table 4.1.3 - ANOVA - Performance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
<u>Between Subjects</u>					
Reward	1	1005.82	1005.82	43.48	.0001
Comm	1	248.62	248.62	10.75	.0011
Expert	1	40.45	40.45	1.75	.1868
Rew * Comm	1	540.77	540.77	23.38	.0001
Comm * Expert	1	3.93	3.93	.17	.6804
Rew * Expert	1	1.28	1.28	.06	.8137
Rew * Comm * Expert	1	7.38	7.38	.32	.5723
Error (Between)	369	8535.80	23.13		
<u>Within Subjects</u>					
Feedback	1	574.22	574.22	74.76	.0001
Feed * Reward	1	2.31	2.31	.30	.5833
Feed * Comm	1	28.66	28.66	3.73	.0542
Feed * Expert	1	92.27	92.27	12.01	.0006
Feed * Rew * Comm	1	1.20	1.20	.16	.6930
Feed * Comm * Expert	1	15.28	15.28	1.99	.1593
Feed * Rew * Expert	1	49.21	49.21	6.41	.0118
Feed * Rew * Comm* Exp	1	48.52	48.22	6.32	.0124
Error (Within)	369	2834.32	7.68		

Table 4.1.4 - Contrast Coding Results

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1045.96	1045.96	67.89	.0001
Unexplained by Model	14	1613.96	115.28	7.48	.0001
Error	738	11370.12	15.41		

Thus, the null hypothesis is rejected, and the model is seen to be significant. The total of the treatment sums of squares in Table 4.1.3 is 2659.92, and the model explains approximately 39% of that treatment variance, which is a significant proportion of the between-groups variation. However, while the model is highly significant, it provides

only marginally more explanatory power than the main effect of reward in the traditional ANOVA. Furthermore, the variance that is not explained by the model is also significant, which indicates that the hypothesized model does not maximize explained variance. As explained in chapter two, the original hypothesis subsumed several sub-hypotheses. A further analysis of the sub-hypotheses indicates that the model was not successful because the expected negative effect of feedback and communication in the competitive reward condition did not occur. The purpose of the following additional tests is to diagnose the error in the model, to probe which relationships implied in the model actually occurred and which did not. Since these tests are not being relied upon for hypothesis testing and since the results of the original model are highly significant, the simplest adjustment --the modified Bonferroni test [Keppel, 1982] -- is being made for the possible increase in the alpha rate due to multiple, non-independent comparisons. Using a familywise error rate of .05, and a total of sixteen cell means, the required significance level for any particular test is .003.

The following analysis is organized by sub-hypothesis. After the sub-hypothesis is stated, the t-test results comparing the means of the two groups, and the group means are presented. Since the presence of feedback was provided for only half of the problem sets, there are two sets of means involved -- performance without feedback and performance with feedback.

Sub-hypothesis A: 1, 1F, 5, 5F > 2, 2F, 6, 6F

This hypothesis predicts that given a cooperative reward, communication will result in improved performance. The t-test results

for performance with and performance without feedback were significant ($p < .0001$). The means are presented in Table 4.1.5; the numbers in parentheses following the means are the cell numbers.

Table 4.1.5 - Sub-Hypothesis A

	Without Feedback	With Feedback
With Communication	19.39 (1,5)	20.85 (1F,5F)
Without Communication	15.96 (2,6)	18.51 (2F,6F)

Sub-Hypothesis B: 4, 4F, 8, 8F > 3, 3F, 7, 7F

Given a competitive reward scheme, performance will be higher without communication than with communication. While the cell means are in the hypothesized direction, this sub-hypothesis was not supported. Results of the t-test were $p < .7064$ for performance without feedback and $p < .1631$ for performance with feedback. Thus, while the hypothesized beneficial effects of communication with a cooperative reward did occur (sub-hypothesis A), the hypothesized negative effects of communication in the competitive scheme did not. The actual means are shown in Table 4.1.6:

Table 4.1.6 - Sub-hypothesis B

	Without Feedback	With Feedback
With Communication	15.86 (3,7)	17.28 (3F,7F)
Without Communication	16.11 (4,8)	18.05 (4F,8F)

Sub-Hypothesis C: 1, 1F, 5, 5F > 3, 3F, 7, 7F

The premise of this hypothesis is that given the ability to communicate, performance will be higher in the cooperative reward than in the competitive reward. This is essentially a comparison of the top row of each of the two tables above. The results are highly significant; for both dependent variables the t-test results are $p < .0001$. The data appear in Table 4.1.7.

Table 4.1.7 - Sub-hypothesis C

	Without Feedback	With Feedback
Cooperative reward	19.39 (1,5)	20.85 (1F,5F)
Competitive reward	15.86 (3,7)	17.28 (3F,7F)

Sub-Hypothesis D: 4, 8 > 2, 6

The prediction was that if subjects were not allowed to communicate, performance with feedback would be higher in the competitive reward condition than in the cooperative reward. This expectation was based on the mixed results of prior research, which indicated a weak advantage for competitive rewards in independent tasks. The relevant cell means are presented in Table 4.1.8 (the cells included are shown parenthetically in the matrix). The t-test results were not significant ($p < .85$).

Sub-Hypothesis E: 2F, 6F > 4F, 8F

The expectation was that without the ability to communicate, performance with feedback would be higher in the cooperative reward condition, since subjects who were ranked low within the competitive

group would be discouraged by their status and would decrease their expectancy. The t-test results were not significant ($p < .416$). The expected strong differential effect of feedback, such that performance would decline in cells 4F and 8F did not occur. Table 4.1.8 contains the cell means of performance. Further discussion of the effect of feedback follows Table 4.1.8.

Table 4.1.8 - Sub-hypotheses D and E

	Without Feedback	With Feedback
Cooperative reward	15.95 (2,6)	18.51 (2F,6F)
Competitive reward	16.11 (4,8)	18.05 (4F,8F)

Generally, the analyses of the sub-hypotheses reveal that the strongest effect was the interaction of the cooperative reward and the communication condition. The hypothesized interaction due to feedback did not appear, with the result that the model tested using contrast coding did not add significant explanatory power over a traditional ANOVA.

Further analysis of the role of feedback is warranted since the observed effects differed from predictions. Feedback was expected to cause a change in subjects' performance, to increase performance under cooperation and to impair it under the competitive incentive plan. It is helpful, therefore, to examine the patterns of change scores. A change score can be calculated by subtracting a subject's performance in the last three problem sets from his performance in the first three

problem sets. The results of a traditional ANOVA using a change score as the dependent variable are presented in Table 4.1.9.

Table 4.1.9 - ANOVA - Performance Change Score

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Reward	1	4.63	4.63	.30	.5833
Comm	1	57.32	57.32	3.73	.0542
Expert	1	184.55	184.55	12.01	.0006
Rew * Comm	1	2.40	2.40	.16	.6930
Comm * Expert	1	30.56	30.56	1.99	.1593
Rew * Expert	1	98.42	98.42	6.41	.0118
Rew*Comm*Expert	1	97.05	97.05	6.32	.0124
Error	369	5668.639	15.362		

The three way interaction arose because of an unusual pattern in the cell means, shown in Table 4.1.10. This table reflects the experimental design shown in Table 4.0, so cell indicators are not included.

Table 4.1.10 - Cell Means - Performance Change Score

		<u>Incentive Plan</u>			
		<u>Cooperative</u>		<u>Competitive</u>	
		<u>Communication?</u>			
		Yes	No	Yes	No
Expert in Group?	Yes	3.283	2.722	1.383	2.50
	No	-.270	2.364	1.470	1.568

The very small decline in performance in cell 5 was unexpected and gave rise to the three-way interaction. The performance in cell 5 without feedback was the highest of the eight cells, and the performance with

feedback was the second highest. Thus, it appears that subjects in this cell attained their maximum performance level during the first three rounds and feedback had virtually no effect. The decline is not significant in absolute terms, nor does it indicate that feedback caused performance to be at low levels compared to those in other cells. Cell 5 included a group of students who were the most communicative of all the subjects during the early rounds. Since all other cells had a positive change, cell 5 is anomalous and causes a significant four way interaction in the ANOVA. These results should not, therefore, lead to conclusions that the effect of feedback is negative in this one experimental condition, and positive in all others. Instead, the more appropriate inference is that if subjects share information effectively, as they did in cell 5, feedback provided by an experimenter does not aid performance.

Because the sample size was very large and the number of comparisons in the ANOVA was high, significant findings may have occurred by chance [Keppel, 1982]. The possibility that the unusual pattern of cell 5 gave rise to the significant four-way interaction was investigated using omega squared, a statistic which indicates the proportional amount of the total population variance explained by the experimental treatments. Omega squared is not affected by sample size. Table 4.1.11 presents the value of Omega squared for the significant interactions from the ANOVA results of Table 4.1.3.

Table 4.1.11 - Omega Squared Results

Source	ANOVA Pr > F	Omega Squared
<u>Between Subjects</u>		
Reward*Communication	.0001	.060
<u>Within Subjects</u>		
Feedback*Expert	.0006	.030
Feedback*Reward*Expert	.0118	.015
Feedback*Rew*Expert*Comm	.0124	.014

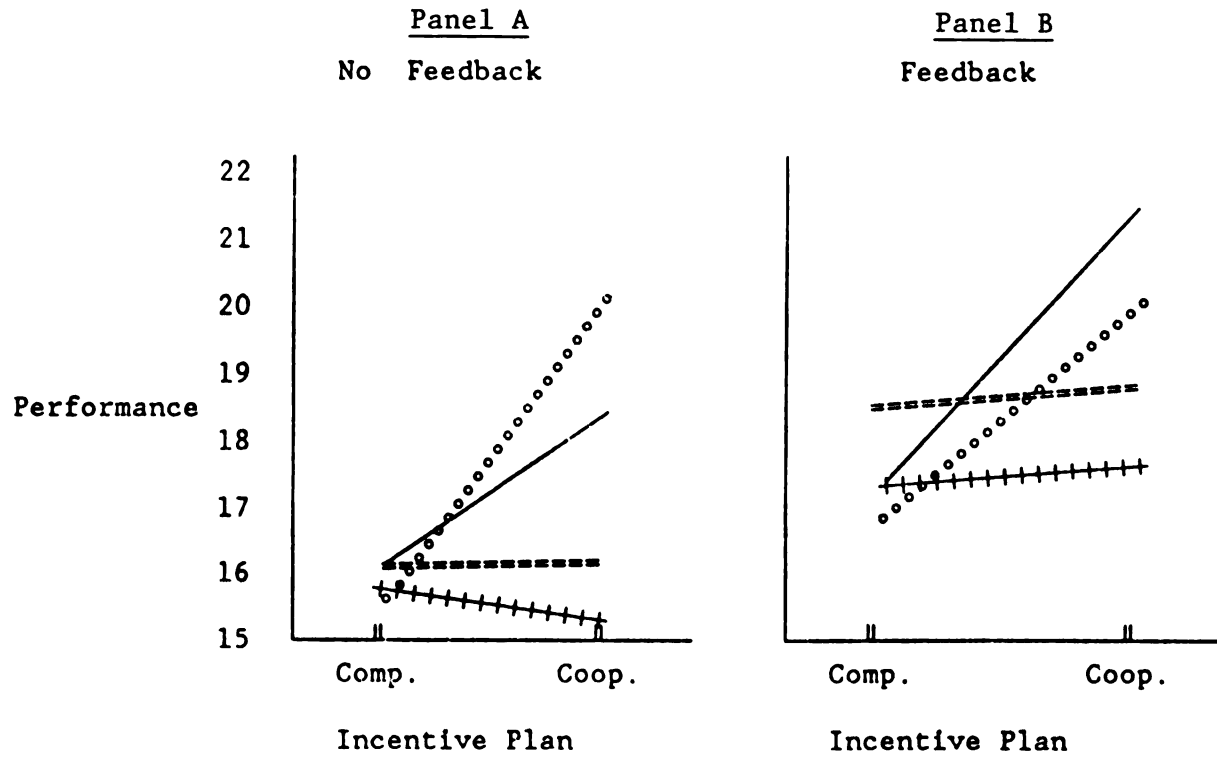
The interpretation of Omega squared is somewhat difficult, but generally in the social sciences an Omega squared of .15 or more is considered a large effect, a medium effect is approximately .06 and a small effect is .01 [Keppel, 1982]. The Omega squared results in Table 4.1.11 imply that the interactive effect that explained the greatest proportion of variance was the reward - communication interaction. Despite a significant main effect for feedback, no interactions involving feedback were significant in the Omega squared computation.

Graphically the pattern of performance is presented in Figure 4.1. The graph demonstrates that for all conditions except the no expert-communication line (cells 5 and 7) the slope increased in Panel B, i.e. the difference in performance across reward conditions was greater with feedback than without feedback. This gives further evidence of the impact that the atypical pattern of cell 5 exerted.

The performance pattern in cell 5 raises the possibility that communication with other group members can be a very effective form of feedback. The general research approach on feedback has been to treat only information provided by the experimenter or teacher as feedback. However, in this study group members of the most cohesive cell provided

sufficient information to one another to render the experimenter's feedback otiose. This suggests that feedback and communication were partially confounded and should be manipulated separately in future research. These results suggest further that in some settings the costs of providing feedback can be reduced by structuring incentive plans to encourage communication among workers.

An informal test of the theory of contests was also carried out. According to the theory of contests, a random shock -- the rewarding of three problem sets which were not specified in advance -- would cause competitive schemes to dominate individual, piece-rate schemes. On the other hand, an individual difference, such as ability, could mitigate the environmental effect and result in higher performance in the individual schemes. The implication was that for performance, cells 1 and 2 would exceed cells 3 and 4, and that cells 7 and 8 would exceed 5 and 6. Instead, performance in cells 1 and 2 exceeded that in cells 3 and 4, and cells 5 and 6 exceeded cells 7 and 8. In both cases the t-tests results had $p > .0001$. In this study, the cooperative piece-rate reward dominated the competitive reward scheme regardless of whether the individual difference was present or absent. In summary, the incentive plan was shown to have a significant effect on performance and to interact with communication. The results support the work done on cooperation versus competition showing that cooperative plans are more productive than competitive incentive plans when communication is allowed. Earlier mixed results indicated that additional variables were important when determining the incentive schemes' productivity. The present results demonstrate that communication among workers is an

**Legend:**

- Expert present, Communication allowed - Cells 1 and 3
- No Expert, Communication allowed - Cells 5 and 7
- Expert present, No Communication - Cells 2 and 4
- +++++ No Expert, No Communication - Cells 6 and 8

FIGURE 4.1

Graph of Performance Results

important variable which may cause increased productivity even when the task is not an interdependent one. Feedback generally had a positive effect on performance, with the exception of cell 5 in which performance did not improve with feedback.

Results and Discussion of Hypothesis Two

Variance of Performance Cells 3, 4, 7, 8 > 1, 2, 5, 6

Hypothesis Two predicts that variance of performance will be greater in the competitive incentive conditions than in the cooperative incentive conditions. In order to statistically test the variance of performance levels in this study a procedure suggested by Games et al. [1972 and 1979] was followed. Games et al. [1979] reviewed several tests for homogeneity of variance in factorial studies. Usually, such tests are comparisons of the variance between cells, with a single variance calculated for each cell. In this study, however, the hypothesis predicts that variances within work groups of a given cell will differ from variances of work groups in other cells. In the Box-Scheffe method recommended by Games, each cell is broken into I random subsamples of M subjects each. The natural log of the variance of the subsamples is computed; and these values are used as data points in an ANOVA with I data points per cell. This transformation alters the test to one of location, which allows "a great increase in the type of hypotheses that may be tested," [Games, 1979, p. 981]. The Box-Scheffe test is robust to violations of normality assumptions. Although it is not as powerful as some alternatives Games et al. [1972] demonstrated that a group size of three is optimal in terms of statistical power, up

to a total of 36 groups. For more subsamples than 36, power is little affected by group size if it falls in the range of 3 to 6. In this study, the experimental design determined the only possible selection of subsamples which is of interest, which was the three person work group.

Because performance was a repeated measure, the variance was computed on performance with and without feedback. The results of the ANOVA using the Box-Scheffe procedure are presented in Table 4.2.1:

Table 4.2.1 - ANOVA - Variance in Performance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Reward	1	94.659	94.659	39.35	.0001
Communication	1	28.721	28.721	11.94	.0008
Expert	1	.292	.292	.12	.7279
Comm * Reward	1	70.274	70.274	29.22	.0001
Comm * Expert	1	.038	.038	.02	.9006
Expert * Rew	1	.009	.009	.00	.9519
Comm*Expert*Rew	1	1.555	1.555	.65	.4230
Error	118	283.823	2.405		

The results of the ANOVA show a significant effect for reward. They also, though, indicate a significant effect for communication and for the interaction of communication and reward.

The data in Table 4.2.2 indicate the pattern of the dependent variable -- group variance -- at the two levels of reward and communication. Visual inspection of the mean scores indicates that for both dependent variables the reward - communication interaction arises because of the significantly lower score in the cooperative reward with communication cell. The typical analysis at this juncture is to compute t-tests to determine any simple effects, i.e., one tests across

Table 4.2.2 - Mean Scores - Six Round Variance in Performance

	<u>Without Feedback</u>		<u>With Feedback</u>	
	Comm.	No Comm.	Comm.	No Comm.
Cooperative	-1.2819	2.0452	-2.3663	1.9368
Competitive	2.2122	1.9993	1.6768	1.673

communication conditions while holding the reward constant. In the cooperative condition, the communication manipulation resulted in a significant difference in performance variance ($p > .0001$). However, in the competitive condition, the communication manipulation caused no statistical difference ($p > .615$ for variance without feedback and $p > .9975$ for variance with feedback).

This result is consistent with the reasoning underlying Hypothesis One. Performance variance can be reduced only when subjects are allowed to communicate. Given this necessary condition, communication will have positive effects only when the incentive plan rewards the sharing of information. In the cooperative condition it is in subjects' interest to share their task knowledge in order to maximize group output. In the competitive condition, conversely, it is not in the subjects' interest to improve the performance of others in their work group. Thus, in the competitive reward condition the opportunity to communicate did not reduce observed variance in performance.

In the above analysis, variances were computed on the performance scores. It was considered possible that the pattern of performance variance over all six problem sets combined could differ from the

pattern of the two variances computed separately with and without feedback. Thus, a second analysis was done using a single variance for all six problem sets, in order to provide assurance that the above results were not due to splitting the performance into two categories. Again, the Box Scheffe procedure was used to obtain the data points for the ANOVA. The results are displayed in Table 4.2.3, which reveals the same pattern as that in the earlier results. Thus, computing the variances separately with and without feedback did not influence the results.

Table 4.2.3 - ANOVA - Six Round Performance Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Reward	1	199.759	199.759	37.65	.0001
Communication	1	50.247	50.247	9.47	.0026
Expert	1	.331	.331	.06	.8031
Comm * Reward	1	59.061	50.061	11.24	.0011
Comm * Expert	1	8.695	8.695	1.64	.2030
Reward * Expert	1	2.404	2.404	.45	.5023
Reward * Comm * Expert	1	19.061	19.061	3.59	.0605
Error	118	626.265	5.306		

The performance variance means presented in Table 4.2.4 reveal the familiar pattern of a significantly lower variance in one cell of the four cells in the two-way interaction.

Table 4.2.4 - Means of Variance - Six Rounds

	Communication	No Communication
Cooperative Reward	-.353 (1,5*)	2.380 (2,6)
Competitive Reward	3.192 (3,7)	3.081 (4,8)

* Since these means are for all six problem sets, the feedback and non-feedback cells are combined.

Finally, although the alternatives to the Box-Scheffe procedure used above avoid the problem of the arbitrary selection of sub-samples, such tests are not theoretically appropriate in this study since they rely explicitly or implicitly on an overall cell measure (such as mean or median) rather than on the variance of the unit of interest -- the work group. For the sake of completeness, one alternative test was conducted. It is the Brown-Forsythe test which uses $X_{ij} = [Y_{ij} - \text{cell median}_j]$ as a test of variance, where Y_{ij} is the Observed score for the i th subject in the j th cell. The results of this test, which is less powerful than the Box Scheffe for this particular hypothesis, appear in Table 4.2.5. Although the Brown Forsythe test is less powerful than the Box Scheffe, the reward effect is still significant. For this test, neither the effect of communication nor the interaction of reward and communication is significant, however.

Table 4.2.5 - Brown Forsythe test

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Reward	1	31.864	31.846	4.12	.0431
Communication	1	12.371	12.371	1.60	.2068
Expert	1	.081	.081	.01	.9183
Reward*Comm	1	1.345	1.345	.17	.6769
Comm * Expert	1	3.143	3.143	.41	.5242
Reward*Expert	1	.000	.000	.00	.9988
Reward*Comm*Expert	1	7.318	7.318	.95	.3313
Error	369	2853.640	7.733		

In order to provide more evidence that variance of performance in this setting affects performance negatively, the correlation between

variance and performance was calculated. This overall calculation precluded any comparisons of the two feedback conditions, the two reward conditions, or the communication conditions. The correlation analysis was conducted to provide further support for the hypothesized inverse relationship between performance level and variance of performance. Using the variance calculated on all six rounds and performance for all six rounds the correlation between the two variables was $-.4377$ ($p > .0001$). Therefore, a strong negative relationship between performance and variance of performance was observed.

In summary, the results of the original analysis and the two supplementary analyses indicate that reward and communication significantly interact in their effect on variance of performance. The research hypothesis was that reward would have an effect on performance variance; no interaction was predicted. The results indicated that while communication has little effect in the competitive condition, the possibility of communication was significantly related to lowered variances in the cooperation condition. These results are consistent with those of Hypothesis One and again provide evidence that in the debate over the relative merits of competitive versus cooperative schemes, an important factor to consider is not only the nature of the task, but the nature of the work process -- i.e. whether or not subjects are allowed to communicate with one another about how to perform their tasks.

Results and Discussion of Hypothesis Three

Information Transfer 1, 1F, 5, 5F > 3, 3F, 7, 7F

It was hypothesized that given the opportunity to communicate, subjects in the cooperative reward condition would do so with greater frequency than subjects in the competitive reward condition. In this case the dependent variable is a categorical variable and the analysis was done on the frequency of information sharing among group members. With frequency data, the Chi-squared test is the preferred statistical test [Siegel, 1956, pp. 175-180].

A copy of the final questionnaire used to gather the data for this hypothesis is presented in Appendix A. The first question asked "Did you receive any information from the experimenter on how to perform the task?" If the subject answered yes, he or she was instructed to go to a series of questions asking about sharing the information. If the subject answered no, then he or she was directed to questions about receiving information from group members. All subjects were asked how they had gone about solving the problems and a general instrumentality question. The purpose of the initial question on receiving information was to segregate those subjects who were the "experts", i.e. those who had received detailed instructions, from those subjects who had not received such instructions. The effectiveness of this identifying question is shown in Table 4.3.1. Before subjects actually began the task, it was necessary to explain progressive matrices in very general terms and that the task was to select the appropriate symbol from a choice of four or five alternatives. In this introduction to the problem no information was provided on how the matrices were designed.

A sample matrix with a random pattern was used as an illustration and was erased before the actual task began. By contrast, the "experts" were provided a set of written instructions describing the two types of matrices they would see, the logic underlying the construction of the matrices, and heuristic rules on how to quickly select the correct choice. A verbal explanation was provided, the examples in the instructions were reviewed, and questions were solicited and answered. In the discussion of Hypotheses One and Two, "expert" referred to groups which included an expert member. In discussing information sharing, "expert" is used to refer to the individual subjects given task information.

Only half the cells (1 through 4) included experts. Since there was one expert per group the actual number of experts was 62. In Table 4.3.1 the responses by all subjects to question one of the final questionnaire are summarized and reveal that while the experts responded correctly, many of the non-experts felt that they too had received information.

Table 4.3.1 - Question One Responses

	Did you receive information on the task?	
	Yes	No
Expert	59	1
Non-expert	109	202

Table 4.3.1 indicates that over one-third of the non-experts responded inappropriately to first question. While this renders the results less

clear, it does not negate them. The point of Hypothesis Three is that the reward scheme under which a subject works will affect information sharing behavior. Whether the shared communication is the information provided by the experimenter is not crucial. The research question is whether subjects shared task information, regardless of the source of that information.

In the second phase of the experiment when the longer instrumentality scale was used, this problem was circumvented by asking subjects if they had received a "pre-test" of a certain color. Since the expert instructions were printed on green paper, and the irrelevant pre-tests given to non-experts were printed on other colors, the experimenter had a mechanism for "forcing" subjects to correctly identify themselves as expert or non-experts. In both phases of the experiment an independent identification was maintained by using identifying subject number for experts. A positive implication of the subjects' apparent confusion is that while the true experts knew they had been given private information, the non-experts did not realize that someone in their group had received such information. This reduces the likelihood that information was shared because of group pressure on the expert and increases the likelihood that information was shared because it was in the individual's interest to do so.

The purpose of the expert manipulation was to enable the experimenter to independently trace, through an increase in performance, the sharing of that information. As the results of Hypothesis One indicate, however, the expert manipulation did not affect performance, while communication did. If subjects shared their understanding,

regardless of whether it was based on information provided by the experimenter, group performance improved. The crucial behavioral question is whether, believing he or she had information that could be helpful, the subject shared it with others in the work group more frequently under one reward scheme than under another. Evidence relevant to that thesis is provided in Table 4.3.2.

Table 4.3.2 - Frequencies: Reward X Information Sharing

	Shared Info. (Communication Cells only)	Did not share Info.
<u>Reward</u>		
Cooperative	46	12
Competitive	8	36

Chi-square is 37.5 with degrees of freedom of 1 ($p < .0001$). Table 4.3.2 includes only subjects in cells in which communication was allowed, since they were the only subjects who were allowed to act on their decision to share information. Thus, the hypothesized main effect for reward was not rejected. As predicted, subjects in the cooperative reward condition were significantly more likely to report sharing information than subjects in the competitive condition. Table 4.3.2 includes only subjects who indicated they had received information from the experimenter. Because some subjects did not respond to all of the questions, there were more missing data points relating to this hypothesis than to other hypotheses. However, several more tests were completed to investigate the accuracy and consistency of responses.

One consistency test was a point-biserial correlation of member

responses in each group. The correlation was .71, with a probability > .0001. Of the fifty-five groups with no missing data, forty-eight showed agreement among all three group members. For instance, if the expert said he shared information, both of the other group members said that they received information from other group members. Seven groups gave inconsistent responses. This manipulation check gives some comfort that responses were accurate.

An additional accuracy check was provided by question eight, which asked subjects if they had worked out a rule to solve problems alone or with a group. This check has the disadvantage of possibly precluding subjects who communicated but failed to develop a problem solving heuristic. It has the advantage, though, of permitting non-experts to indicate whether information was shared in their group. The cross-tabulation of responses to question eight with the incentive condition appears in Table 4.3.3:

Table 4.3.3 - Frequencies: Reward X Work Style

<u>Reward</u>	Worked as Group (Communication Cells Only)	Worked Alone
Cooperative	59	29
Competitive	9	61

Chi squared is 46.698 for one degree of freedom, $p < .0001$, for 158 responses of a total of 232. The Chi squared results indicate that the frequency of work style was not independent of the reward or incentive plan.

Another question regarding information sharing behavior asked if subjects had received information from anyone in their group. Responses to that question were tested against responses to the question regarding developing a problem solving rule together or with other group members. The data are shown in Table 4.3.4.

Table 4.3.4 - Frequencies: Work Style X Receiving Information

	Received info. from others in group (Communication Cells Only)	Did not receive info. from others
Worked alone	18	26
Worked together	48	15

Chi squared is 13.64, degrees of freedom = one, $p < .0001$. The final questionnaire was not precise and that imprecision is indicated by the responses. It is feasible that subjects did receive some advice from others but still felt that they developed a rule or heuristic for solving the problems by themselves.

A final consistency check was performed by cross-tabulating the responses to question two and question eight in Table 4.3.5. The former question asked whether subjects had shared information, while the latter question asked whether they had worked out a rule to solve the problems by themselves or in a group. Chi square is 20.38, one degree of freedom, $p < .0001$. Although these additional analyses indicate some imprecision in the final questionnaire, this weakness does not vitiate the obtained results showing that reward scheme results in differential

frequencies of information sharing.

Table 4.3.5 - Frequencies: Work Style X Information Sharing

	Reported Sharing (Communication Cells Only)	Did not Share
Worked Alone	8	19
Worked Together	25	3

An open-ended question on subjects' motivation for sharing or withholding information was provided. Only subjects who responded that they had received information from the experimenter were directed to this question. Responses regarding the motivation to share (or not share) information tended to fall into seven categories and were coded numerically. Typical responses in the categories are listed in Table 4.3.6. The frequency of each response is shown in parentheses with the frequency in the cooperative reward condition followed by the frequency in the competitive condition:

Table 4.3.6 - Reasons for Information Sharing Behavior

- 0 - I had no information the others did not have as well (1,11)
- 1 - to earn more money (5,21)
- 2 - fairness (9,0)
- 3 - I was told not to talk with others, or I did not know the others did not have the same information (26,14)
- 4 - not enough time, didn't understand the information (6,8)
- 5 - to maximize group profits, to get the most correct (30,10)
- 6 - others did not appear to need my help (5,7).

There were no hypotheses made regarding subjects' responses, but the results confirm intuitions that different incentive conditions result in different motivations for behavior.

For the sake of brevity the following discussion will be narrative only, without the inclusion of tables. The summary statistics will be provided, however. When the responses to question two (did you share information) were crossed with question four (the reason for sharing or withholding information) those subjects who shared information were significantly more likely to give fairness and maximizing group profits (2 and 5 above) as their reasons. Those who did not report sharing information were significantly more likely to give selections 0, 1, 4, or 6 as their reasons. That is, they felt the others did not need the information, or already had the information, or they wanted to earn more money, or felt time constraints. A Chi squared was done on the reasons given by the two groups and the results were 81.72, degrees of freedom of 5, $p < .0001$. When reward was crossed with motivation subjects in the cooperative condition gave fairness and maximizing group profit as reasons significantly more than subjects in the competitive condition. Subjects in the competitive condition more often gave the following reasons - the others had the same information, to earn more money, or the others did not appear to need. Again a Chi-square was done on the distribution with results of 40.819, degrees of freedom = 6, with $p < .001$. Although no hypotheses were made regarding the reasons people would give for information sharing, these results support the thesis that reward schemes and reasons given for behavior are related. This

study does not resolve the question of whether the reward scheme affects the reasons people give for their behavior or whether the reward scheme directly affects behavior and subjects chose reasons which support or rationalize their behavior.

One anomalous pattern did emerge from the various Chi square tests performed. It was expected that the experts in the cooperative condition would be highly motivated to share information, while the experts in the competitive condition would not be likely to share information. A Chi square crossing the actual "expertise" with reported information sharing yielded some surprising results. The data in Table 4.3.7 include all those subjects in communication cells who responded to question two, indicating whether or not they had shared the information they had received.

Table 4.3.7 - Frequencies: Expertise X Information Sharing

	Shared info.	Did not share
Expert	9	29
Non-expert	45	19

The Chi squared is 20.91, one degree of freedom, $p < .001$. Contrary to expectations, the subjects with expert information were not significantly more likely to share that information; in fact they were less likely to do so. The significant Chi squared results are based on the high level of information sharing by non-experts combined with the low incidence of sharing by the experts. Given the significant effect

of reward scheme on reported information sharing, a further breakdown of Table 4.3.7 by reward scheme was completed. The cross tabulation of reward by information sharing by the thirty-eight expert subjects (the top row of Table 4.3.7) is shown in Table 4.3.8.

Table 4.3.8 - Frequencies: Reward X Information Sharing

	Shared info. (Experts - Communication Cells)	Did not share
Cooperative reward	7	11
Competitive reward	2	18

Chi square is 4.374 with one degree of freedom, $p < .036$. This indicates that there was a greater percentage of information sharing in the cooperative reward than in the competitive reward and that the proportions were significantly different in the two reward conditions.

However, Tables 4.3.7 and 4.3.8 indicate that regardless of the reward scheme, the informed subjects were not as likely to share information as they were to withhold it, an unexpected finding. The research hypothesis was accepted, however, because of the high rate of information sharing by non-experts in the cooperative incentive condition. The results of only the non-expert subjects (the bottom row of Table 4.3.7) appear in Table 4.3.9. Chi square is 37.77, one degree of freedom, and $p < .0001$. Table 4.3.9 parallels Table 4.3.2 and indicates that non-expert behavior caused the strong results for Hypothesis Three.

Table 4.3.9 - Frequencies: Reward X Information Sharing

Shared info. Did not share
(Non-experts - Communication cells)

Cooperative reward	39	1
Competitive reward	6	18

The low level of information sharing by experts in the cooperative condition is surprising. All experts were told that they were the only member in their group receiving specific task-related information and that during the "pre-test" other subjects were completing problems unrelated to the experimental task. The nature of the incentive was reviewed with all subjects at the beginning of each session. Outcome feedback indicating the number correct and - in the competitive condition - the rank within the group was provided. This feedback was expected to clarify and reinforce the nature of the incentive plan. Since the experts were chosen at random and had not earned their privileged knowledge, equity theory implies they would be likely to share this information. Sharing of information was predicted to be more frequent in the cooperative condition because it was in the expert's interest to increase the performance of his group. The researcher does not have an explanation for the low incidence of information sharing by the experts. The observed results could be due to a small sample; there were only 62 experts in total and 38 who were allowed to communicate. The lower rate of information sharing by experts indicates that differential ability or expertise should be considered in research on group information sharing and on reward effects. Possibly, the expert

manipulation was not successful; i.e. the experts did not believe they were more proficient than the non experts were. Finally, the experts may have felt the others did not deserve to make more money because of the experts' knowledge, regardless of how that knowledge had been obtained.

Results and Discussion of Hypothesis Four

Expectancy (4.A) 1F, 2F, 5F, 6F > 1, 2, 5, 6

Expectancy (4.B) 3, 4, 7, 8, > 3F, 4F, 7F, 8F

In general, the predicted effect of outcome feedback was to increase expectancy (Hypothesis 4.A). However, that effect was expected to interact with the reward scheme, such that in the competitive reward condition, feedback would decrease expectancies (Hypothesis 4.B). The first measure was a very general measure based on a five-point Likert type scale of estimated ability relative to other people. It was used at the beginning of the experiment, just after the researcher provided a general explanation of the task. At this point, subjects were expected to have statistically equal expectancies regarding their abilities. Expectancies were measured after round two, which was prior to feedback, and again after rounds three and five, after subjects received feedback on their performance. The scale used for the last three measures is based on Locke et al. [1984] and is actually a measure of self-efficacy, which provides better predictions of performance in this type of setting. An example of the form used is provided in Appendix C.

After round two subjects were again expected to have basically equal expectancies. Once feedback was supplied, however, the expectancies

were predicted to diverge. In the cooperative condition, particularly with communication, it was posited that subjects would work together, thereby improving performance, and increasing expectancy. In the competitive condition, feedback was expected to have a negative effect on those subjects who were not ranked highest in the group. While the predicted effect of feedback on the best performer in the group was positive, it was expected to be outweighed by the negative effect on the other two group members.

Several analyses were conducted on the data. The first was an ANOVA based on the initial expectancy, presented in Table 4.4.1.

Table 4.4.1 - ANOVA - Initial Expectancy

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Reward	1	.090	.090	.16	.6872
Communication	1	.303	.303	.54	.4618
Expert	1	.891	.891	1.60	.2074
Reward*Comm	1	1.535	1.535	2.75	.0984
Reward*Expert	1	3.753	3.753	6.72	.0100
Comm* Expert	1	.055	.055	.10	.7518
Reward*Comm*Expert	1	.560	.560	1.00	.3172
Error	335	187.210	.558		

Although no significant differences in means were expected, the reward * expert interaction was significant. However, the cells means were examined and were not substantively different. Therefore, no conclusions are drawn regarding the initial expectancies.

On the form used to elicit expectancies (Appendix C) subjects indicated their expectations regarding certain levels of performance and the certainty of their expectations. A summary expectancy figure was

obtained by multiplying the increment of the score (which was two, in all cases) by the likelihood of obtaining that score level in decimal form. An example is presented in Table 4.4.2. The number correct column was pre-printed on the form. Subjects filled the middle two columns.

Table 4.4.2 - Computation of Expectancy - an Example

<u>At Least # Correct</u>	<u>Yes or No</u>	<u>Degree of Certainty (0 to 100%)</u>	<u>Expectancy Contribution</u>
2	Y	90	2 x .90 = 1.80
4	Y	80	2 x .80 = 1.60
6	Y	75	2 x .75 = 1.50
8	Y	60	2 x .60 = 1.20
10	N	100	2 x 0 = <u>.00</u>

Total Expectancy = 6.10

Using the total expectancy as calculated in Table 4.4.2, the hypotheses were examined with simple t-tests. The cell means of expectancy for the feedback and the reward conditions are shown in Table 4.4.3.

Table 4.4.3 - Cell Means - Expectancy

	Without Feedback	With Feedback
Cooperative	5.7827	6.6589
Competitive	5.3385	5.6975

Test results of means in the cooperative condition were significant, $t = 5.087$, $p < .001$, in the direction predicted. In the competitive condition the t-test results were also significant, $t = 1.9468$, $p < .05$, in the opposite direction of that predicted. Feedback did not have a negative effect on expectancy in the competitive reward condition.

Instead, expectancy increased with feedback in both reward conditions which indicates that at least in this type of competitive reward the Stackelberg equilibrium did not emerge. It is not clear what the effect of negative feedback in a more prolonged work setting would be.

Hypothesis Four makes the strong claim that feedback will increase expectancy in one incentive condition and decrease it in the other incentive condition. The focus of Hypothesis Four is on the change in expectancy across the two levels of the feedback manipulation. Therefore, an explicit test of the change in expectancy was also performed. Cohen and Cohen [1975] caution against the over-use of change scores because they are less reliable measures than direct measures, which themselves, include measurement error. The following analysis is not serving as a basis for hypothesis testing, however, but simply to explore the data. Difference scores were computed by subtracting the expectancy obtained after round two from the expectancy obtained after round five. The results of the ANOVA are shown in Table 4.4.4 and the related cell means are presented in Table 4.4.5. The expectancy change means presented in Table 4.4.5 demonstrate the now familiar pattern we have seen in the analysis of performance and variance of performance. When reward and communication are crossed, the dependent variable (change in expectancy) is significantly higher in the cooperation-communication cell and approximately equal in the other three cells.

In summary, expectancy increased in all cells with the addition of feedback. Since expectancy is closely correlated to performance, and performance increased in all cells except cell 5, this supports

Table 4.4.4 - ANOVA - Change in Expectancy

Source	DF	Type III SS ¹	Mean Square	F Value	Pr > F
Reward	1	10.907	10.907	3.74	.0539
Communication	1	8.460	8.460	2.90	.0894
Expert	1	1.742	1.742	.60	.4399
Reward*Comm	1	13.021	13.021	4.47	.0353
Reward*Expert	1	.218	.218	.08	.7843
Comm* Expert	1	.345	.345	.12	.7310
Reward*Comm*Expert	1	6.482	6.48 0	2.22	.1368
Error	340	991.065	2.914		

Table 4.4.5 - Cell Means - Change in Expectancy

	Communication	No Communication
Cooperative	1.1739	.4313
Competitive	.3955	.4923

expectancy theory. The predicted deleterious effect of feedback on expectancy in the competitive reward condition did not occur, although

1 Prior to this particular ANOVA all Sums of Squares displayed have been Type I Sum of Squares, which is the typical computation taught in experimental design textbooks (see, for example, Keppel [1982]). In Type I Sum of Squares, the order in which effects are entered does not affect the computation. By contrast, the Type III Sum of squares is computed as if each effect were the last to be entered into the equation, i.e. after all other effects have been accounted for. Generally, this will result in lower significance levels than in Type I analyses. Because of the highly significant results obtained in results reported to this point, there has been no difference between the two methods in which effects were found to be significant. In this analysis, however, there was a difference, and so the more restrictive Type III results are being shown. Using an alpha level of .05, the one effect which would be reported differently using the Type I Sum of Squares is reward, which had an F of 6.84 and pr. > F of .0093.

the increase in expectancy under the competitive incentive plan was lower than under the cooperative incentive plan. The incentive plan interacted with communication to generate the largest expectancy increase in the cooperation - communication cells.

Results and Discussion of Hypothesis Five

Instrumentality 1, 2, 5, 6 > 3, 4, 7, 8 (with or without feedback)

Hypothesis Five predicts that instrumentality will be higher in the cooperative reward than in the competitive reward. Instrumentality was measured in two ways. For the first phase of the experiment, instrumentality was measured in the final questionnaire with one question, based on Ilgen et al. [1981], who found the average test-retest reliability of such a scale to be .58. Subjects were asked, "If you had an average of five items correct per set and then began to do substantially better, your average pay per set would:" and were given a nine point verbally anchored Likert scale. Level 7 was designated "Increase Moderately" while level 5, as the mid-point, was labelled "Stay About the Same." The ANOVA for this single-item measure is displayed in Table 4.5.1.

Table 4.5.1 - ANOVA - Single item Instrumentality

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Reward	1	.673	.673	.66	.4157
Communication	1	5.543	5.543	5.47	.0200
Expert	1	.185	.185	.18	.6695
Reward*Comm	1	1.357	1.357	1.34	.2482
Reward*Expert	1	2.082	2.082	2.05	.1529
Comm* Expert	1	3.244	3.244	3.20	.0746
Reward*Comm*Expert	1	.066	.066	.07	.7975
Error	284	287.843	1.013		

There was an unanticipated main effect for communication, with the mean response of subjects allowed to communicate being 6.635 and the mean response of subjects who were not allowed to communicate being 6.354. The cell means are presented in Table 4.5.2.

Table 4.5.2 - Cell Means - Single item Instrumentality

	Communication	No Communication
Expert in Group	6.711	6.212
No Expert in Group	6.556	6.474

Further examination of cell means reveals that communication had no effect in the non-expert condition and a positive effect in the expert condition, which is an interactive relationship ($p < .0746$). The result that instrumentality was lowest in cell 4 (expert in group, no communication, competitive reward) is not surprising. Subjects in this category who were not doing well and could not communicate with other group members to obtain information on the task or on others' performances were expected to have lower instrumentalities. That is, they were expected to perceive a lower correlation between performance and increases in pay because they had the least information with which to estimate that relationship. This simple, single question regarding instrumentality was based on the measure used by Ilgen et al. [1981] in their comparative study of scales to measure expectancy theory variables. While all four scales for instrumentality used in that study were found to have high validity, the reliabilities ranged from the mid

.40's to the mid .70's. The single question measure has the virtue of being a relatively simple and very brief instrument. This gross measure was not expected to differentiate between incentive conditions as effectively as the longer scale based on probabilities. The results in Tables 4.5.2 and 4.5.4 confirmed this expectation.

For the second phase of the experiment the longer scale based on probability assessments was used (Appendix D). Ilgen et al. [1981] stress the need for further exploration of scales used to measure expectancy theory variables. By using two measures in the current study provides additional data on their relative sensitivity. The scale used in the second phase of this experiment had .78 test-retest reliability in the Ilgen et al. [1981] study, as well as high validity.

Because pay and performance are related in a monotonic pattern in both incentive plans, their perceived correlation was expected to be high under both incentive plans. However, the cooperative incentive plan provides a simple, linear relationship between pay and performance, while the competitive incentive scheme represents a step relationship. The hypothesis was that the step relationship would result in lower instrumentality (perceived correlation between performance and reward) than the linear pattern. Instrumentality was computed by correlating performance with expected pay for five levels of performance. The correlation scores were transformed using Fisher's Z transformation. The ANOVA results using the Z transformed correlation scores appear in Table 4.5.3. Because this instrument was used in a second phase which included only communication cells, the model is a two-factor model including reward and expert only.

Table 4.5.3 - ANOVA - Fisher Z Scores

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Reward	1	95.957	95.957	57.21	.0001
Expert	1	.003	.003	.00	.9690
Reward*Expert	1	.920	.920	.55	.4612
Error	75	125.788	1.677		

The cells means of the Fisher Z Scores are presented in Table 4.5.4.

Table 4.5.4 - Instrumentality - Fisher Z Scores

	Expert	No Expert
Cooperative Reward	4.1029	4.3389
Competitive Reward	2.1093	1.9131

The hypothesized results were strongly supported, with the reward effect accounting for more than 99% of the non-error variance. In addition, two Student-Newman-Keuls tests were performed. The reward variable was significant and the expert variable resulted in no statistical difference among means.

Because the z score is a natural logarithm, it could exaggerate differences in raw correlations. Therefore a test done directly on the correlation scores was also performed. The results of that analysis are shown in Table 4.5.5. The results using the untransformed correlation scores replicate those obtained by using Z scores, providing added assurance that the results are not caused by manipulation of the data.

Table 4.5.5 - ANOVA: Instrumentality Correlations

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Reward	1	.042	.042	9.11	.0035
Expert	1	.000	.000	.09	.7622
Reward*Expert	1	.000	.000	.08	.7787
Error	75	.346	.005		

In summary, the results of this section provide further support for expectancy theory. Instrumentality varied in the direction predicted and most of the non-error variance was explained by the incentive plan effect. As a final test of expectancy theory, total performance on all six problem sets was regressed on expectancy and instrumentality. The residuals were symmetrically distributed and kurtosis was low (-.16), indicating that the data are suitable for regression analysis. The results showed that both instrumentality and expectancy were significant in explaining the variance in performance ($p > .0028$ and $.0001$) respectively. This provides additional support for the explanatory value of the two expectancy theory variables tested in this study.

Overview of Results

Table 4.6.1 summarizes the test of hypotheses results presented in this chapter. In sum, Hypotheses 1, 2, 3, 4A, 5 were supported; while Hypothesis 4B was rejected. Generally, performance in the cooperative reward combined with the communication condition was highest and variance of performance was lowest in that condition. Variance of performance was inversely related to performance and was highest in the competitive incentive plan. Information sharing was affected by

incentive plan, although those subjects who had been given individual expertise did not share information to the same extent as the non-experts did. Expectancy was affected by reward, but increased with the provision of outcome feedback in all conditions. Feedback did not prove to be a negative factor in the competitive condition, as was predicted in Hypothesis 4B. Finally, instrumentality was significantly higher in the cooperative incentive plan. Further discussion and implications of the results are presented in Chapter Five.

Table 4.6.1 - Summary of Research Findings

<u>Hypothesis</u>	<u>Conclusion Re: Null</u>	<u>Main Table</u>
1	Reject the null	4.1.4
2	Reject the null	4.2.1
3	Reject the null	4.3.2
4A	Reject the null	4.4.4
4B	Fail to reject the null	4.4.4
5	Reject the null	4.5.3

CONCLUSIONS

The purpose of this chapter is to summarize the results of this research, discuss the limitations of the study, and indicate some further research which could be carried out.

Research Findings

Research results on the question of productivity under cooperative versus competitive incentives have been mixed. The nature of the task was shown to be an important, orthogonal variable. The results of the current research indicate that the opportunity of agents to communicate is another important variable, which can significantly affect results. Performance was enhanced and the variance of performance levels was reduced when subjects could communicate and were rewarded under a cooperative incentive plan. The expectations regarding feedback effects were that it would positively affect performance in the cooperative reward and negatively affect it under the competitive incentive plan. Instead, feedback was found to positively affect performance regardless of reward structure, although the improvement in performance was somewhat larger in the cooperative reward.

Information sharing was affected by reward structure. The results on information sharing support the conclusion that managerial accountants must consider not only the effect a reward scheme will have on an

individual's motivation to expend effort, but also on that individual's behavior towards other individuals. If agents can be motivated via incentive structures to share information with others, the principal will generally be better off. Information exchange among workers was shown to be an important form of feedback. Managerial accountants should consider group interaction as a form of feedback when designing incentive plans. In addition, the reasons people cited for sharing or withholding information were different under the cooperative and competitive reward structures. The information sharing results suggest that economic models of worker behavior which assume a single agent and a single principal should be enlarged to include the possibility of inter-agent communication. An important aspect of this study is that subjects were allowed to communicate face-to-face, rather than through restricted mechanisms such as notes [De Jong, et al., Waller and Payes, 1989]. Given the significance of the communication variable on performance, expectancy, and variance of performance, the effects of direct, unrestricted communication deserve further study.

Expectancy theory provided the framework for measuring motivational variables. Two of the three theoretical variables suggested by expectancy theory -- instrumentality and expectancy -- were shown to be significantly affected by reward structure. Expectancy was hypothesized to increase in the cooperative reward and to decline in the competitive reward because of an interactive effect of reward and feedback. Instead, expectancy increased in both reward conditions. The results parallel those of performance in that expectancy increased the most in the communication-cooperation cell, while the increase was approximately

equal in the other three cells. Instrumentality was significantly affected by reward, as predicted. The results on instrumentality are important because prior studies have compared instrumentalities of grossly different pay structures -- a piece rate which is performance based versus hourly or straight pay, which is not performance based. By contrast, this study compared two structures which were both performance based. Finally, the variance of instrumentality was not significantly different across any of the experimental manipulations.

Contributions of the Research

The results of this research demonstrate the importance of considering additional factors in testing the relative efficacy of incentive plans. It was already known that the nature of the task and the existence of goals were important variables in the comparison of cooperative and competitive incentive plans. This study has shown that the opportunity to communicate directly with other workers is an important factor affecting performance levels differently under varying incentive plans.

This study offers another, closely related contribution in that it suggests that workers provide heuristic feedback to one another when they are appropriately rewarded for doing so. Given the strong effect of communication on performance, this research provides evidence that the single-agent, single-principal model needs to be expanded to a multi-agent model. Results showing the superiority of competitive rewards may be significantly altered in the presence of direct communication among agents.

This study also provided a more rigorous application of instrumentality and expectancy scales used in earlier research. The instrumentality scale distinguished between two performance based incentive plans, which is a more subtle comparison than that tested in prior research. While the expectancy results were not entirely as predicted, the expectancies obtained reflected actual performance patterns, which supports the validity of the scale and supports expectancy theory.

The use of contrast coding was demonstrated, although the particular model hypothesized contributed only marginally to the total variance explained.

An informal, tentative test of the theory of contests was conducted. The results relating to the effect of individual and environmental differences did not support the theory. Results relating to the variance of performance also did not support the theory, but did replicate prior empirical findings.

The unexpected results showing that designated "experts" were less willing than non-experts to share information, regardless of the incentive plan they were working under, indicates that differential abilities may be problematic. Theory of contest researchers [O'Keeffe, et al. 1984] speculated that abilities that this would be the case. In this study, the information provided to experts was a surrogate for ability. However, because the expert effect was not significant, the surrogation was not successful. It is possible, therefore, that two separate issues are involved here -- the use of privileged information and the effect of individual ability.

Limitations of the Research

Constraints on generalizing the results of this research generally relate to the experimental methods used in testing the hypotheses. The limitations of the experiment are described below.

The Progressive Matrix problems were chosen because subjects' performance in pilot tests improved significantly with a short description and explanation. However, the matrix problems are not so difficult that only the designated experts could complete them. While a very difficult task could have made tracing the effect of experimenter provided expertise easier, an extremely difficult task could have caused motivational problems and resulted in inappropriate rewards. The results could be generalized more if other types of tasks were used. In addition, the role of expertise could be clarified if more different types of task were studied.

The manipulation of expertise was not entirely successful. Although the experts were given a written explanation, a verbal description, a chance to ask questions, and even -- in the second round -- some samples to work on, not all experts were the highest performer in their group. Subjects' visual ability was an important variable in their performance and that skill was not measured by a pre-test. However, given the large sample sizes used, it is probably safe to assume that the ability required for solving progressive matrices was randomly distributed among the experimental cells. If this assumption is correct, ability should not have caused any significant differences in cell means. In this

study the group process of research interest was information sharing. The experimenter's intent was to supply the experts with the information that could be shared or hoarded. During the actual experiment, however, many non-experts shared their skills and insight into the nature of the experimental task. That the information shared was not always the information supplied by the experimenter is not crucial. The important point is that the amount of sharing was shown to depend significantly upon the reward structure used. The obtained results raise some interesting questions as to why non-experts were, in fact, more willing to share information than experts.

Another limitation was the relatively short time involved. The number of problem sets was six, each one lasting three minutes. The entire experiment took from 70 to 100 minutes. While subjects had time to communicate if they chose to, in a more dynamic and extended setting different behaviors may have emerged. The possibility of such outcomes is discussed more fully in the following section of the paper. An additional benefit of using an extended time period [Ilgen et al., 1981] is that test-retest reliabilities could be determined for various scales. The advantage of the relatively short time required for the experiment was that it increased the likelihood of obtaining subjects.

Two instrumentality scales were used in the analysis. One was a single item used by Ilgen et al. [1981] and all subjects in the first phase of the experiment responded to it. An additional five item scale was used, but the questions were poorly designed, and the results were indicative of subjects' confusion. Further testing was carried out to emulate the longer scales used by Ilgen et al., modifying them as

appropriate for this study. That modification consisted of some simplification of the presentation. Had the longer questionnaire been used for all of the subjects the results on instrumentality might be more powerful because of the larger sample size.

In the communication condition, subjects often told each other their performance levels. It is possible that fuller disclosure of the other group members' scores in both conditions would have had some impact on performance.

An additional limitation is based on the particular incentive plans tested in this research. Within the broad categories of cooperative and competitive rewards, there are many individual methods of relating pay to performance. The two plans used here were chosen because they emphasized the group nature of the incentive plan. A competitive scheme in which pay differential was greater could result in different behaviors.

Finally, many questions still exist about the most appropriate form of feedback and the differing effects of feedback under various incentive plans. In this research a very minimal form of outcome feedback was tested. Because this research is a study on incentive plans, which link performance and reward, it was essential to include at least minimal feedback. By definition incentive plans must include a feedback mechanism. If pay is not linked to performance, then employees do not have to know their performance levels. However, if pay is linked to performance, then employees must be told their performance levels. Because an additional purpose of the study was to explore the effect of incentive plans on intra-group information sharing, it was essential

that the feedback provided by the experimenter be limited. Outcome feedback indicates only the level of past performance. In the competitive condition, subjects were told their rank as well as the number they had correct. In the cooperative condition, subjects were told only the number they had correct. Their rank did not have a direct relationship to their pay so this information was not supplied. However, it would have been possible to tell them their total group productivity and their pay based on that. The appropriate feedback is determined by the nature of the incentive plan. It is difficult to structure an experiment with different incentive structures and identical feedback.

Other forms of feedback are primarily motivational, consisting of exhortations to work harder and not be discouraged. Feedback can also be more heuristic and individualized. One can examine how an employee is approaching the problem and provide guidance and directions for working more efficiently or effectively. None of that was done in this study since the focus was not on the efficacy of feedback, but rather on how incentive plans would alter group behavior. By sharing information on their performance and on how to perform the task, the group members were providing heuristic feedback to one another. Many questions are still unanswered about the most appropriate type and amount of feedback in various work settings.

Future Research

Future research on incentive plans and their effect on inter-agent behavior could be developed along several distinct directions. Other

types of tasks should be tested -- particularly those involving complex decision making. Generalizability is limited until numerous replications over a wide range of tasks and subjects have been completed. In future research ability should be a covariate, measured at the beginning of the experiment in order to see how performance or output changes over time. The theory of contest researchers suggest that differential abilities may play a significant role in agent behavior. It may prove fruitful to control for this variable and to purposely manipulate it in order to determine its impact. This could be done, for instance, by using more difficult or specialized tasks, such that expert knowledge is necessary for successful completion. Such a manipulation must be handled carefully, however, since an increase in difficulty could lead to the confounding of task difficulty with task interdependence.

The unexpected results in which the experts were relatively reluctant to share information support the conjectures of the theory of contest researchers and emphasize the importance of differential ability. In this study the experts were given some information which ostensibly affected their ability to perform the task. They were less willing to share this information than subjects who had not received any privileged information. Did the experts feel they had earned the right to benefit from this privileged information? Did they genuinely misunderstand their instructions? Did the experts in the cooperative reward fail to see that sharing information was in their own interest? These questions are rendered more significant when considering the fact that information sharing by non-experts was significantly affected by the reward

structure. The non-experts apparently realized they could exchange information to their benefit. Why were they more willing to share their ability with other group members?

The experiment should be run over longer time periods or over more periods, if possible. This would increase the possibility of either a Stackelberg equilibrium or collusion arising. An additional, methodological benefit to extending the time would be the possibility of measuring test-retest reliabilities of various scales. Ilgen et al. [1981] have stressed the need for such testing of expectancy theory variables.

The possibility of collusion -- an intentional and coordinated level of production below a level that could be reasonably achieved -- is an interesting avenue for future research. The existence of such behavior has been documented [Roy, 1952; Hickson, 1961; Coch & French, 1948; Marriott, 1971]. Furthermore, the possibility that workers may collude is widely recognized [Dye, 1984; Holmstrom, 1982; Lawler, 1981; Hopwood, 1976]. Nonetheless, the effect of various incentive plans on collusion has not received much attention.¹ In this study collusion would have been most likely in the competitive setting. Since subjects were paid a flat minimum wage (\$.50) for every period and a bonus for higher performance relative to the others in their group, effort averse subjects would be expected to communicate with other group members and

¹ The studies mentioned above focussed on the social processes that are involved in maintaining a restricted output level among group members, rather than looking at whether such behavior is affected by reward structures.

agree to do the minimum necessary to allow the principal to differentiate among the group members. Successful collusion would require side-payments, or other means of assuring pay equity. For instance, the group members could agree to take turns being the most productive member of the group. Both the restricted time-span and the educational setting contributed to the fact that collusion did not arise in the current experiment. Future experiments would strive for greater realism in terms of length of study or could be done in the field.

Another suggestion for future research is to separately test the effect of feedback and inter-agent communication by manipulating only one at a time instead of using a factorial experiment. Since feedback has been widely researched, the greater need is to study the effect of inter-agent communication. Much of what was communicated among group members was obviously feedback on the nature of the task and how to do it correctly. If the appropriate technology is available, it would be very interesting to monitor the exchanges among workers to see what information is exchanged and what -- if any -- means are used to encourage or discourage such sharing of information. Different variations of cooperative and competitive incentive plans could be tested using a similar research design. In particular, the differential of pay in the competitive reward could be manipulated.

A final, difficult and profound issue underlying this research is the question of the definition of rational self-interest. In the current study fairness and self-interest were united in the cooperative reward scheme, but were at odds in the competitive reward scheme. Ethical motives were not the subject of this research. The study of the force

of ethical values in shaping economic decisions has not yet developed in the accounting and economics literature. Kahneman et al. [1986] say, "The absence of considerations of fairness and loyalty from standard economic theory is one of the most striking contrasts between this body of theory and other social sciences...." They suggest that the standard economic model would be enriched by the inclusion of fairness in agents' motivation. Noreen [1988] argues that economic markets would be eliminated without the assumption of ethical behavior. He quotes Kenneth Arrow, "It can be argued that the presence of what are in a slightly old-fashioned terminology called virtues in fact plays a significant role in the operation of the economic system..." Arrow includes truth, trust, loyalty and justice in future dealings as examples of such virtues. The importance and value of cooperative behavior have been emphasized in recent psychology research. The benefits of altruistic behavior have been shown to include the unexpected result of positive biochemical changes in the agent [Luks, 1988]. By contrast, competition is shown to have many negative psychological consequences. These include decreased motivation and enjoyment and increased anxiety. See Kohn [1986] for a thorough review of the literature in this area. One of Noreen's [1988] stated purposes is to stimulate the inclusion of ethical considerations in discussions of accounting. Future research on reward structures could be done focussing on the force of ethical considerations both separately and in conjunction with more traditional economic incentives.

APPENDIX A

INFORMED CONSENT DECLARATION

APPENDIX A
INFORMED CONSENT DECLARATION

The purpose of this research is to explore the effectiveness of various incentive plans. In order to comply with University rules, it is necessary that you read and sign this form.

This research requires you to participate in several sets of problems called progressive matrices. In addition, you will be asked to answer some questions about your performance and how your performance relates to your pay. All the information you supply will be kept confidential by the researcher, Sue Pickard, and will be seen only by her. She assumes all responsibility for maintaining the confidentiality of all results. You will be given a subject number to use on all forms.

Your pay for this experiment will depend upon your performance. As there are different types of sessions, details of this will be explained at the beginning of the session you participate in.

You may stop at any time, but if you choose to do so, you will not be eligible for any compensation.

At the end of the study, a written description of the study and the findings will be available from Sue Pickard.

Along with these rights, you incur some responsibilities by being a subject. The primary responsibility is that you provide reliable answers to the questions asked. We also ask that you do not discuss this experiment with students outside this group; since the project is still in progress other sessions will be conducted.

I certify that I have read and understand the rights and responsibilities I have incurred as a subject in this research. Given this understanding, I voluntarily agree to participate.

Print your name

Signature

Date

APPENDIX B

FIRST EXPECTANCY MEASURE

APPENDIX B

FIRST EXPECTANCY MEASURE

SUBJECT NUMBER _____

The task you are about to perform and for which you will be paid involves seeing relationships among abstract, visual symbols. Some people are better at this sort of task than others are. Please indicate below on a scale of one to five how you rate your general ability in this area by circling the appropriate number. Examples of similar skills are map-reading and interpreting graphs.

My skills at this sort of task are:

Worse than most other people's	Somewhat lower than average	About Average	Somewhat better than average	Better than most other people's
1	2	3	4	5

APPENDIX C
LATER EXPECTANCY MEASURE

APPENDIX C

LATER EXPECTANCY MEASURE

SUBJECT NUMBER _____

Test Set _____

Please indicate what you believe your performance will be on this set by indicating whether you believe you can get the scores below and how certain you are of getting that score:

	Y - Can do N - Cannot do	Degree of Certainty: 0 to 100%
At least 2 right	_____	_____
At least 4 right	_____	_____
At least 6 right	_____	_____
At least 8 right	_____	_____
All 10 correct	_____	_____

APPENDIX D
FINAL QUESTIONNAIRE

APPENDIX D

FINAL QUESTIONNAIRE

Subject Number _____

Please answer the following questions as accurately as possible.

1. Did you receive a green test during the pre-test portion of the experiment?

Yes _____ Please go to Question 2.

No _____ Please go to Question 5.

2. If you answer yes to question 1, did you share the information you received from the experimenter with your fellow group members? Yes _____ No _____.

3. If you answered no, please go to Question 4.

If you answered yes, at what point in the experiment did you share the information? For example, did you share it before you started working on the tasks? After two rounds?

4. What was the reason you decided to share or to not share the information?

_____ GO TO QUESTION 9

5. Did any group members give you information on how to perform the task?

Yes _____ No _____

6. If you answered yes, was the information helpful? Yes _____ No _____

7. If you answered no to #5, did you figure out a rule to use in answering the questions? Yes _____ No _____.

If you did figure out a rule, could you please describe it:

8. Did you work this rule out alone or as a group?

Alone _____ As a group _____

9. In this part of the questionnaire I am trying to get at what you feel are the consequences or effects of how much work you do at this task. The questions are in a somewhat unusual format. I will be asking you to imagine that something happened 10 times and asking you to indicate the number of times in 10 that specific consequences would follow. This can be a difficult idea to grasp, so I will start with an example.

EXAMPLE: Suppose that on 10 different days you went to Hamburger Heaven and each day you ate two Giganto-Burgers, one shake and an order of fries. How many times in 10 would you.....

Still be hungry Feel Comfortably full Feel Stuffed

_____ + 3 + 7 = 10

In this example, the person has indicated that he or she would feel comfortably full 3 of the 10 times but on 7 of the 10 visits would have been too full. This person also indicated that he or she would never have felt hungry on any of the 10 days. Note that the answers total up to 10.

Here is a second example. Assume that a person was offered a ride to school on 10 different occasions and was asked the following:

How many times did you ride in a

Red car White car Green car Blue car Silver car

$$\frac{2}{} + \frac{2}{} + \frac{2}{} + \frac{2}{} + \frac{2}{} = 10$$

This person has indicated that it is equally likely that he or she has ridden in cars of the colors indicated by the five choices.

NOW I WOULD LIKE YOU TO ANSWER SOME QUESTIONS ABOUT THE RELATIONSHIP OF YOUR PERFORMANCE TO YOUR PAY. PLEASE ANSWER EACH LINE AS A SEPARATE QUESTION AND ASK IF YOU ARE CONFUSED.

Based on the method of payment you are receiving and the experience you had doing these problems, indicate your chances in ten of being paid at each of the following levels if you get the following number correct:

IF I GET THE
FOLLOWING # MY CHANCES IN 10 OF BEING PAID AT EACH LEVEL IS:
CORRECT:

2 Correct: _____

NOW ANSWER THE SAME SET OF QUESTIONS ASSUMING THAT YOU HAD 4
CORRECT, ETC.

[illegible]

10. Now, please indicate what amount you would expect to be paid if you have the following number correct in a single problem set. Notice that this is another way of answering the same questions you answered above:

Correct Expected Pay

2 _____

3 _____

4 _____

5 _____

6 _____

7 _____

8 _____

9 _____

10 _____

11. Could you please indicate:

a. Your sex M _____ F _____

b. G. P.A. _____

c. Major _____

d. Age _____

e. Have you ever worked under an incentive plan? Yes _____ No _____

f. If yes, could you please describe the plan?

THANK YOU FOR YOUR PARTICIPATION.

Please turn in your questionnaire and pick up your compensation. Please remember that the research project is not completed and it is important that you do not discuss the project with anyone outside this classroom.

A summary of the research results will be available spring quarter from Sue Pickard, in the Accounting Department, if you are interested. If you would like to discuss the project with Sue before then, feel free to contact her at 355-7486.

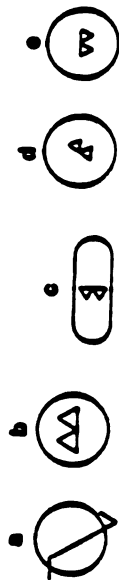
APPENDIX F

PRE-TEST FOR NON-EXPERTS

5. PREFER is to LIKE as SAFE is to:—
 a. valuables b. secure c. keep d. spend e. want

6. 33, 26, 19, 12, —

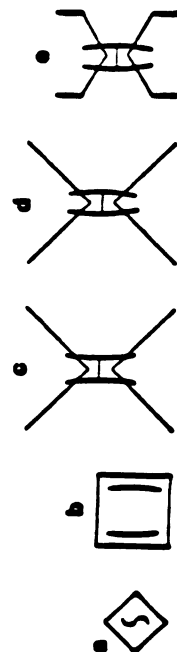
7.  is to  as  is to:—



8. HOUR is to TIME as INCH is to:—
 a. foot b. minute c. hurry d. carry e. length

9. 4, 8, —, 32, 64

10.



11. SEED is to PLANT as CHILD is to:—
 a. boy b. play c. human d. adult e. toy

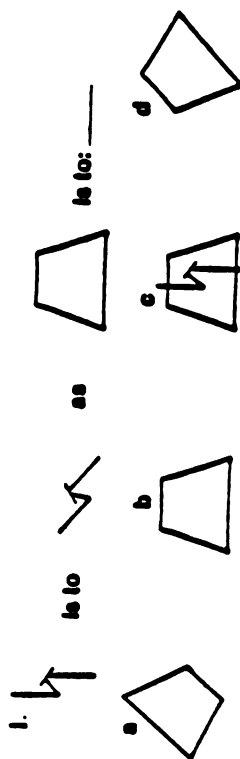
12. 1, —, 9, 27, 81

PLEASE DO NOT WRITE ON THIS TEST.

An Answer Sheet will be provided.

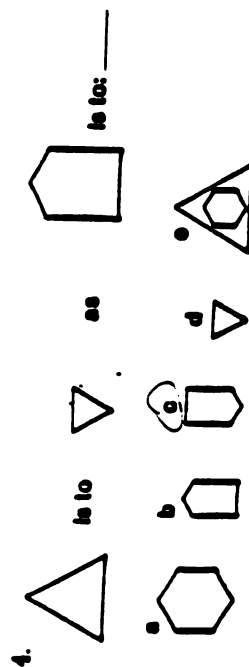
Thank you. Remember, it is unlikely that

you will finish all the items.

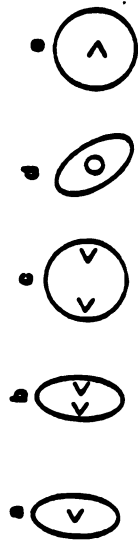


2. BUY is to SELL as GIVE is to:—
 a. employ b. save c. receive d. slow e. purchase

3. 5, 9, 13, —, 21



13.

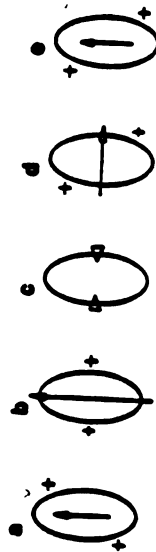


14. OCEAN is to POND as MANSION is to:—

- a. home b. cottage c. puddle d. bricks e. dwell

15. 2, 4, 7, 11, —, 22

16.

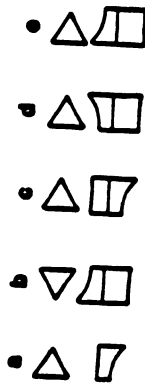


17. EWE is to SEED as ONE is to:—

- a. number b. sell c. grow d. does e. get

18. 3, 5, 9, 15, —, 33

19.



20. RED is to GREEN as LIME is to:—

- a. apple b. tree c. stem d. eat e. fruit

21. 0, 3, 9, —, 30, 45

22.



23. RUNNY NOSE is to HANDKERCHIEF as SILVER is to:—

- a. cold b. shake c. sniff d. healer e. omit

24. 4, 7, 11, 17, —, 39

25. What Will George Do Tonight?

George has a problem about what to do with his spare time this evening. There's a pro football game on TV, friends have invited him to a party, he has free tickets to see the ballet, and the cinema near his apartment is showing a movie he has been looking forward to seeing. To make his dilemma even more acute he has just reached the last chapter of a gripping novel and is about to discover the murderer. What will George do tonight given that he...

Likes parties less than movies.

Dislikes reading less than sports.

Doesn't like the ballet as much as parties.

Dislikes reading more than the ballet.

When you have found out what he will choose, find out what he is least likely to have chosen.

26. The Nukkeldowne Elementary School believes in good old-fashioned discipline; its educational philosophy allows for only moderate use of positive stroking.

In fact, Ms. Rapp, Ms. Ruhl, and Mr. Palmer - each a specialist in either reading, writing, or arithmetic (though not necessarily in that order) - are the only teachers at the Nukkeldowne School who regularly reward their students for good work.

From the following clues, can you determine which teacher is in charge of each class, and offers each reward?

1. Ms. Ruhl, who doesn't teach the arithmetic class, gives her best students brownie points.
2. Mr. Palmer and the teacher who gives her students gold stars for excellence work in adjacent classrooms.
3. The writing teacher rewards the neatest, most legible, work with red letters.

27. A A G N N O T R U

How many names of animals can you form using any or all of the nine letters above? For each word, you may repeat only those letters that appear more than once. Our list includes 13 animals, one using all nine letters.

APPENDIX G

INSTRUCTIONS FOR EXPERTS

INSTRUCTIONS ON RESEARCH TASK

Please note that you are the only member of your work group to get this information. You are under no obligation to share this information with anyone and should follow your own self-interest.

You will be given some matrix problems which only look difficult. Once you know the ways to solve them you will be able to do so quickly and easily. There are several different types of matrices that you will see. A majority of the matrices you will see are based on the principle that each symbol appears only once in each row (Horizontal) and once in each column (vertical).

See the example below:

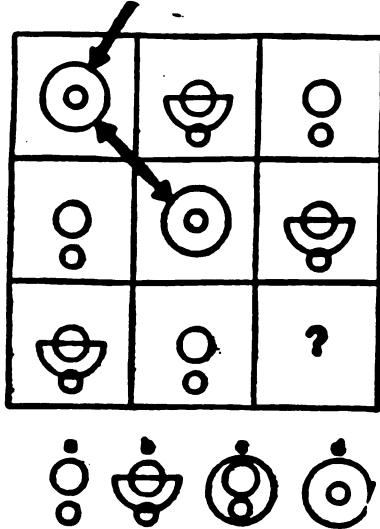
+	○	□
○	□	+
□	+	
A	B	C
□	+	○

You are to pick which of the three choices belongs in the empty square in the lower right corner of the matrix.

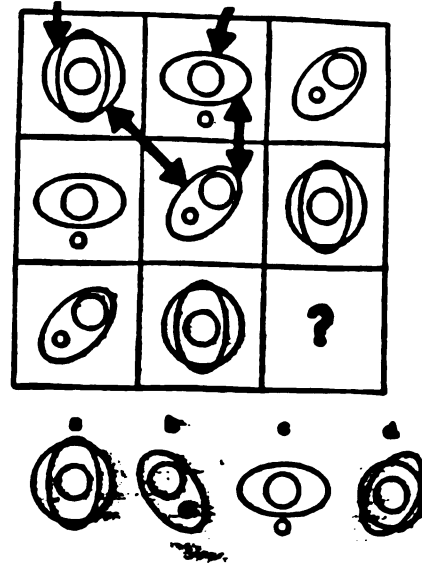
If you study the pattern you see that each symbol, the cross, the circle, and the square, appears three times in the matrix. Each one appears once in each row and once in each column. You have probably guessed by now that the circle is the correct choice.

There are two approaches to this problem. You can look at the first row to see what the three symbols are and then look at the bottom row and see which symbol is missing. A speedier approach when the symbols are more complex is called the diagonal method. To do this you look at the diagonal going from the upper left to the lower right. If the two symbols are the same then the missing symbol is also the same. If the two symbols are different then you look at the middle square of the highest row and that is your missing symbol.

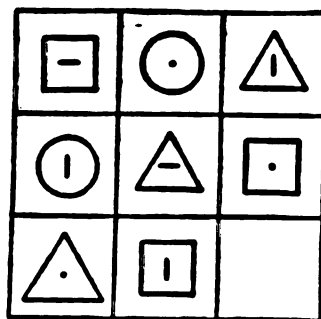
Here the two symbols in the diagonal are the same and so the missing symbol must be the same also.



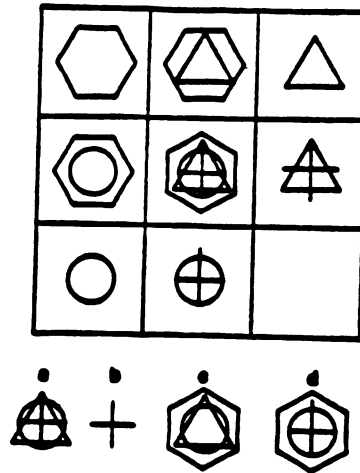
Here the two symbols on the diagonal are different so you look at the middle square of the first row to see what the missing symbol is



Things can become more complex by having several parts to the symbols. In the following example you have to treat the outside symbol, the square or circle or triangle, separately from the lines and dots in the middle of the symbol. Going down the diagonal, you see a square and a triangle, so you move up to the middle square in the first row and see a circle. That means the correct answer is either choice a or b. Now you look at the symbol in the middle of the squares and triangles and see that both items on the diagonal are short horizontal lines and you know that the correct answer is b, which has a short horizontal line in the circle.

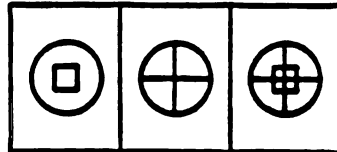


There are other types of matrices you will see as well. These are called change matrices and they tend to fall into three categories. An example is presented:



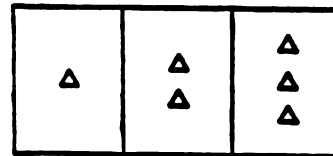
TP Add-On

Certain key parts of the first two boxes are added together to produce the design in the third.



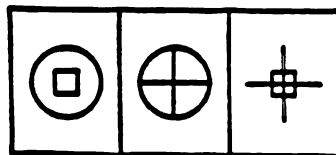
The Count-Up

When this change is brought into play, objects increase from one box to the next according to some counting rule.



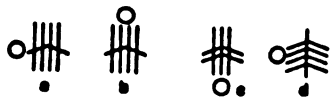
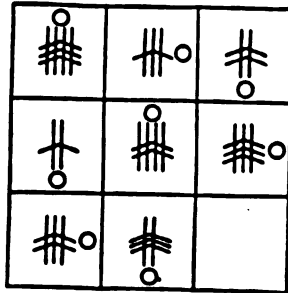
The Add-On and Drop-Out

As you can see in the example below, some key parts may be added together, while others are dropped from the final design. Here the small square and the cross combine, while the large circle disappears.

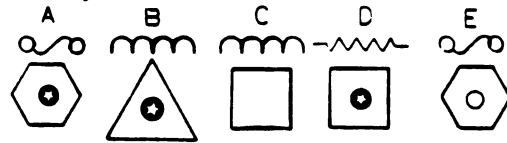
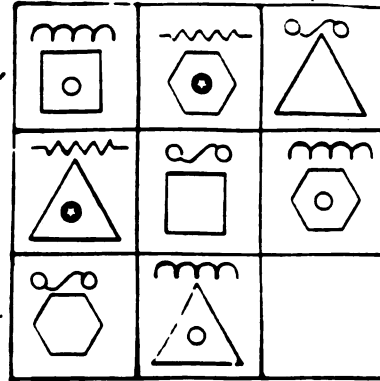


SAMPLE PROBLEMS

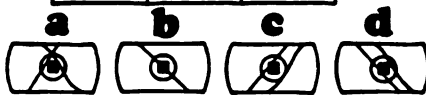
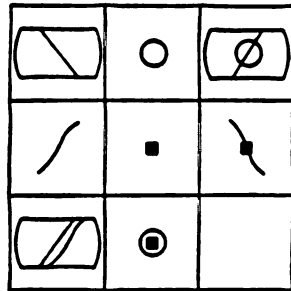
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2.



3.

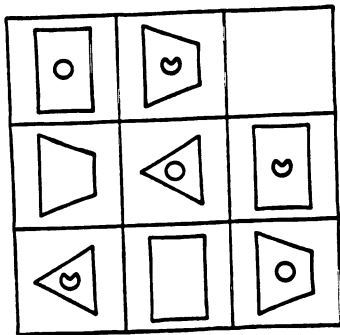
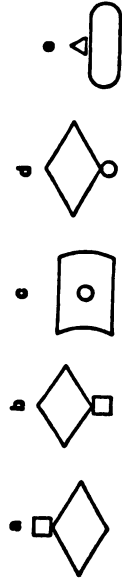
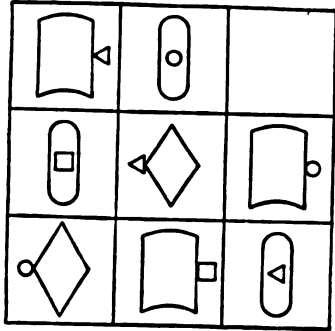


APPENDIX H

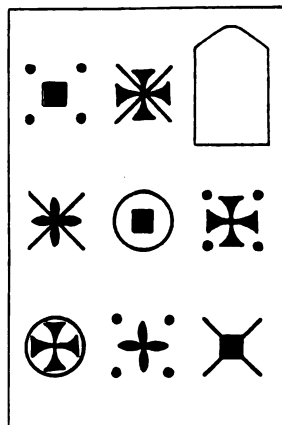
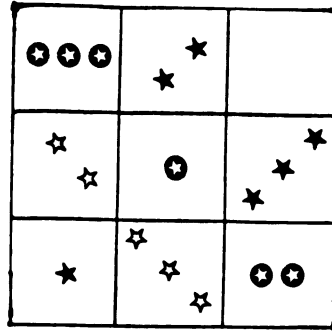
EXPERIMENTAL TASK - PROGRESSIVE MATRICES

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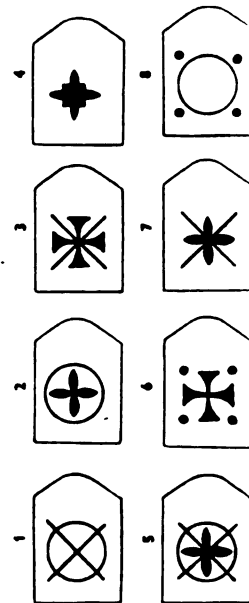
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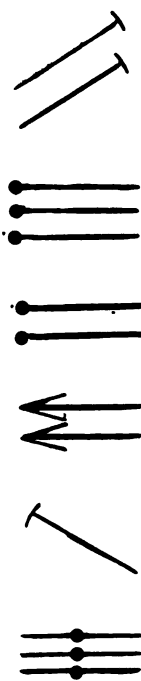


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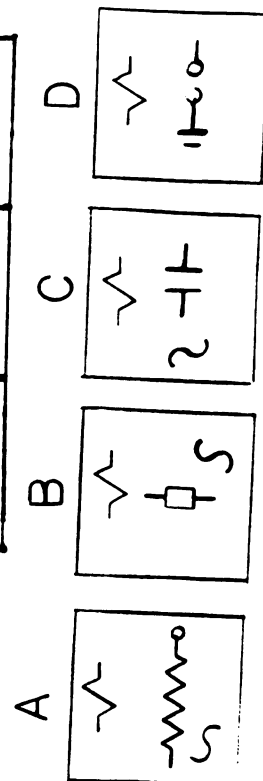


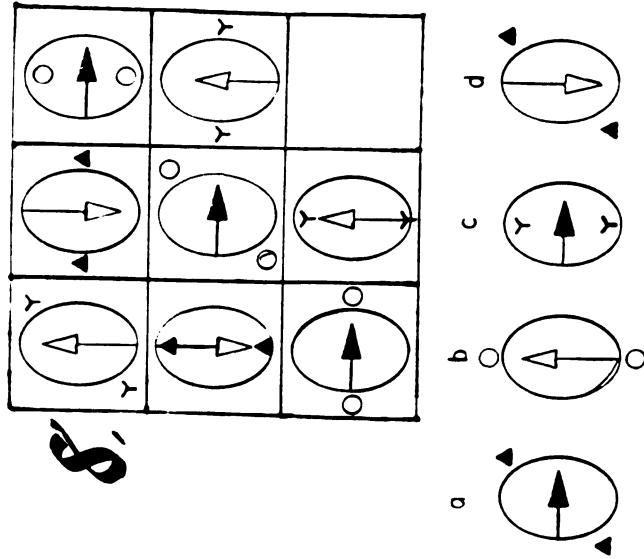
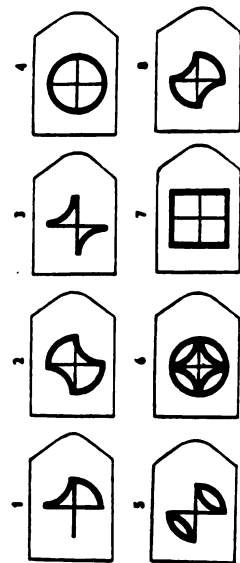
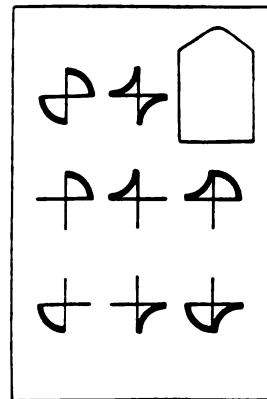
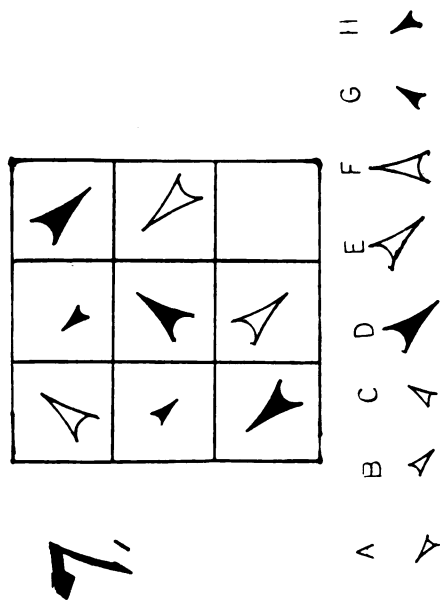
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A B C D E F

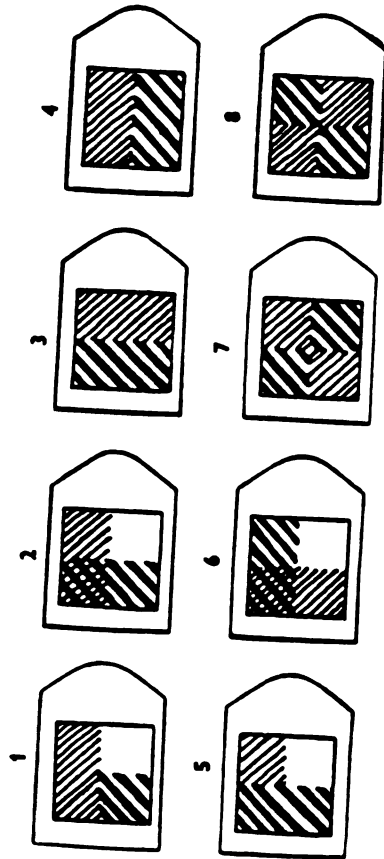
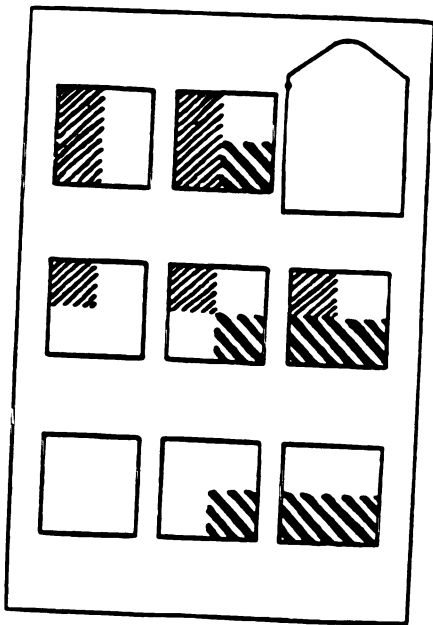


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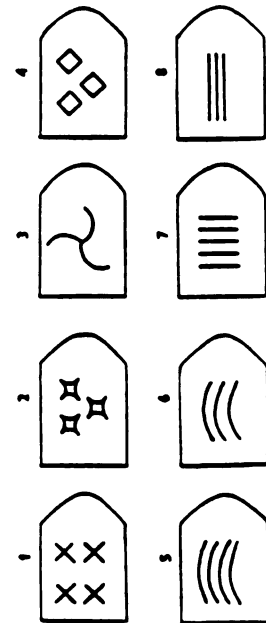
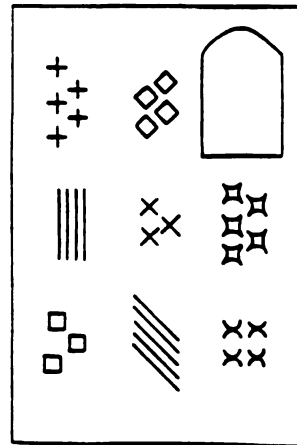
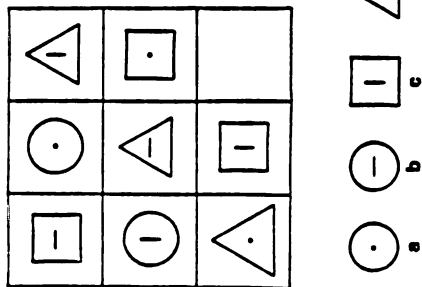
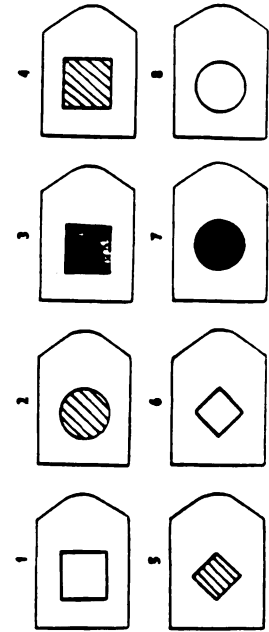
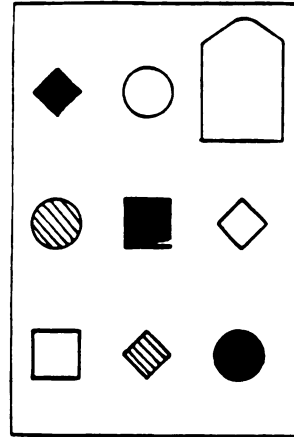
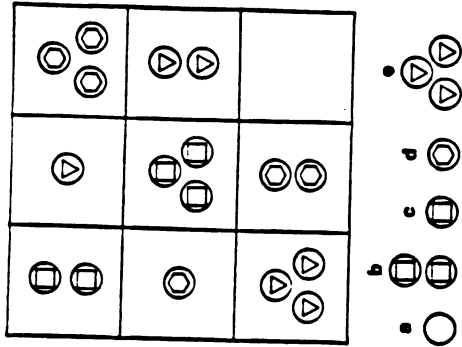


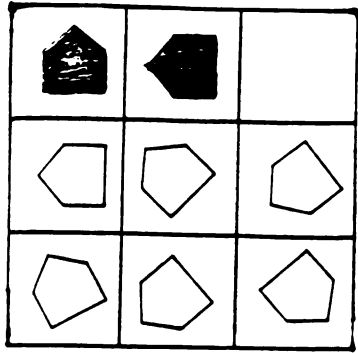


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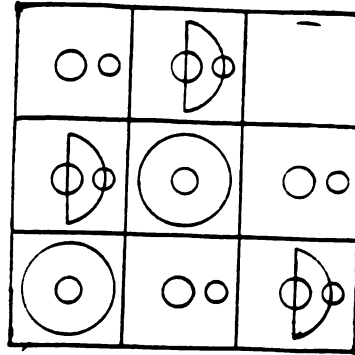
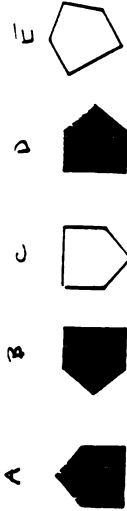


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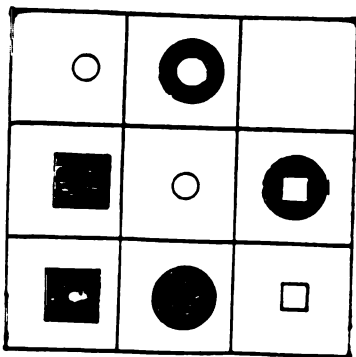




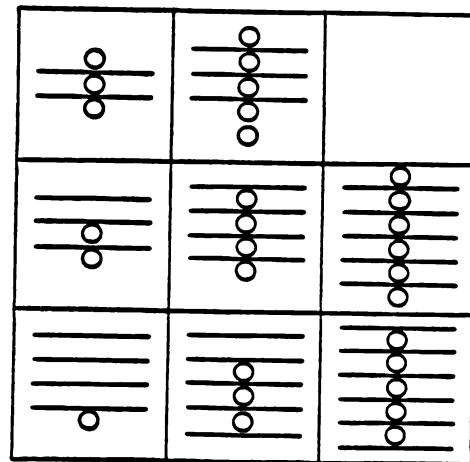
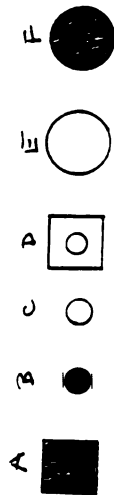
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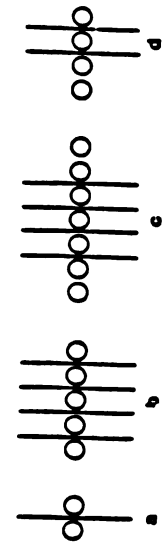
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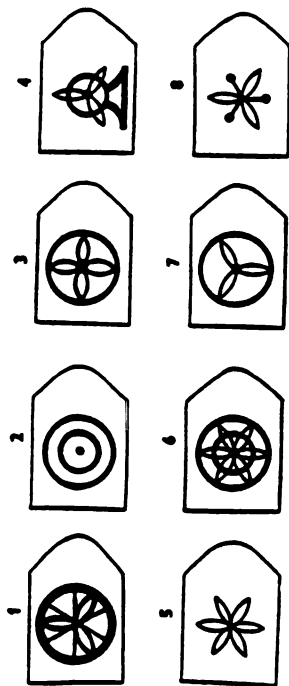
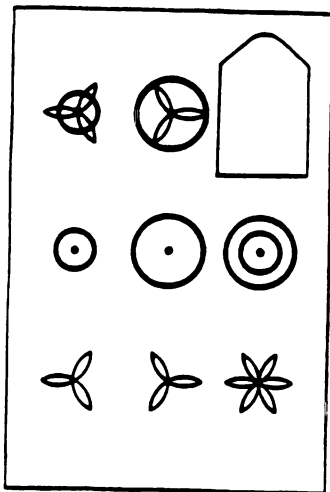
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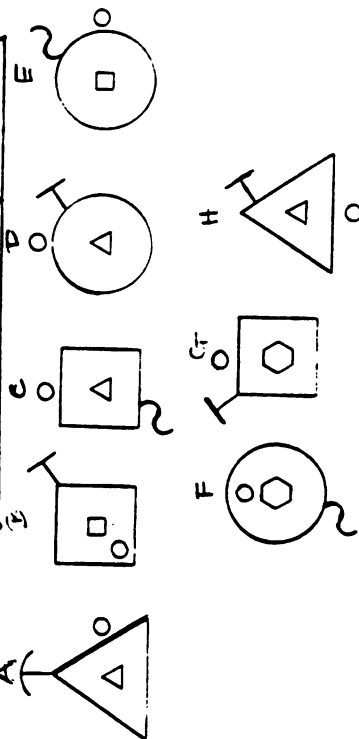
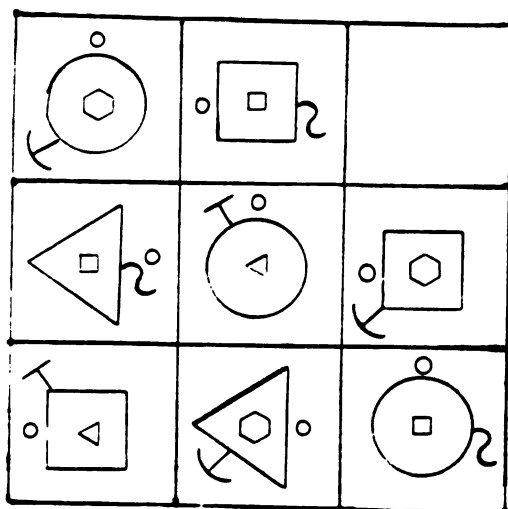
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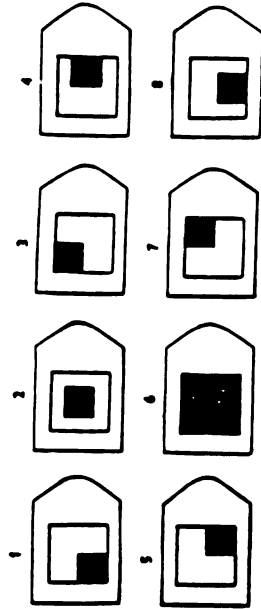
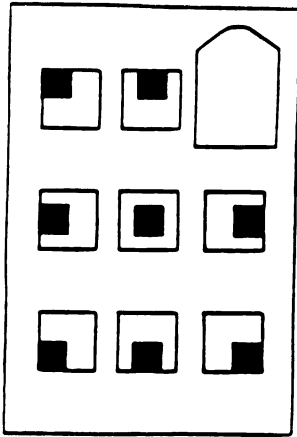


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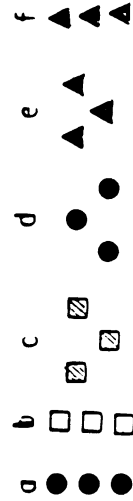
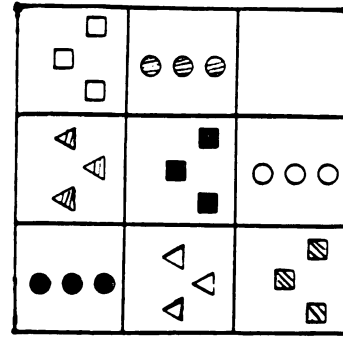


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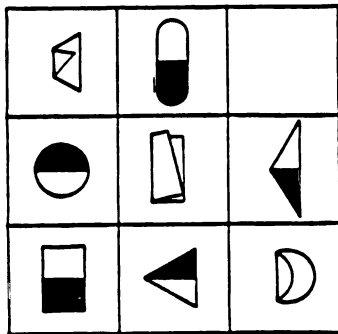
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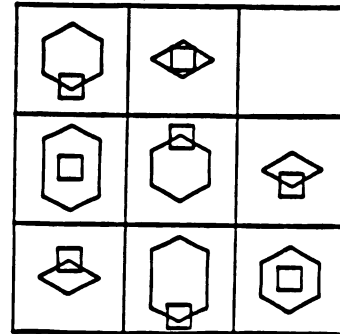
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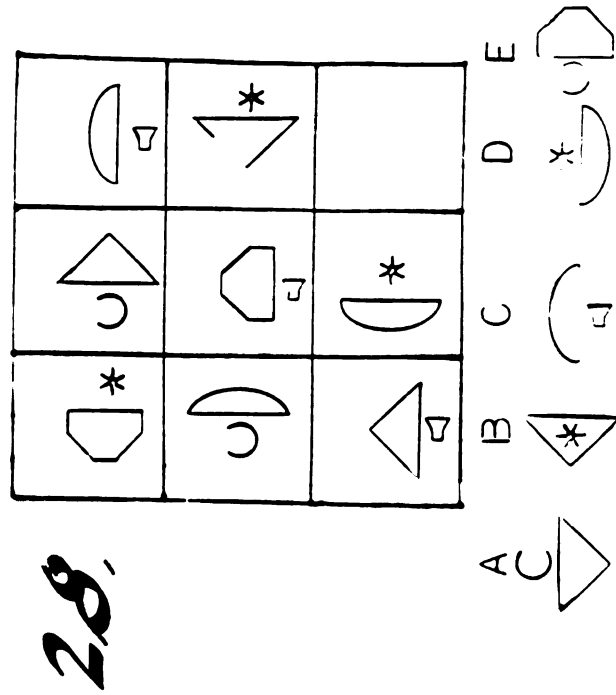
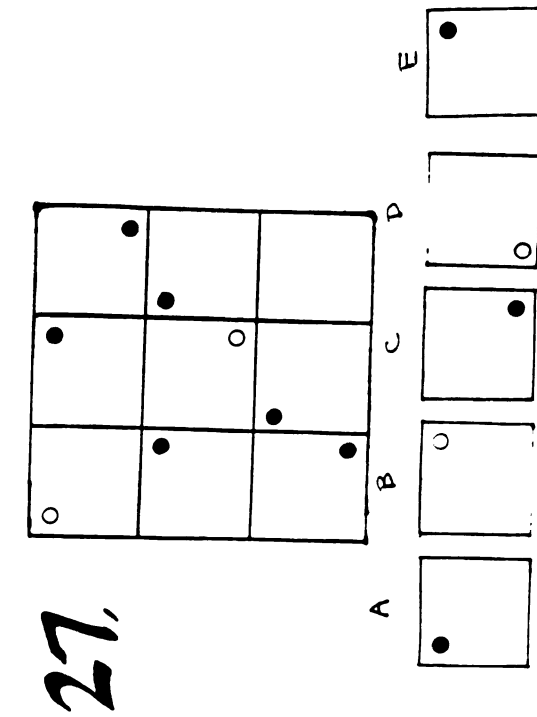
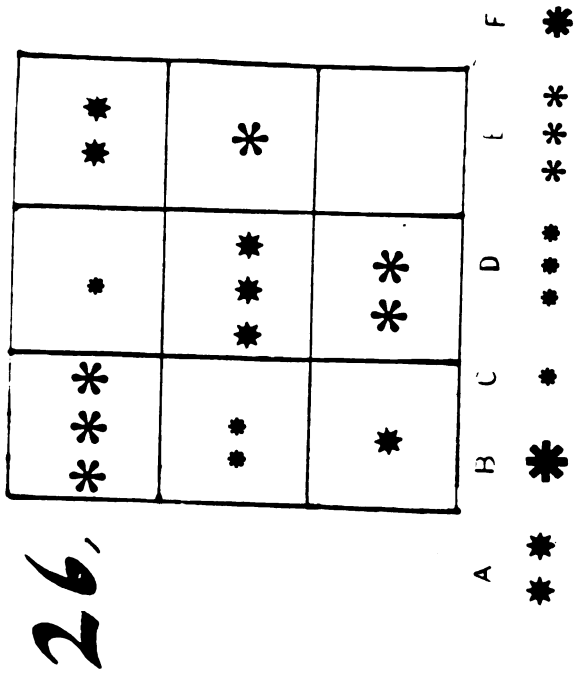
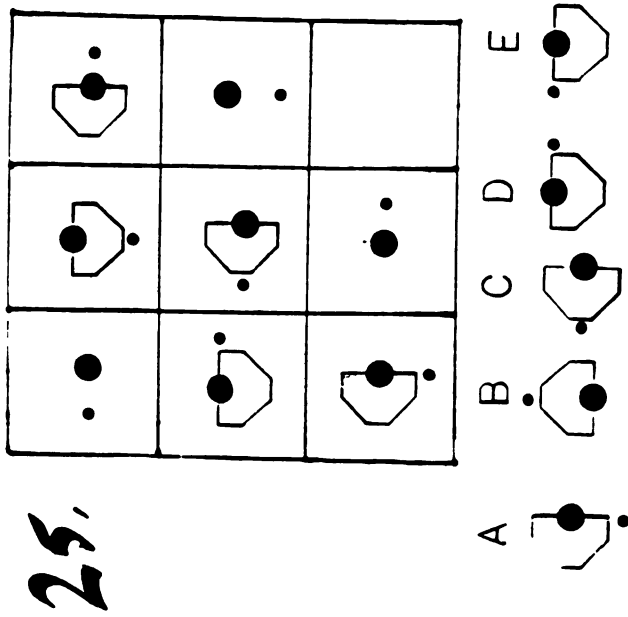


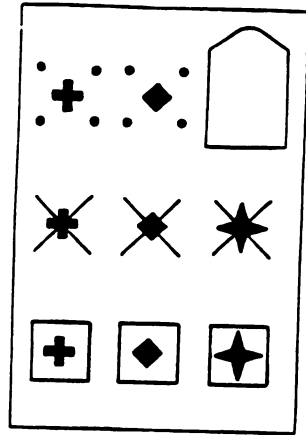
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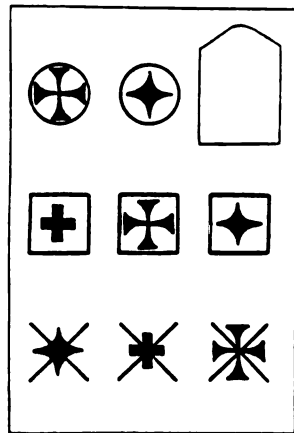
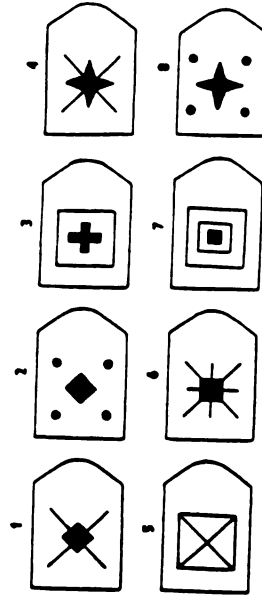
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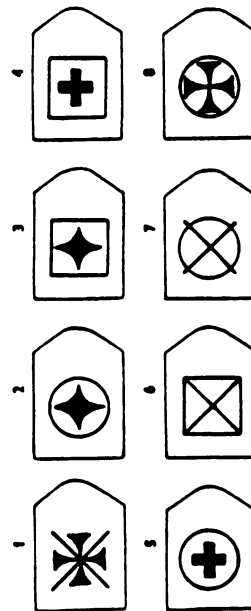




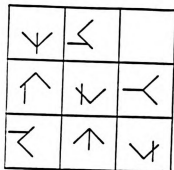
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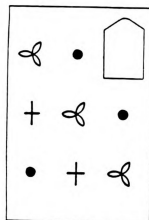
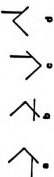
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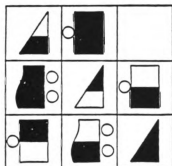
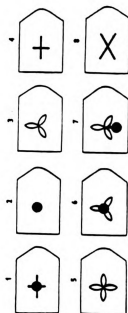
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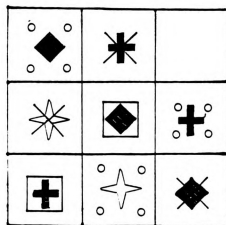
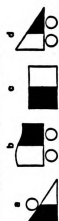
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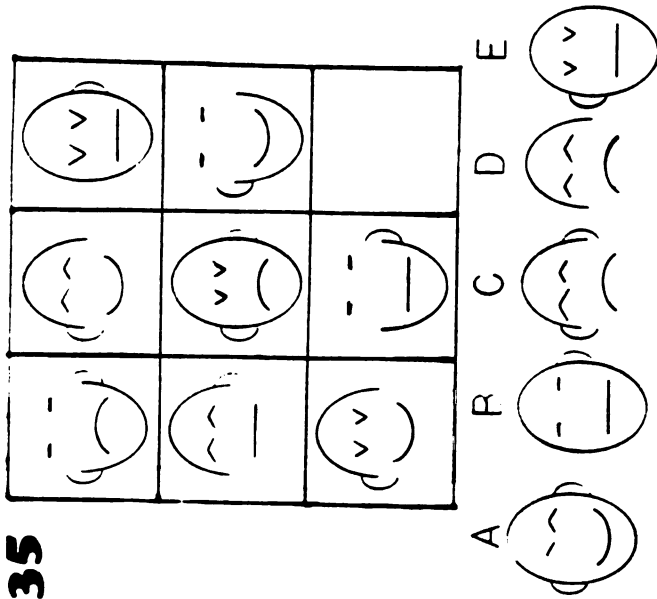
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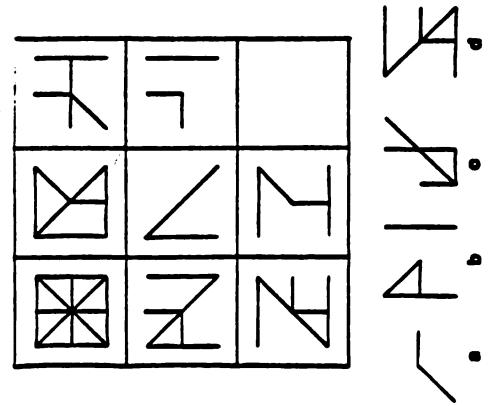
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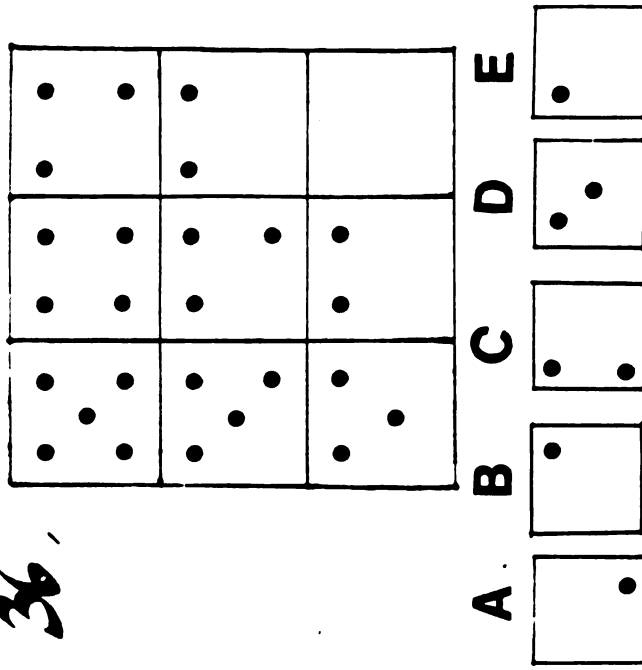
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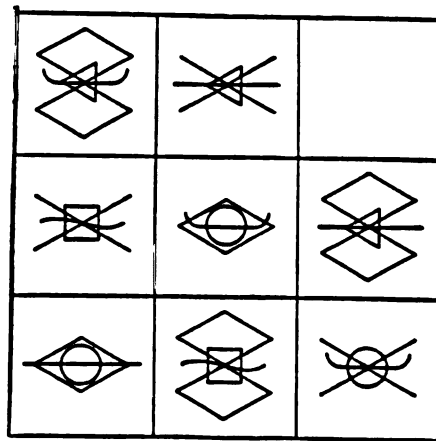


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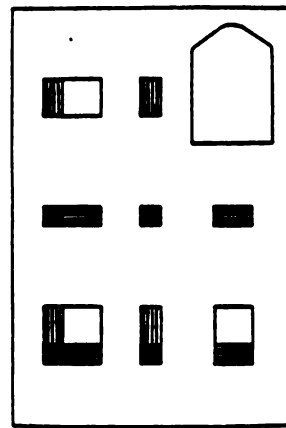
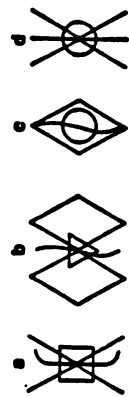


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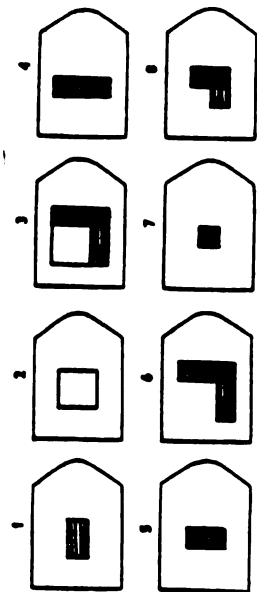




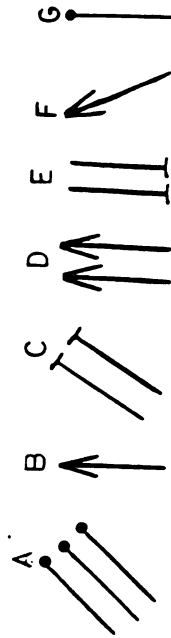
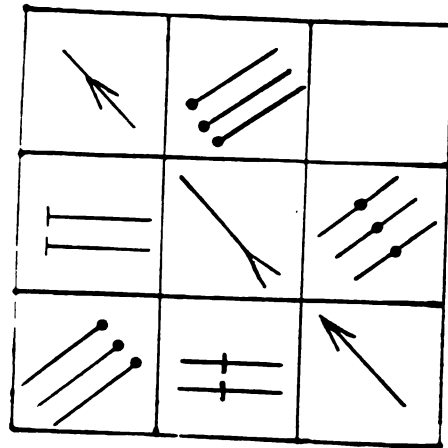
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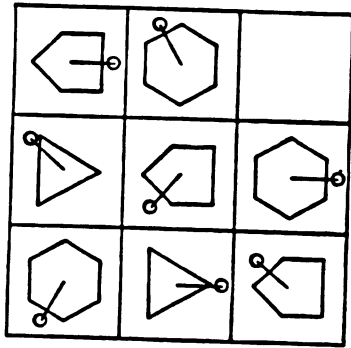
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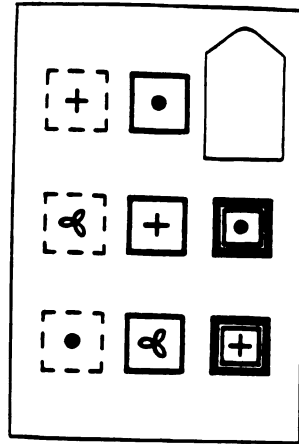
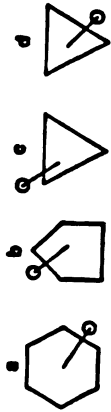
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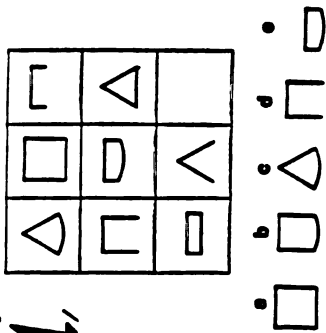
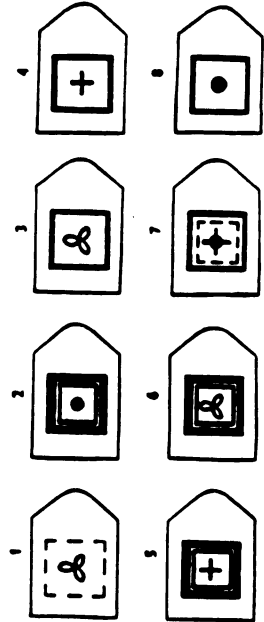
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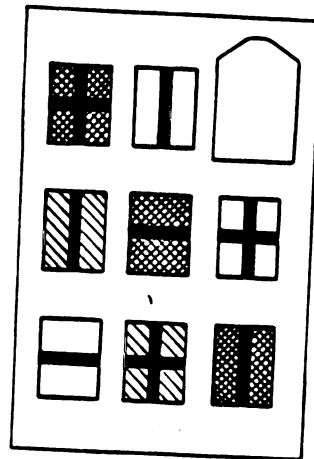
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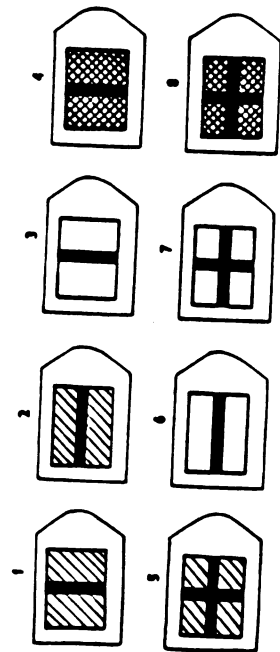
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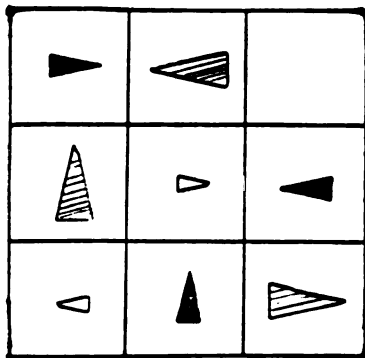
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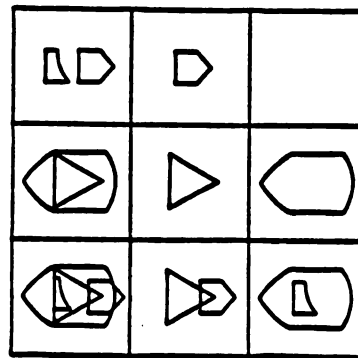
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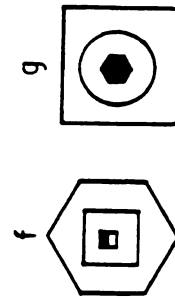
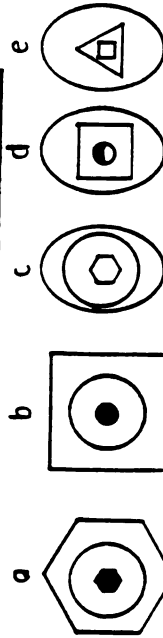
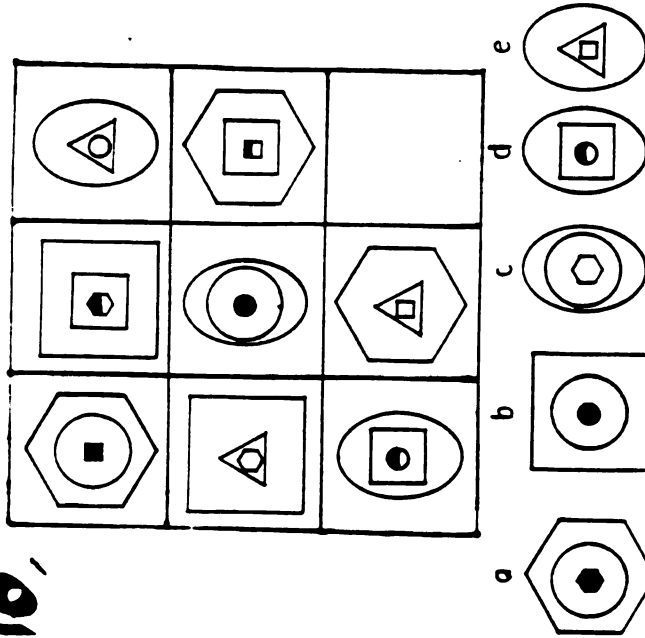
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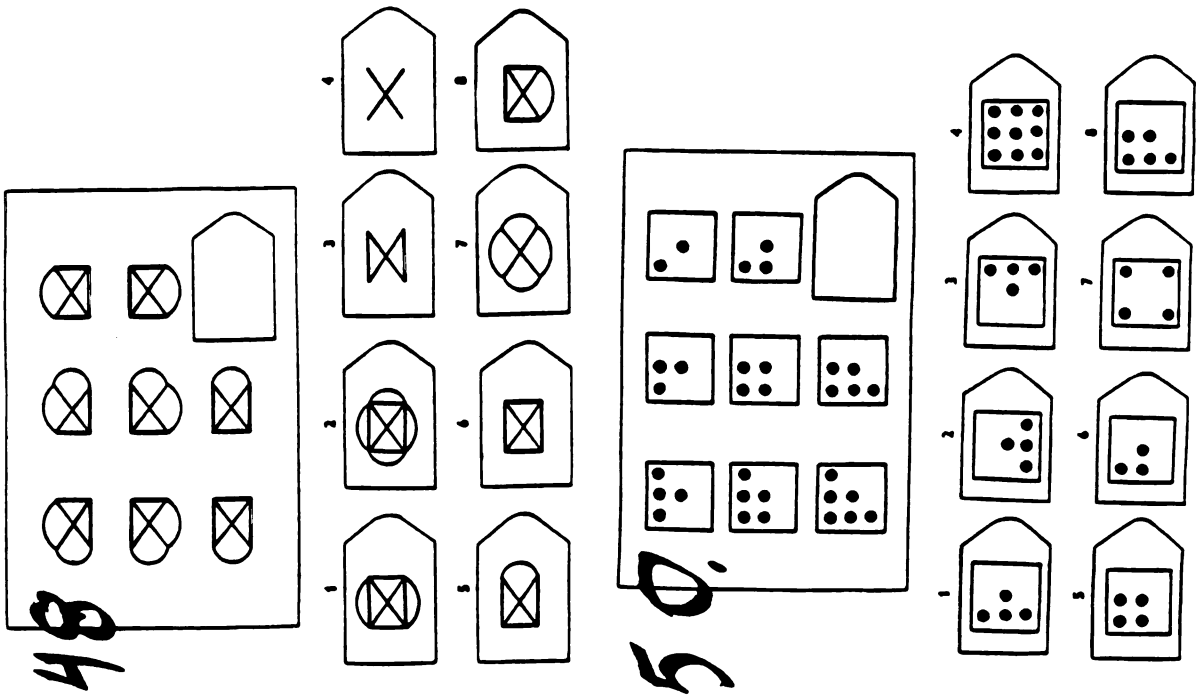
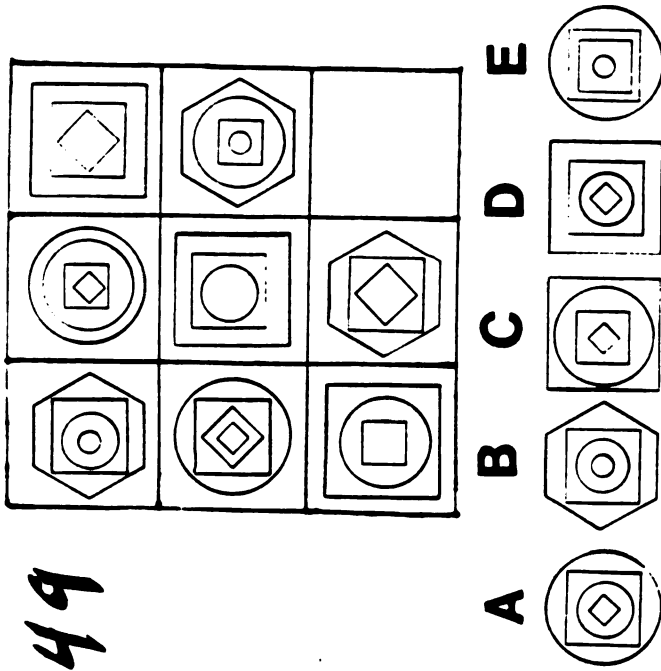


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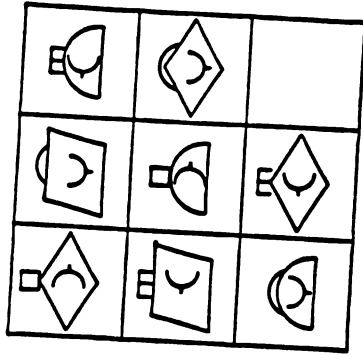


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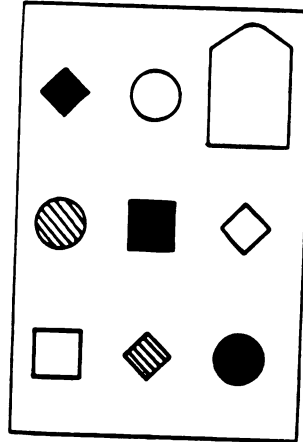




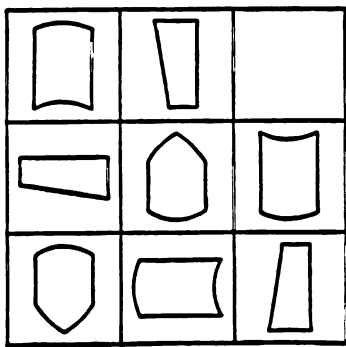
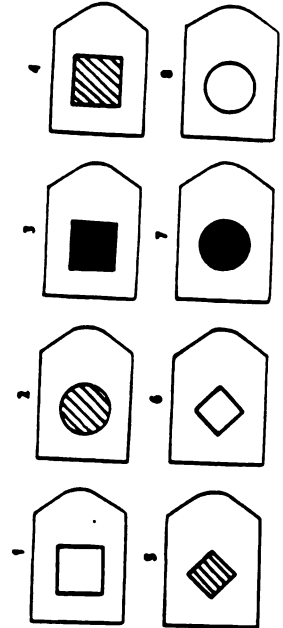
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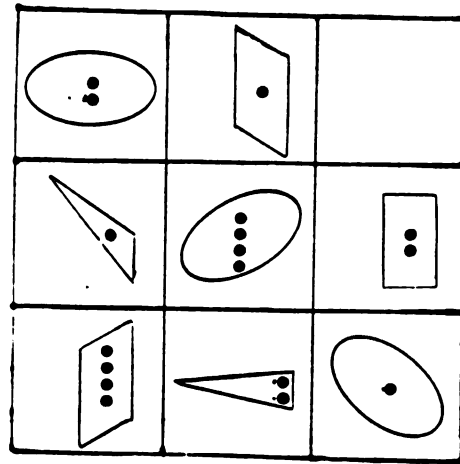
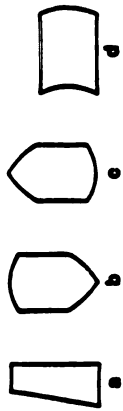
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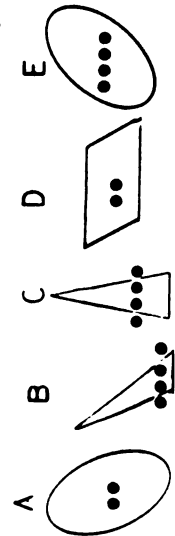
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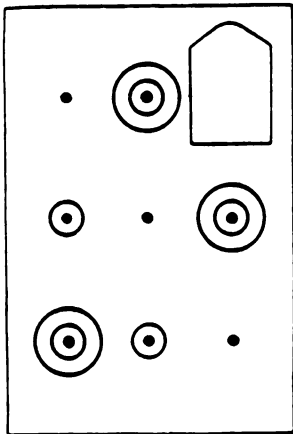


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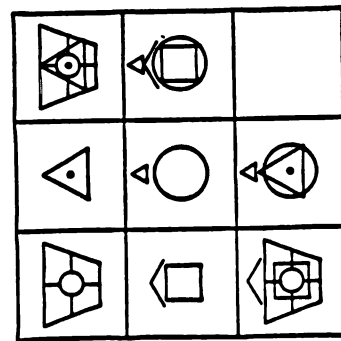
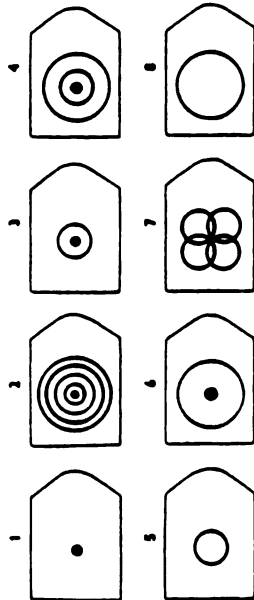


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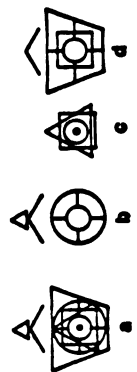




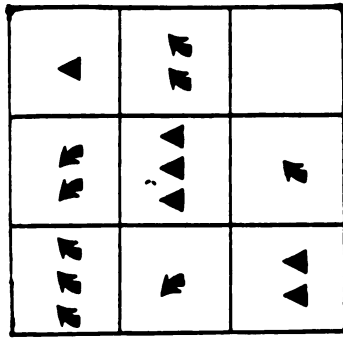
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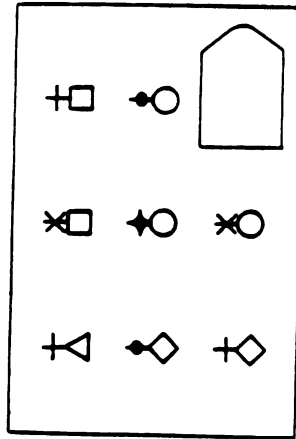
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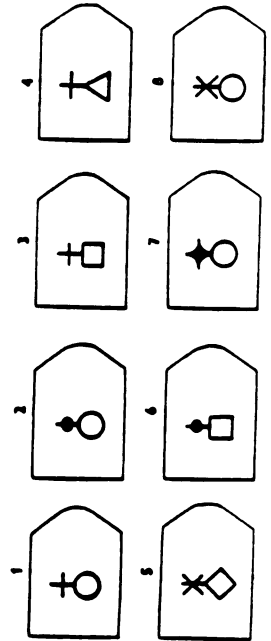
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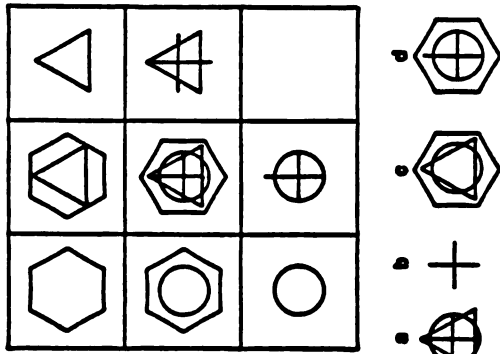


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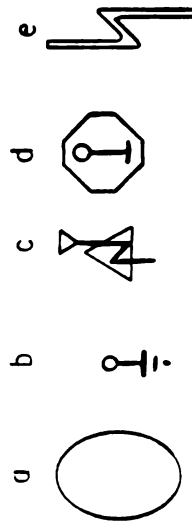
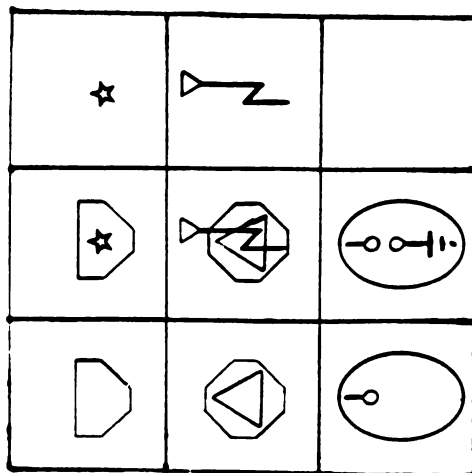


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