INVESTIGATION OF THE EFFECTS OF FEEDBACK AND GOAL-SETTING ON KNOWLEDGE WORK PERFORMANCE IN THE DISTRIBUTED WORK ENVIRONMENT

by

Kriengkrai Tankoonsombut

Dissertation submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

IN

INDUSTRIAL AND SYSTEMS ENGINEERING

APPROVED:

C. Patrick Koelling, Co-Chair	Brian M. Kleiner, Co-Chair
Benjamin S. Blanchard	Doris H. Kincade
Peter Simis	

October 16, 1998
Blacksburg, Virginia

KEY WORDS: Feedback, Goal Setting, Knowledge Work, Performance Improvement, Performance Measurement, Distributed Work Environment, Virtual Work Environment

INVESTIGATION OF THE EFFECTS OF FEEDBACK AND GOAL SETTING ON KNOWLEDGE WORK PERFORMANCE IN THE DISTRIBUTED WORK ENVIRONMENT

by

Kriengkrai Tankoonsombut

Committee Chairmen: C. Patrick Koelling and Brian M. Kleiner

Industrial and Systems Engineering

(ABSTRACT)

Enabled by advanced information technologies, the distributed work environment has become a choice of organizations. When employees and supervisors work in geographically separate locations, management challenges emerge. Performance improvement may become an issue.

Performance may be improved by identifying, studying, and improving factors that affect work performance. Two factors—feedback and goal setting—were chosen for this study because of the strong evidence of the effects of these components. Positive effects of feedback and goal setting are commonly accepted in the literature concerning the traditional work environment. This study focused only on knowledge work because most work in the distributed work environment may be knowledge work. The purpose of this study was to investigate the effects of feedback and goal setting on knowledge work performance in the distributed work environment.

A laboratory experiment was conducted using 36 student subjects. The experimental design was a 3 X 2 factorial design consisting of three levels of feedback (i.e., no feedback, task feedback, and task feedback with comparisons with others) and two levels of goal setting (i.e., no goal setting and goal setting). Subjects were randomly assigned to various combinations of these two variables.

The evidence did not outright support the claim that feedback and goal setting improve task performance; task performance of the subjects was improved only under certain conditions. Task feedback did not improve task performance because of its added pressure, especially in the presence of goals. Task performance was higher for the subjects who received both task feedback and information about others' performance than for the subjects who received task feedback only. Overall, feedback was not found to improve task performance.

The study did not support the hypothesis that specific and difficult goals improve task performance. The added pressure of having difficult goals was found to have demotivating effects. The notion that the co-presence of feedback and goals is necessary to improve task performance was not supported because of the combined pressure that both components created. The subjects who had feedback and/or goals did not perform better than those who had neither feedback nor goals.

DEDICATION

To Him Who gives me strength

To Dad, Mom, and Sisters

ACKNOWLEDGMENTS

This dissertation is undeniably the largest single effort I have ever undertaken. Throughout the course of this research, which has taken hundreds of hours and days to complete, uncertainties and unknowns abounded and made my research even more difficult and challenging. I am very glad that I have come this far to write this part of my dissertation, the part in which I can give thanks to the persons who have made this research possible and the persons who have made my learning experiences worthwhile.

This research would not have been possible without the help and guidance of my research committee. I thank Dr. Koelling for his love throughout my years at Virginia Tech. He has given me help and guidance in every phase of my life, more than I could ever imagine. Through highs and lows, one thing I could count on is that he would be there to help me. Precious moments at Virginia Tech have come from talking with, working for, and learning from him. I will remember the time he helped me with assistantships; I will remember the complete trust he had for me to run the ISE Computer Lab; I will remember our good times during the lab/research meetings; and I will always remember my great Ph.D. advisor and mentor, Dr. Koelling.

I thank Dr. Kleiner for his guidance and support during the final stretch of this research. His insights into human factors have added a valuable dimension for this research. I am grateful that he assumed the role of co-advisor for my research and that he provided the lab facility and equipment for my research.

I thank Dean Blanchard for providing his insights into systems engineering to my research. It was my pleasure to be his student in his systems engineering classes. His guidance and knowledge have been an invaluable contribution to my life. I thank him for giving me encouragement throughout my years at Virginia Tech.

I thank Dr. Kincade for giving my help when I needed it most. I will remember her willingness to help me with my class project even though I came from a different department; I will remember her willingness to serve on my research committee; and I will always remember hours of discussions and laughter that we had together—hours that often made her miss her meals. Her diverse knowledge in many areas has been so valuable to my research. Her love, support, continual encouragement, and dedication to help me as if I were her own student will be forever treasured. There is no doubt in my mind that Dr. Kincade is a valuable asset to Virginia Tech and that her students are very fortunate to have such a dedicated advisor like her.

I thank Dr. Simis for being a member of my research committee even though it was not always easy for him logistically. Having his insights into business administration and information systems has proven to be very critical. He has provided inputs and comments that were crucial to this research. I will remember the time that I took his class; I will remember the time that I worked for him; and I will always remember his support and encouragement throughout my years at California State University, Fresno and Virginia Tech.

Outside my research committee, there are three other persons who greatly contributed to my research. Dr. Robert S. Schulman from the Statistics Department at Virginia Tech has significantly contributed to this research. Dr. Schulman, who is very knowledgeable, articulate, and organized in his teaching, provided inputs and suggestions in statistical planning, analysis, and interpretation. I am very thankful that he has been a tremendous help during my research. I thank him for taking extra effort to help me with my research.

Dr. Gayle A. Sobolik from the Business School at California State University, Fresno painstakingly helped edit my writing many times over. I really appreciate her special love and care that she has had for me since my first semester of American education. I am grateful that she has always looked after me just like a member in her family throughout these years. I will always remember the seven-layer brownies that she sent me every winter to give me energy; I will remember her encouraging phone calls, postcards, and letters; I will remember this kind,

friendly, and special professor; and I will always remember my special time of the year for Dr. Sobolik—Mother's Day.

Dr. Robert T. Sumichrast from the Management Science Department at Virginia Tech has also contributed significantly to this research. Without his inputs, suggestions, and permission to use the Auction Task, it would have been impossible to accomplish this research. I am thankful that he took the time and extra effort to help me with my research.

In addition, I also want to thank two other professors who have made my American educational experiences memorable. I thank Dr. William G. Sullivan of the Industrial and Systems Engineering Department at Virginia Tech, who has always given me very special attention and assistance. I am grateful that he has always been very accessible to me. I especially want to thank him for always bringing out the best in me when I studied from and worked for him. Despite his tremendous responsibilities, his door has always been open for me and he has always found time to help me and give me advice. I am thankful for his effort to go the extra miles for me.

I thank Dr. Uthai Tanlamai, who was my advisor at California State University, Fresno. Her unmatched dedication to and love for students inspired me to be a better person. I am especially grateful that she granted me my first-ever graduate assistantship which, subsequently, led to so many good things in my educational experiences. My educational success would not have been possible had it not been for her ultimate dedication, love, and care.

I also would like to have an opportunity to thank all my friends in Thailand, California, and Virginia for their friendship. (Friends, you know who you are; I treasure our friendship.) Finally, my ultimate thanksgiving goes to my dad, mom, and sisters. They have wholeheartedly supported and trusted in their only son and brother in his doctoral mission. This mission has been a very long, draining, and exhaustive mission. They have patiently, sacrificially, and sometime anxiously waited for the end of the journey. I am very happy that the journey has a happy ending, and I thank everyone who has made this research come to a happy ending.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION AND SCOPE OF RESEARCH

INTRODUCTION

NEW WORK ENVIRONMENT

Within the past decade, the roles of information and information technology have increased exponentially. The dramatic increase in the power of personal computers and computer networks and the continuous decline of computing prices make it possible for large and small businesses alike to enjoy the power of computing technologies. With the advancement of wireless communication, Electronic Data Interchange (EDI), Computer Conferencing Systems (CCSs), computer networks, electronic mail, groupware, a powerful new class of project-management software, and client/server technology, businesses have seen and will continue to see a change in the workplace environment.

Information technologies have transformed the workplace into a virtual work environment. Managers and workers no longer must co-exist in the same location in order to work together. The literature uses many terms to describe this new work environment. Some examples of these terms are virtual corporations, virtual teams, virtual offices, borderless organizations, seamless organizations, cybercorp, and telecommuting. The distributed work environment is one type of virtual work environment, and, in this study, the term "distributed work environment" is used to represent this new work environment. Although all these terms represent a very similar work environment concept, a slight difference exists among these terms, specifically in their scope. A detailed discussion of these work environments is presented in Chapter 2.

Distributed work is defined as "… work activity conducted by groups or teams of people separated from each other in time and space" (Grantham and Nichols 1994, 31). According to the authors, "The coordination of work processes takes place using advanced communications technologies such as a telecommunications network. … This involves moving work to the

worker using electronic technology instead of moving the worker using conventional forms of transportation" (p.31).

According to this definition, employees do their work without commuting to central offices. Some of them may choose to work at home, while taking care of their families. Some may choose to do their work at a beach. Some may form teams that are intact work groups whose members stick together indefinitely, while others may form teams for a finite time to accomplish short-term, specific projects. Employees or team members work jointly toward the same goals even though they may be geographically separated by many miles, even continents (Geber 1995).

The distributed work environment has become a choice of organizational establishments in the last several years. "Currently, perhaps 4 percent of the workforce is in distributed work, that is, working in unconventional sites, at home, on the road, at satellite centers, and in other arrangements. This will grow to 20-25 percent by 2005 and possibly to as much as 40 percent by 2020" (Coates 1997, 2). The trend toward distributed work is expected to radically transform the American workplace in the coming years (McGoon 1995).

Many reasons create the need for managers to consider implementing a distributed work arrangement for their operation. *First*, to compete in the fast-changing global marketplace, managers are compelled to select the best persons with the best skills to accomplish their projects no matter where those persons may be located. With electronic communication, companies can now hire employees and distribute work to their employees who may be miles, or even continents, away. In addition, distributed work increases the employment of potential workers who would otherwise be omitted from work (e.g., handicapped persons, working mothers). *Second*, the distributed work environment is prompted by the demand for more work flexibility, especially with the rise of two-income and single-parent households (McGoon 1995).

Third, employers continually look for ways to cut costs. Tackett (1996) states that companies can save as much as $8,000 per employee in office space. In addition, companies that implement a distributed work arrangement should save expenses in areas such as insurance and traveling expenses. *Fourth*, working in a distributed work environment may increase employees' productivity levels. Distributed workers may feel more comfortable working in a familiar environment; they may be able to take care of some personal issues; and they can reduce traveling time from home to work (Malone and Davidow 1992; Maloff 1995). Employees in the distributed work environment can be as much as 20 percent more productive than those who have to travel to work in offices (Tackett 1996). *Fifth*, the distributed work environment is enhanced by the need to comply with ever-tightening air quality and traffic regulations.

The rise of the distributed work environment is a relatively recent phenomenon, brought about in part by the advancement of information systems and technologies (Geber 1995). According to Coates (1997), the new work environment "… will be absolutely dependent on information technology for unprecedented coordination" (pp.1-2). An organization may be considered a distributed organization only if work is distributed to employees in geographically separated locations and employees are connected by computers and networks in order to do work (Coyle and Schnarr 1995).

MANAGEMENT CHALLENGES AND ISSUES

When both employees and supervisors work in geographically separate locations, challenges will emerge—specifically, challenges in managing knowledge employees who work in the distributed work environment.

Challenges in the Distributed Work Environment

According to Coates (1997), a new set of issues and problems in the distributed work environment will "… challenge the assumptions of HR [human resources] and the assumptions of top management about managing a corporation …" (p.1). Coates says, "More important is how does one mentor, select, train, and acculturate those off-site workers" (p.2). Similarly,

Valovic (1993) points out some important questions: "How should this array of highly individuated and nonuniform relationships be effectively managed? Or to put it somewhat less optimistically: can it be? And, assuming that it indeed can and must be managed, what are the major challenges in doing so?" (p.50).

Managers of the new work environment will meet challenges for their roles and responsibilities. Sink and Tuttle (1989) claim that the primary responsibilities of managers are to 1) get the job done and 2) continuously strive to improve performance of themselves, their group, the system, and the organization. Performance improvement is an important component of management's responsibilities; therefore, performance improvement in the distributed work environment will become a very important issue. Geber (1995) claims that, although the technical challenges of such an environment will be enormous, one of the "thorniest" problems future managers will face will be how to make their distributed employees productive. To be able to deal effectively in the new environment, managers demand new skills and attention (Coyle and Schnarr 1995). Grantham and Nichols (1994) argue that managers will face challenges in ensuring the productivity and performance of employees who cannot be supervised closely because of geographical distance.

Challenges in the Knowledge Work Environment

Challenges in the new work environment will come in the forms of managing and improving knowledge work. Most work in the distributed work environment may be qualified as knowledge work because the main advantage of the distributed work setting is to utilize human resources available anywhere regardless of geographical location. Knowledge workers lend themselves most easily to distributed work (Grantham and Nichols 1994; Coates 1997).

Beruvides (1993) defines knowledge work as work of any nature (e.g., manual, physical, and mental). The inputs of knowledge work may not be clearly definable and can be influential to the output, which is mainly intangible with some factors being tangible. A high level of discretion is permitted in the job task for knowledge work. Knowledge workers are those who create, design, and develop things or ideas. These workers "… may plan, schedule, control,

direct, supervise, oversee, research, analyze, and make decisions" (Beruvides and Sumanth 1987, 128).

Performance improvement of knowledge work has become a major management challenge in this century and will continue to be so into the twenty-first century. For well-defined, routine, and structured work (i.e., blue collar work), one may argue that performance improvement can be readily accomplished because managers and industrial engineers have developed a large number of tools for work in this area. They have designed, developed, and implemented ways to improve efficiency and productivity of blue collar workers. Motion study, time study, work measurement, and methods improvement are just some examples. These traditional methods of performance improvement were not originally developed for knowledge work. One of the most significant challenges for the 1990s and beyond lies in designing organizations to effectively improve knowledge-based, white collar, and professional work (Duffy 1995). This challenge should be a main concern for managers in a distributed work environment because the work involved may not be blue collar.

Why is knowledge work more of a challenge than blue collar work? The answer has to do with the nature of the work itself: non-routine, non-linear, unstructured, and often one-time work. Another problem that makes improvement of knowledge work more challenging is that managers and industrial engineers have not invented or defined tools and methods to deal with white collar work or knowledge work as effectively as they have with blue collar work. Lehrer (1983) mentions that the most significant barrier to enhancing knowledge work performance is the lack of adequate conceptual work for dealing with the many facets of the problem. Davenport et al. (1996) claim that "Managers treated the way that knowledge workers performed their activities, and sometimes even the time, cost, and quality with which knowledge work outputs were produced, as an impenetrable 'black box.' Any sense of management often ended when the employee entered or received tenure in an organization" (p.54).

Because managers consider knowledge work as an impenetrable "black box," they often feel no need to enhance knowledge work. They think there is nothing they can do to improve knowledge work inside their organization and become complacent with whatever outputs are produced by their knowledge workers. Work performance in service- or information-intensive sectors is measured on the basis of input rather than on the effectiveness of the transformation process (Davenport et al. 1996). Managers are admitting that they cannot and, even worse, do not need to identify and improve the performance levels of their employees from one day to the next. Olson (1983) argues that this could be counter productive. If they do not know where they are, how will they know where they are going? How will they get there? And will they know when they finally get there?

Even though knowledge work can be chaotic and difficult to define, managers can and should continuously strive to improve performance. Management just needs a new mind-set (Duffy 1995). Davenport et al. (1996) suggest that the current laissez-faire approach to dealing with knowledge work is not sufficient. Managing knowledge work improves performance of employees and organizations. Several companies have discovered that knowledge assets of the companies can be described, that they can be managed, and that it is possible to measure how knowledge adds value (Duffy 1995). Although some useful and proven approaches exist for improving knowledge work performance, more research in this area is needed (Lehrer 1983).

PERFORMANCE IMPROVEMENT AND MEASUREMENT CHALLENGES AND ISSUES

To improve their employees' performance, managers in this new work environment must try to find ways to measure their performance, no matter how difficult it may seem. According to Sink and Tuttle (1989), "The most important, and perhaps the only really valid, reason for measuring performance … is to support and enhance improvement" (p.141). This statement captures the significance of measurement in the distributed work environment. A basic rule of management is one cannot manage that which one cannot measure (Sink and Tuttle 1989).

Grantham and Nichols (1994) contend, "Managers now have fairly well-established procedures for conducting performance reviews in a face-to-face environment. How this will be done at a

distance with little or no face-to-face contact is not known" (p.34). Coates (1997) asks, "How does one identify and judge their performance when almost all supervision in the United States depends on direct visual monitoring?" (p.2). Performance measurement of knowledge workers in the distributed work environment will become a specific issue within this question. Knowledge work performance is harder to assess than blue collar work performance because knowledge work is mainly cognitive, unstructured, non-routine, and unique. Work standards have not been established. Measuring knowledge workers' performance in a distributed work setting is even harder than in a typical setting because employees in a distributed work setting cannot be observed while working (because of geographical separation). Supervisors may not be able to determine whether or not the employees are working effectively, efficiently, or productively.

Some may argue that performance measurement of distributed workers will be difficult to conduct and that results can be subjective and, therefore, considered useless. Although some performance measurement may be subject to pressure and biases and the results may not be completely accurate, striving to have some form of measurement and later continuously trying to improve the measurement process is better than not doing anything. Measurement may not tell managers and employees whether the performance is good or bad, but it simply gives them a benchmark for measuring progress (Olson 1983). The primary role of performance measurement is to enhance performance improvement (Sink and Tuttle 1989; Thor 1993b). Employees cannot improve their performance unless they know their current performance. They need to know how they are doing, how their work affects the process and products, and how they can improve their work.

From a *broad* perspective, this research addresses Lehrer's (1983) suggestion—to study and provide a better understanding of the issues of knowledge work performance (more specifically, performance improvement in the distributed work environment). In this study, performance improvement of knowledge work is examined at the task level. From a *more focused* perspective, this research is intended to address issues of task performance improvement (see Figure 1.1).

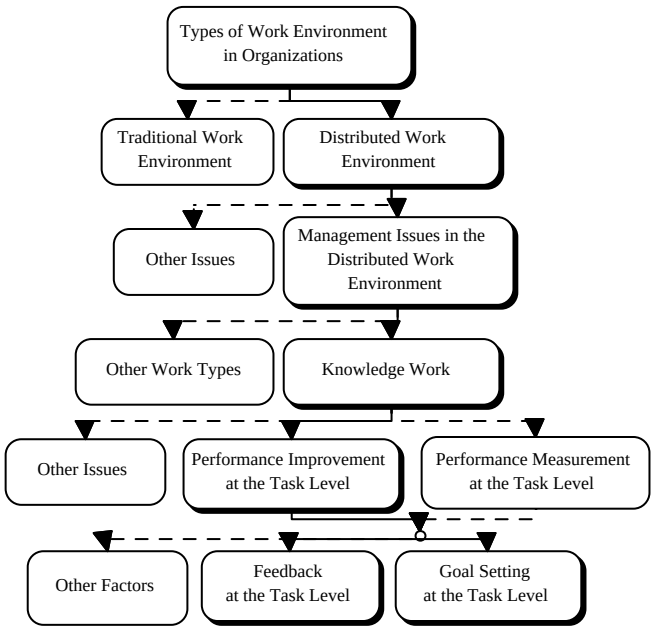


Fig. 1.1. Thought diagram of the development of this research

FACTORS THAT AFFECT TASK PERFORMANCE

One way to improve task performance is to identify, study, and improve factors that affect task performance in the work environment. In this research, literature in several areas is reviewed, including that related to distributed work (Section 2.2), knowledge work (Section 2.3), project management (Section 2.4), and R&D management (Section 2.5). Concepts from studies in these areas are used to identify factors that affect work performance in the traditional work environment. Examples of these factors are types of work, phases or stages of work, performance measures, feedback, and goal setting. Although these factors will be reviewed in the sections that will follow, only two of these factors will be investigated in detail: *feedback* and *goal setting*.

Only feedback and goal setting have been chosen for detailed investigation because the literature shows supporting evidence that the selection of both feedback and goal setting possibly makes the best combination for explaining work performance. The two factors have been extensively studied, both individually and collectively. The positive effects of feedback

and goal setting are commonly accepted in the literature (e.g., management, psychology, organizational behavior, and industrial engineering research literature). The existing literature related to feedback and goal setting in the traditional work environment shows convincing evidence that feedback and goal setting have positive effects on task performance. This research is designed to investigate whether similar positive effects of these two factors on task performance can be achieved in the distributed work environment.

Another reason for choosing these two factors is their close interrelationship with task performance measurement. Feedback and goals are not only believed to affect task performance but also believed to be closely related to task performance measurement. This relationship results from a strong interrelationship between performance improvement and performance measurement. Sink and Tuttle (1989) claim, "… the most important reason for measuring performance is to improve performance" (p.1). Feedback and goals are among the two most important components in task performance measurement. Managers usually measure and evaluate the performance of their employees against pre-set goals. The information from the measurement is usually fed back to the employees.

Because feedback and goal setting have been found to play an important role in task performance measurement and, therefore, performance improvement in the traditional work environment, the two components may play a similar role in the distributed work environment. Although the effects of feedback and goal setting may be implicitly related to the general performance measurement process, this research is intended to study the effects of feedback and goal setting on the specific area of task performance improvement. Drucker (1977) claims that, although managers do not know how to measure knowledge workers' performance, they know how to improve knowledge workers' performance. Beruvides et al. (1988) also provide a supporting comment, arguing "Due to the lack of clarity in the definition and measurement approaches proposed, the emphasis is beginning to shift from measurement to improvement techniques" (p.40). This research examines the effects of feedback and goal setting on task performance of knowledge work in the distributed work environment.

FEEDBACK AND GOAL SETTING

Drucker (1993) highlights an important characteristic of the knowledge work environment, saying "The knowledge-based organization therefore requires that everyone take responsibility for that organization's objectives, contribution, and indeed, for its behavior as well (p.108)." Drucker (1993) suggests that in a knowledge work environment, feedback and goals become an integral point of the employee's work. Out of all the potential factors that may affect task performance in the distributed work environment, these two factors are the best candidates for researchers to study, both individually and collectively.

Feedback

In general, the literature has revealed beneficial effects of feedback on performance. The positive effects of feedback on task performance have been widely recognized as essential for learning, motivation, satisfaction, and performance (Greller and Herold 1975; Ilgen et al. 1979). When feedback improves task performance, it is because feedback provides knowledge of performance that corrects errors, facilitates learning, and, most importantly, motivates feedback recipients (Busby 1997).

Even though feedback may generally have a positive impact on task performance, it is not unlikely that, in some situations, feedback may have no impact on task performance at all. For example, feedback information may be useful only if the recipient is able to convert and translate the message into something meaningful to him,[1] whether by increasing existing knowledge or by eliminating uncertainty (Ilgen et al. 1979). Providing excessive feedback does not necessarily improve task performance. Additional feedback, Ammons (1956) claims, may have little or no effect when a person is already performing at a high level or when the task is complex. Crafts and Gilbert (1935) mention that when tasks become difficult or complex, excessive feedback may become confusing to feedback recipients; and, therefore, they may choose to use only part of the feedback and disregard the rest.

[1] In the remainder of this dissertation, the terms "he," "his," "him," and "himself" will be used to refer to both sexes.

Feedback may also create a negative impact. Feedback may reduce pride, induce defensive behavior, create misdirected effort, decrease the recipient's motivation to perform, and, as a result, decrease the task performance of the recipient (Ammons 1956; Nadler 1977; Levy 1984; Ashton 1990). Ammons (1956) argues that providing excessive feedback can create negative effects; excessive feedback may lead to a decrease in motivation when the person is doing poorly. This outcome may be due to the added pressure induced by feedback. Ashton (1990) points out that feedback increases the pressure on the recipient. This increased pressure can either help or harm task performance, depending on the level of preexisting pressure and/or the demands of the decision tasks. Increased attention and effort induced by pressure are positive results from increased pressure, while increasingly intense pressure may result in detrimental psychological impacts, thus harming task performance. Ashton claims that for a given level of task difficulty, increased pressure induced by feedback can result in improved performance, no change in performance, or decreased performance. Feedback can have detrimental effects on task performance via its impact on anxiety, especially in difficult tasks.

Feedback source is a topic that deserves attention. Greller (1980) classifies feedback sources into six categories: formal rewards, informal assignments, supervisors, co-workers, comparisons of one's work to that of others (benchmarking), and information one receives from the task itself (task feedback). The six categories of feedback sources may be viewed from an employee's perspective as consisting of two primary groups. The first group includes feedback sources that are intrinsic to, under the control of, or psychologically closer to the individual. The second group includes feedback sources that are external to, beyond the control of, or psychologically farther away from the individual. Feedback from one's own comparisons of one's work to that of others (benchmarking) and from the task itself falls under the first category, while feedback from the organization (i.e., formal rewards and informal assignments), supervisors, and co-workers falls under the second category.

Feedback sources have been found to affect how the recipient perceives, accepts, and responds to the feedback (e.g., Ilgen et al. 1979). Feedback sources that are intrinsic or psychologically

closer to the individual are relied on more heavily than are those sources identified as external or psychologically distant (Greller and Herold 1975). According to Greller and Herold (1975), an individual's feeling of his own performance may serve as a feedback source, which is relied upon more heavily than feedback from other sources.

Goal Setting

Another factor that will be investigated in this study is goal setting. As does feedback, goals can serve as a source of motivation and inspiration to employees (Griffin 1990). The literature reveals that goal setting can be used as a motivational technique to improve task performance. Locke's (1968) theory identifies the motivational impact of goal setting by indicating that the setting of hard and specific goals can lead to higher task performance. When an individual consciously accepts a goal that is specific and challenging, that person is motivated to understand what he has to do to reach that goal. Locke et al. (1981) classify the motivational mechanisms of goal setting into four mechanisms: direction, effort, persistence of action, and strategy-development mechanisms.

Although goal setting can be used as a motivational technique to improve task performance, if it is not being used properly, it may create undesirable results. Locke et al. (1981) argue that "Goal setting is most likely to improve task performance when the goals are specific and sufficiently challenging, the subjects have sufficient ability … and assigned goals are accepted by the individual" (p.125). This simple statement indicates at least three things. *First*, it indicates that to achieve performance improvement, the content of each goal has to be clear so that people can carry out appropriate actions to reach the goal. If the content is not clear and it is misunderstood, there might be confusion and frustration on what needs to be done.

The *second* indication is that goals should not be too easy to attain, but at the same time, they must be attainable goals. Setting easy goals may create no effect because people do not have to exert any more effort to reach the goals. As Griffin (1990) mentions, "Of course, goals should not be so easily attainable that employees see them as a joke or an insult." He indicates that "Goals must be challenging but within reach" (p.170).

Latham and Yukl (1975a) contend that setting unattainable goals may decrease the level of task performance. One may argue that setting an impossible goal may decrease task performance because the goal is not accepted. This leads to the *third* indication that goals that are not accepted may have negative impacts on task performance. When assigned a goal that is perceived as impossible to reach, the individual rejects the goal and stops trying for that goal (Locke 1968). Employee participation in the goal-setting process may lead to greater goal acceptance or facilitate greater goal commitment than if goals had been assigned; however, the literature reveals no consistent results in the performance differences of top-down or autocratic goal setting and participative goal setting (Latham and Yukl 1975a; Latham and Saari 1979a; Locke et al. 1981; Naylor and Ilgen 1984).

Feedback and Goal Setting

Although feedback and goal setting have been found to increase performance, some researchers claim that feedback or goal setting individually cannot improve performance. Neither feedback nor goals alone are sufficient to improve or significantly affect task performance (Locke et al. 1981; Campion and Lord 1982). To achieve motivational purposes, one component cannot exist without the other. The co-presence of the two components is necessary, and only when they are present concurrently is task performance improvement attainable (Locke et al. 1981). Naylor and Ilgen (1984) state that "… performance is highest in the presence of both goals and feedback" (p.99).

In the distributed work environment, employees are not physically supervised and may be left alone to do their own work. Feedback and/or goal setting may not improve task performance in a distributed work environment. No supervisor interactions by periodically setting goals, measuring performance, and providing feedback during the work process may be necessary in improving knowledge work performance in the distributed work environment. This notion is implied by Drucker (1993), who claims that knowledge workers cannot be supervised, and they cannot be forced to be productive. Knowledge employees, he argues, must act as responsible decision makers and see themselves as executives. This may imply that knowledge workers

should just be left alone to do and finish their own work. However, strong support exists in the literature on the traditional work environment for the importance of performance measurement on performance improvement.

SCOPE

RESEARCH PURPOSE

This research examines one of the management issues and challenges in the distributed work environment, the performance improvement issue. The scope of this study is limited to performance improvement at the task level. To improve task performance of employees in the distributed work environment, managers must identify, study, and improve factors that may affect work performance. This research is intended to be a small step in that direction. Specifically, the purpose of this study is to investigate the effects of feedback and goal setting on task performance of knowledge work in the distributed work environment. This research provides practical and theoretical knowledge to business practitioners and academic researchers in how to design a better workplace to improve work performance. Achieving this purpose will contribute to the body of knowledge of industrial engineering, which is to effectively design a work system for knowledge work in a distributed work environment.

NEED FOR THIS RESEARCH

This study addresses issues related to knowledge work. This is considered a very important area because knowledge workers are becoming increasingly vital to organizations in the dynamic, highly competitive global marketplace (Ikeler and Vancil 1997). Taylor and Felten (1993) claim, "As the importance of knowledge work increases in North America, it becomes more urgent to design it for excellence in performance and quality of working life" (p.204). This research also addresses issues related to distributed work. Work in this area is very much needed because it is predicted that, by 2020, as much as 40 percent of the American workforce will be involved in some kind of distributed work (Coates 1997). The trend toward distributed

work is expected to radically transform the American workplace in the coming years (McGoon 1995).

The effects of feedback and/or goal setting have been investigated thoroughly in the traditional setting, but these factors have not yet been studied in the distributed work setting. This research need is implied by Pritchard et al. (1988), who studied the effects of feedback and goal setting on work performance in a traditional organization. They found that the interventions of feedback and goal setting had an important role in performance improvement. In their Future Research section, they say, "We would be interested in opportunities to try the system in a variety of different organizations" (p.354). Obviously, a study in the distributed work setting would be interesting and different from their study that was conducted in a traditional setting. This research investigates whether the effects of feedback and goal setting, as have been found in the traditional work environment, will be similar in the distributed work environment.

RESEARCH QUESTIONS

This research examines the following main research question: *What effects do feedback and goal setting have on knowledge work in the distributed work environment?* Specifically, the effects of feedback and goal setting on 1) task performance and 2) feedback and goal beneficial effects will be addressed in this research. To answer this main question, the following related sub-questions will be answered:

1. Task Performance

1.1 What effects does *feedback* have on task performance in the distributed work environment?

1.1.1 What are the differences in task performance on knowledge work between workers who receive any form of feedback on how well they and/or others are performing their task (i.e., task feedback and/or task feedback with comparisons with others) and those who receive no feedback in the distributed work environment?

1.1.2 What are the differences in task performance on knowledge work between workers who receive feedback on how well they are performing their task (i.e., task feedback) and those who receive no feedback in the distributed work environment?

1.1.3 What are the differences in task performance on knowledge work between workers who receive feedback on how well they and others are performing (i.e., task feedback with comparisons with others) and those who receive feedback on how well they are performing their task (i.e., task feedback) in the distributed work environment?

1.2 What effects does *goal setting* have on task performance in the distributed work environment?

1.2.1 What are the differences in task performance on knowledge work between workers who receive goals and those who do not receive goals in the distributed work environment?

1.3 What effects does the interdependence of *feedback* and *goal setting* have on task performance in the distributed work environment?

1.3.1 What are the differences in task performance on knowledge work between workers who receive both feedback and goals and those who receive either feedback or goals in the distributed work environment?

1.3.2 What are the differences in task performance on knowledge work between workers who receive feedback and/or goals and those who receive neither feedback nor goals in the distributed work environment?

2. Feedback and Goal Beneficial Effects

2.1 What effects does *feedback* have on feedback beneficial effects (i.e., error correction, task learning, motivation, and satisfaction) in the distributed work environment?

2.1.1 What are the differences in feedback beneficial effects on knowledge work between workers who receive any form of feedback on how well they and/or others are performing their task (i.e., task feedback and/or task feedback with comparisons with others) and those who receive no feedback in the distributed work environment?

2.1.2 What are the differences in feedback beneficial effects on knowledge work between workers who receive feedback on how well they are performing their task (i.e., task feedback) and those who receive no feedback in the distributed work environment?

2.1.3 What are the differences in feedback beneficial effects on knowledge work between workers who receive feedback on how well they and others are performing (i.e., task feedback with comparisons with others) and those who receive feedback on how well they are performing their task (i.e., task feedback) in the distributed work environment?

2.2 What effects does *goal setting* have on goal beneficial effects (i.e., task learning, motivation, and commitment) in the distributed work environment?

2.2.1 What are the differences in goal beneficial effects on knowledge work between workers who receive goals and those who do not receive goals in the distributed work environment?

2.3 What effects does the interdependence of *feedback* and *goal setting* have on feedback and goal beneficial effects (i.e., error correction, task learning, motivation, commitment, and satisfaction) in the distributed work environment?

2.3.1 What are the differences in feedback and goal beneficial effects on knowledge work between workers who receive both feedback and goals and those who receive either feedback or goals in the distributed work environment?

2.3.2 What are the differences in feedback and goal beneficial effects on knowledge work between workers who receive feedback and/or goals and those who receive neither feedback nor goals in the distributed work environment?

RESEARCH MODEL

There are some variables that may mediate the effects of feedback and goal-setting variables on task performance. However, those variables are beyond the scope of this study and will not be identified. The research model of this study is shown in Figure 1.2.

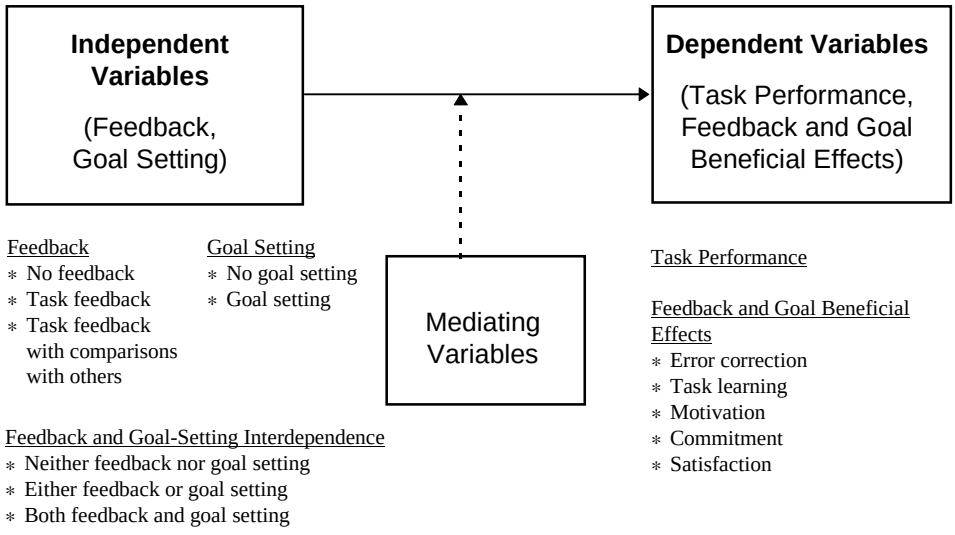


Fig. 1.2. Research model for this research

RESEARCH HYPOTHESES

This research will examine one main hypothesis and sub-hypotheses. All these hypotheses are related to the main research question and Sub-Question 1 (i.e., sub-question that addresses task performance). Sub-Question 2 (i.e., sub-question that addresses feedback and goal beneficial

effects) is exploratory in nature and is not used to make hypotheses. The research hypotheses are as follows:

Main Hypothesis

- *Main Hypothesis:* Feedback and goal setting improve task performance of knowledge work in the distributed work environment.

Sub-Hypothesis 1.1 (Feedback)

- *Sub-Hypothesis 1.1.1:* Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive any form of feedback on how well they and/or others are performing their task (i.e., task feedback and/or task feedback with comparisons with others) than for those who receive no feedback.
- *Sub-Hypothesis 1.1.2:* Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive feedback on how well they are performing their task (i.e., task feedback) than for those who receive no feedback.
- *Sub-Hypothesis 1.1.3:* Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive feedback on how well they and others are performing (i.e., task feedback with comparisons with others) than for those who receive feedback on how well they are performing their task (i.e., task feedback).

Sub-Hypothesis 1.2 (Goal Setting)

- *Sub-Hypothesis 1.2.1:* Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive goals than for those who do not receive goals.

Sub-Hypothesis 1.3 (Feedback and Goal Setting)

- *Sub-Hypothesis 1.3.1:* Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive both feedback and goals than for those who receive either feedback or goals.

- *Sub-Hypothesis 1.3.2:* Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive feedback and/or goals than for those who receive neither feedback nor goals.

Table 1.1 illustrates the summary of research questions, sub-questions, and their related sub-hypotheses. Because the main interest of this research is related to task performance, only task performance related questions (i.e., Sub-Questions 1.1.1, 1.1.2, 1.1.3, 1.2.1, 1.3.1, and 1.3.2) are hypothesized. Their related sub-hypotheses are shown along the side.

Table 1.1
Research questions, sub-questions, and sub-hypotheses

RESEARCH QUESTIONS	SUB-QUESTIONS	RELATED SUB-HYPOTHESES
Main Research Question: What effects do feedback and goal setting have on knowledge work in the distributed work environment?	1 2	- -
Research Questions 1.1 & 2.1: What effects does feedback have on knowledge work in the distributed work environment?		
■ Feedback versus no feedback	1.1.1 2.1.1	1.1.1 -
■ Task feedback versus no feedback	1.1.2 2.1.2	1.1.2 -
■ Task feedback with comparisons with others versus task feedback	1.1.3 2.1.3	1.1.3 -
Research Questions 1.2 & 2.2: What effects does goal setting have on knowledge work in the distributed work environment?	1.2.1 2.2.1	1.2.1 -
Research Questions 1.3 & 2.3: What effects does the interdependence of feedback and goal setting have on knowledge work in the distributed work environment?		
■ Both versus either †	1.3.1 2.3.1	1.3.1 -
■ Both/either versus neither †	1.3.2 2.3.2	1.3.2 -

† Both = both feedback and goal setting
† Either = either feedback or goal setting
† Neither = neither feedback nor goal setting

Sub-Questions 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.3.1, and 2.3.2 are exploratory questions, and they are not hypothesized. Sub-Questions 2.1.1, 2.1.2, and 2.1.3 are designed to study the effects of feedback on its beneficial effects (i.e., error correction, task learning, motivation, and

satisfaction). Sub-Question 2.2.1 is designed to study the effects of goal setting and its beneficial effects (i.e., task learning, motivation, and commitment). Sub-Questions 2.3.1 and 2.3.2 address the effects of feedback and goal beneficial effects (i.e., error correction, task learning, motivation, commitment, and satisfaction).

Sub-Hypotheses 1.1.1, 1.1.2, and 1.1.3 are designed to study the effects of feedback on task performance, and they are varied by the levels of feedback. Sub-Hypothesis 1.2.1 is designed to study the effects of goal setting on task performance. Sub-Hypotheses 1.3.1 and 1.3.2 are designed to study the interdependence between feedback and goal-setting factors.

CHAPTER 2: BODY OF KNOWLEDGE REVIEW

In this chapter, an extensive review of the literature is provided. The purpose of this chapter is to present necessary concepts and backgrounds that led to the development of this research. The chapter starts with an overview of the concepts of performance measurement and its interrelationship with performance improvement (Section 2.1). After the overview of performance measurement has been given, the sections that follow look at the concepts of performance measurement and improvement from different perspectives (i.e., performance measurement and improvement in different environments).

Section 2.2 deals with the virtual work environment. The concepts of the virtual work environment are discussed in detail. Included in Section 2.3 is the review of different work types—blue collar work, white collar work, and knowledge work. Knowledge work and issues related to knowledge work are the highlight of this section. In Section 2.4, the concepts of project management are presented. Next, the issues related to performance measurement and improvement in the R&D environment are provided in Section 2.5. The purpose of these four sections (Sections 2.2 - 2.5) is to provide supporting concepts and foundations to build an understanding and address the underlying issue of performance measurement and improvement in the distributed work environment.

After all the supporting concepts have been provided, this chapter continues with the defined scope of this research—namely, feedback and goal setting. Section 2.6 explains thoroughly the concepts, dimensions, and impacts of feedback. In Section 2.7, the concepts, dimensions, and impacts of goal setting are then presented in detail. Taken together, the purpose of Chapter 2 is to provide the necessary background to study the effects of feedback and goal setting on knowledge work performance in the distributed work environment, which is the purpose of this study. The thought process for the logical development of Chapter 2 is shown in Figure 2.1.

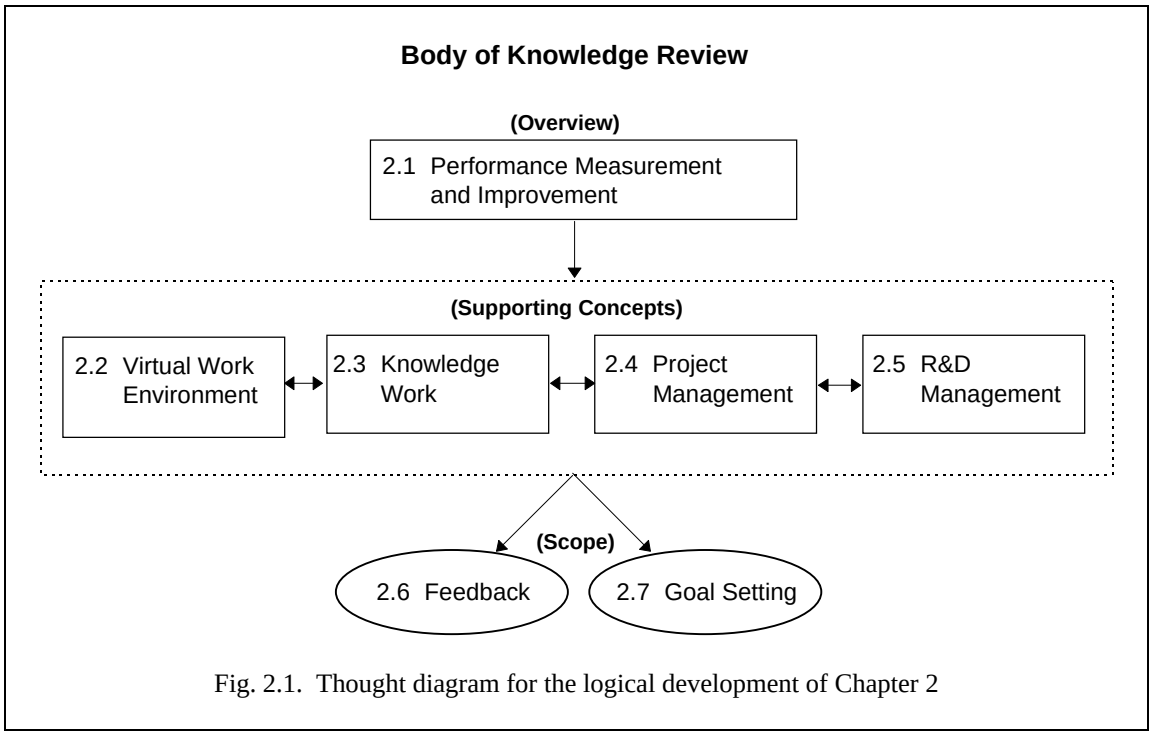


Fig. 2.1. Thought diagram for the logical development of Chapter 2

2.1 PERFORMANCE MEASUREMENT

PERFORMANCE MEASUREMENT AND IMPROVEMENT

In a continuous improvement process, the method of improving and enhancing an organizational system must be a closed-loop or cyclic process. By closing process loops, decision makers can create continuous improvement and learning, creativity, and innovation. Many improvement efforts in the past have failed because decision makers were not concerned about this closed-loop process. They made adjustments on their work and expected that things would be better without studying the effects of their actions. In addition, they lacked follow-through processes needed to improve or change their adjustments.

A systematic method for the continual improvement process was created by Shewhart (see Figure 2.2). This cyclic method—PDSA cycle—was created and used to illustrate the importance of learning and improvement as a continuous process. The concept of this method must be clearly understood before the continuous improvement process will work. The PDSA cycle consists of four steps—Plan, Do, Study, and Act.

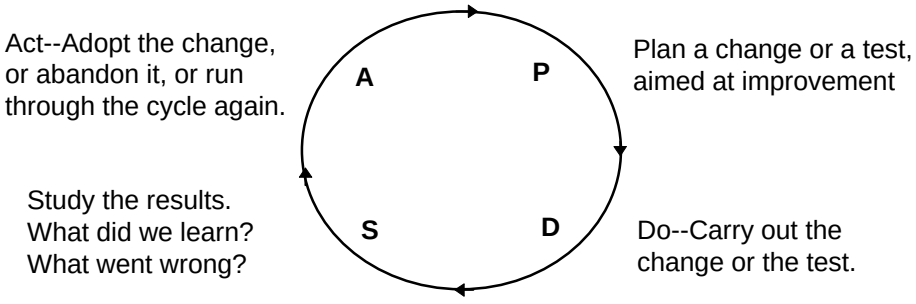


Fig. 2.2. A flow diagram for learning and for improvement of a product or a process (taken from Deming 1993, 135)

STEP 1: PLAN

This first step is the foundation for the whole method; a thorough examination of the existing situation, operation, or process is needed. A hasty start is ineffective and costly. A careful plan involves "… exhaustive thoroughness in thinking about, studying, and analyzing the current situation or process, gathering data to fully understand consumer needs, understand our products and processes in depth …" (Conway 1993, 2-4.11).

STEP 2: DO

Once a plan has been formulated, it is then executed. This is the carrying out or implementation of the plan or strategy from the first step (Plan).

STEP 3: STUDY (OR CHECK)

This is the step where measurement comes in. Here, decision makers inspect or study the results of their plans and their actions. They gather and analyze data collected from the second step (Do). The results are compared with what they expect. The results are documented, and the differences are further investigated.

STEP 4: ACT

At this step, decision makers must act upon the result from the inspection and keep repeating the process. The decision makers must study the results and ask themselves what they have learned from the change, what they can predict, and what they should do next. They may 1) adopt the change, 2) abandon it, or 3) run through the cycle again.

From the PDSA cycle, Deming (1993) advocates Shewhart's recognition of the importance of the Study step. This is where the measurement system comes into play. Without a measurement system, the organization is aimlessly moving into an unknown direction. It is similar to driving in a car without a measurement instrument, not knowing the current speed, the RPM, the engine temperature, the amount of gas left, etc.

Thor (1983) uses another model to underline the significant role of measurement (see Figure 2.3). He says, "Measurement is not the goal; improvement is the goal. A measurement system is a tool to direct scarce resources to the targets where the most benefit can be obtained from those scarce resources" (p.29).

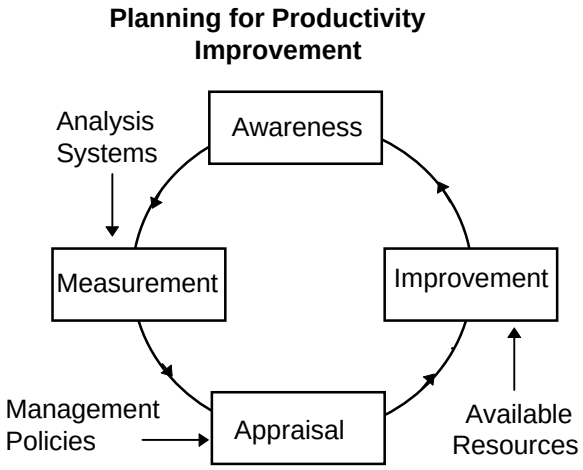


Fig. 2.3. Measurement as an integral part of the improvement role (taken from Thor 1983, 30)

Thor's (1983) process starts when decision makers are aware of the opportunity to improve work productivity (or performance). The next step is to develop a measurement system in conjunction with the other measurement and analysis systems that already exist in the organization. With the results from the second step, the third step is to diagnose or appraise the problems or opportunities revealed by the measurement system. After analyzing the problems or opportunities, the decision makers then direct available resources to improve work performance. This, Thor claims, is a continuous and recursive process, whose results should be fed back to the first step (i.e., awareness) for further improvement.

In the organization of the future, according to Sink and Tuttle (1989), the use of measurement is balanced between control-oriented and improvement-oriented measurements. In organizations, the purpose of measurement should be to enhance performance improvement (Sink and Tuttle 1989; Thor 1993b). To successfully pursue quality and productivity improvement, decision

makers must start with measurement (Thor 1993a). However, many American decision makers are still not effective in using measurement systems. As Louis (1991) indicates from the study of Longenecker and Gioia, "90 percent of organizations in the United States use some kind of performance evaluation systems, but less than 20 percent of these appraisals are conducted effectively" (Longenecker and Gioia 1988 qtd. in Louis 1991, 469).

HOW PERFORMANCE MEASUREMENT INFLUENCES BEHAVIOR

Measurement can go beyond just a regular tool that provides data and information; it can be a tool that supports, motivates, and directs employees in their work. An effective measurement system can increase the amount and quality of feedback given to the employees, provide feedback that is positive, help the employees see the results of their efforts linked to the productivity, and enable them to be accountable for their productivity (Pritchard et al. 1990). Performance measurement can influence and bring about desired behavior changes in the workplace. Nadler (1977) claims that performance measurement influences individuals' behaviors because it generates and directs energy. He says, "… even the simple act of collecting information in an organization can arouse and direct energy" (p.59). Figure 2.4 provides a model of how performance measurement can *create* and *direct* energy in organizational settings.

PERFORMANCE MEASUREMENT AS IT GENERATES ENERGY

According to Nadler (1977), measurement generates energy because it influences perceptions of how the behavior being measured may be rewarded or punished. As a result, individuals tend to put more efforts, energies, and resources into the areas where measurement is being made, as opposed to the areas where there is no measurement or data collection at all. Specifically, individuals will direct their attention to the areas in which they perceive that efforts, energies, and resources will lead to desirable outcomes and avoid the behaviors that will lead to undesirable outcomes. According to the author, the amount of energy or motivation created depends on how individuals perceive whether their behaviors are being measured, the accuracy

of the measures, and the influence of the power group (i.e., those who will use the data from the measurement).

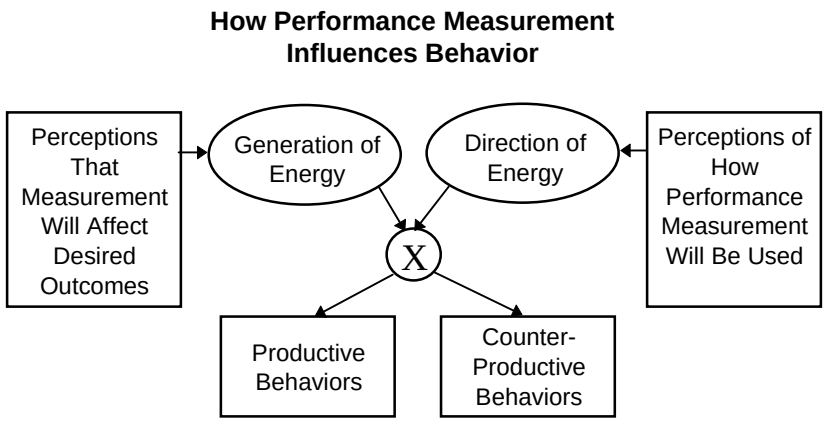


Fig. 2.4. A model of the effects of performance measurement on behavior (adapted from Nadler 1977)

Nadler (1977) claims that performance measurement can generate energy in three different ways. *First*, it creates energy through implied sanctions or rewards. Individuals whose performance is being measured perceive the importance of a specific behavior or activity that can result in a sanction or a reward. *Second*, measurement creates energy when it is tied to explicit rewards. Performance measurement can be a powerful tool to generate energy when it is linked directly with external rewards such as pay, raise, bonus, etc. *Third*, energy is created because measurement enables evaluation and comparison. Data collection can provide valuable information about and enable the evaluation and comparison of individuals' performance where it was not available before. With the information now available, individuals can compare their performance with others', with standards or goals, or with their own performance level in the past.

Performance Measurement as It Directs Energy

Nadler (1977) claims that performance measurement can generate positive energy; it can increase effort, enhance motivation, identify more effective problem solving, or direct a better use of resources. On the other hand, performance measurement can also generate some

negative forms of non-productive or counterproductive activities. Examples of such negative effects are reduction of valid information, misleading information, misdirected energy, and defensive behavior. Nadler argues that the major determinant of the direction of energy is the individual's perception of how the results from performance measurement will be used by the power group. Individuals whose performance is being measured develop perceptions and expectations about how the power group will use the results obtained from the performance measurement. If these individuals have had bad experiences with and do not trust their supervisors in using the results, they may distort the data, deny the accuracy of the data, or choose not to conform to any activities suggested by the results of the measurement. On the other hand, if they trust their supervisors in using the results in a fair, open, and non-punitive manner, they may be motivated to provide accurate data and cooperate with supervisors in solving any problems suggested by the information.

Sink and Tuttle (1989) suggest that supervisors understand the difference between the use of measurement as a control device versus the use of measurement as a driver of performance improvement. Appropriate uses of measurement can drive performance improvement; however, using measurement as a mechanism to control and punish can be demotivating and counterproductive. In addition, the authors urge the supervisors to understand fear and resistance that may result from performance measurement. Fear could come in several different forms: fear of exposing good or bad performance, fear of more work, fear of loss of autonomy, fear from past experience, fear of failure, fear of change, fear from lack of skills and knowledge, and fear of instability.

To overcome fear and resistance, ownership and commitment of the people involved is important. The answer for this is to develop a measurement system as participatively as possible, by having those whose performance is measured involved in the development of the system (Sink and Tuttle 1989). Meyer (1991) mentions, "Effective organizations are moving away from the control-oriented approach toward an involvement-oriented climate designed to elicit commitment on the part of employees at all levels" (p.75). The employee involvement can help overcome resistance from those who will be affected by the system.

PERFORMANCE MEASUREMENT AND FEEDBACK

Perhaps the most important use of measurement in the organizational system is *feedback.* The most direct use of performance measurement is "… to give the information back in some form to the organization's members. This process of giving data back for the purpose of bringing about change is called feedback" (Nadler 1977, 67). Just as the acts of collecting information can create and direct energy, feedback can affect individuals' behaviors and their performances because it both creates/motivates and directs behaviors.

Employees cannot improve their performance unless they know what their current performance is, how they are doing, how their work affects the process and products, and how they can improve their work. As a result, feedback plays an important role in performance improvement. It has been recognized that organizational effectiveness depends on the organization's ability to assess job performance and give feedback (Varca and Levy 1984). This is especially important in participative organizations. Measured results must be fed back to all employees in every process so that they will feel empowered.

2.2 VIRTUAL WORK ENVIRONMENT

TYPES OF THE VIRTUAL WORK ENVIRONMENT

With the rapid advance of information technology in the past decade, businesses have seen changes in the workplace environment. An example of how information technologies have transformed the American workplace is revealed in a form called "the virtual work environment." The virtual work environment, which is referred to by some as "the virtual workplace" or "the virtual corporation," has become a choice of organizations in the last several years. Literature (e.g., Goldman 1994; Betts 1995; Bird 1996; Conley 1996; Harris et al. 1996) has revealed that the virtual work environment has emerged as a compelling business strategy. A large number of companies have adopted some forms of virtual settings inside their organizations (Davis and Darling 1996; Klein 1994; Semich 1994; Sheridan 1996). "More companies are being managed like virtual corporations or network organizations …" (Davis 1996, 68).

What are the characteristics of a virtual work environment? It may be important to know what distinguishes a virtual work environment from a typical work environment. Barnatt (1995) explains that a virtual workplace is likely to exhibit the following characteristics:

1. A virtual workplace will be reliant on the medium of cyberspace.
2. A virtual workplace will be enabled via new computing and communications developments.
3. A virtual workplace will exist across conventional organizational structures (p.83).

From the above characteristics, a virtual work environment is different from a typical work environment because employees, with the enabling power of information technologies, can communicate with their peers, subordinates, and supervisors electronically regardless of geographical barriers. They need not locate at the same place in order to work together. They

communicate; they share their ideas, data, and information; and they collaborate on the work through the medium of cyberspace. This establishment was not possible until the enabling power of information technologies.

The literature has created and used many terms to describe concepts similar to or the same as virtual work environment. Some examples of these are virtual workplace, virtual corporations, virtual teams, virtual offices, borderless organizations, seamless organizations, cybercorp, telecommuting, and distributed work environment. Often, these terms are used interchangeably even though there might be some slight difference among them.

Most articles tend to use the term "the virtual work environment" to describe the concept of virtuality in organizations regardless of the extent of virtuality being applied in those organizations. Goldman (1994) believes there are different levels of virtuality, arguing that "… virtuality entails not only full enterprise integration, but inter-enterprise integration as well" (p.17). Klein (1994) distinguishes the level of virtuality in the virtual work environment. He uses the terms "virtual corporation" and "virtual office" to distinguish the two possible levels of virtuality in the workplace. According to Klein, the virtual corporation consists of several independent organizations that function as a single entity, while the virtual office consists of organizational units that function as a single organization without a physical office.

Similar to Klein's (1994) two levels of workplace virtuality, the concepts of virtual work settings may be divided into two categories: *semi-virtual settings* and *extended-virtual settings*. The category of settings is based on the scope of the company—whether the scope of its corporation is extended beyond its own organizational boundary to include anyone outside the company or not. If the scope of any particular company includes only those who are hired as employees, then the company falls into the first category, the semi-virtual setting. On the other hand, if the scope of any particular company is extended to include partners, suppliers, customers, or competitors, it may be called the extended-virtual setting.

SEMI-VIRTUAL SETTINGS

With the power of information technology, the best persons with the best skills can be brought to accomplish a project that otherwise would be impossible because of geographical barriers. An employee can work for his employer, regardless of the geographical location, as long as both sides can communicate with each other. "Whether at home, in the car, at a customer's office, a third-party site, in a branch office or in headquarters, employees are unified via highly sophisticated information technology, and by skilled team coordinators who foster a strong sense of common identity and mission" (Barnatt 1995, 87).

Semi-virtual settings have been described according to several related terms; such as, the virtual office, telecommuting, office in a box, hot desk, hotelling, and distributed work. According to Klein (1994), the virtual office has two main components: telecommuting and the office in a box. Telecommuting enables employees to work for a company and participate in activities typically carried on in the central office regardless of the physical location of those individuals. The office in a box, according to the author, brings to those employees all the support systems normally found in the central office; e.g., file storage and retrieval, duplication, word or document processing, telephone and facsimile connections. A hotelling arrangement is one in which the employees temporarily work at the customer's location and have office space and support systems there. For the hot desk arrangement, employees will call in before they come to the office so that office arrangements can be made. These employees will be assigned temporary and different desks every time, and they will have access to telephones and computers that they need (Barnatt 1995).

One thing common about these arrangements is that the individuals working in these environments are hired and compensated by their employers. The companies that engage in this type of work "distribute" their work to their employees. Through the use of advanced information and telecommunication technologies, these individuals are able to work for the company even though they may be separated geographically. Information and telecommunication technologies are allowing organizations to become time and distance insensitive. Companies can now draw upon human resources whenever and wherever the

companies need them, as opposed to relying only on resources available through the traditional environments (Valovic 1993).

Employees in this semi-virtual setting may work as individuals or as a team. If they work as a team, they may form a virtual team. A virtual team is a type of teamworking in which employees in a variety of locations collaborate closely and communicate with each other electronically. Kristof et al. (1994), as quoted in Van Aken (1995), defined a virtual self-managed team as a "… self-managed knowledge work team, with distributed expertise, that forms and disbands to address specific organizational goals and is characterized by fluid human resources in terms of membership, leadership, and boundaries (functional, organizational, and geographical)" (pp.21-22). Davidow and Malone (1992) mention that a task force for a virtual team is formed around a specific project. Such a group may contain representatives from several different departments (e.g., sales, marketing, R&D, and manufacturing). This group may meet on a regular basis but often would be geographically dispersed and would communicate using telephones, facsimiles, and other electronic media.

According to Davidow and Malone (1992), the virtual team may also include people outside the organization—suppliers, distributors, academicians, and customers. If the scope of a virtual setting is extended to include individuals outside the company, the company may, for instance, contract its work to outside partners or the company may hire independent workers for a specific venture. Then this particular company is operating in the extended-virtual setting.

EXTENDED-VIRTUAL SETTINGS

The literature has claimed that the advancement of information technologies will accelerate the change in the way companies carry out their business. Valovic (1993), for example, believes that computer networking capabilities will enable the restructuring and redesigning of the corporate structure. He believes that computer networking technologies will lead to a virtual venture, in which those who choose to work based on a bidding process are called "employee as consultant."

In such a virtual arrangement, suppliers will search for customers and employees will search for potential employers electronically. Employees may not be employed permanently by any employers but may be negotiated and hired to form teams to accomplish short-term, specific projects. Once the project has been completed, the team is dissolved and the employees start working for another project or another employer. With this arrangement, the company uses information technologies and innovative relationships with its independent partners to function like an organization.

Such a setting may be called "the [extended] virtual setting," which Byrne et al. (1993) defines as a "… temporary network of independent companies—suppliers, customers, even erstwhile rivals—linked by information technology to share skills, costs, and access to one another's markets. It will have neither central office nor organization chart" (p.99). Extended virtual corporations may resource part or even all of their operations externally via strategic alliances, collaborations, partnerships, or straight outsourcing. Some virtual corporations may form teams among themselves as a virtual enterprise for accomplishing their short-term, specific projects.

The literature reveals that many companies have already used, to a different extent, this concept of extended virtual settings. Harris et al. (1996) give guidelines of how one can apply the concept of the virtual corporation to one's R&D operation. Several authors reveal how different companies have chosen to resource different parts of their operations externally (Davis and Darling 1996; Conley 1996). Semich (1994) points out that it is possible to contract out the majority of the company's operations to other partners. He mentions, "… you could just think up a great new product and then kind of orchestrate the whole process—let others do all the work, and you just make sure all the designers, suppliers, assemblers, packagers, and distributors stay synchronized with customer demand …" (p.38). Author and lecturer James Martin uses the term "cybercorp" for the extended virtual setting in which most of its operations will be outsourced (Betts 1995). Other authors (e.g., Sheridan 1996; Bird 1996) show how different companies have teamed up together to pool their expertise on a particular business venture or opportunity.

BENEFITS AND COSTS OF THE VIRTUAL WORK ENVIRONMENT

BENEFITS (ADVANTAGES) OF THE VIRTUAL WORK ENVIRONMENT

With the power of information technology, the best persons with the best skills can be brought to accomplish a project that otherwise would be impossible because of geographical barriers. The virtual work environment can also increase the employment of potential workers. For example, handicapped and working mothers who may be reluctant to work outside their home because of personal reasons may find it is possible for them to work for a company.

The virtual work environment can easily share skills, costs, or resources and access to a new market with outside parties (i.e., suppliers, customers, and competitors). The power of information technology makes it easier, more possible, and more efficient to do so. Without electronic communications, the collaboration of parties in different geographical locations might be very limited and inefficient.

Companies using a virtual work arrangement can benefit from the reduction of building or office expenses. Employees may work at home or work at the customer's location and, therefore, do not need office space. Even when employees need to come to the office and use office space temporarily, virtual companies do have a special setting, called Hot-Desk System, to accommodate them. Ernst & Young, for example, has to provide only one office per three consultants and reduces its office space by 25% (Barnatt 1995).

Companies that use a virtual work arrangement should also save expenses in some other areas, including insurance, traveling expenses, and many more areas. Since building and property costs could be less, insurance premiums should be less. Accident insurance should also be less since workers do not come to the building so often. Traveling expenses should be lower because employees can work together using e-mail, video-conferencing, and groupware. The need for travel from home to office or from one office to another will be reduced because of electronic links between employees. This can create another benefit--environmental compliance.

Working in a virtual work environment may increase the productivity level of employees. For example, employees can cut down traveling time from home to work (especially important in large cities); they may feel more comfortable working in a familiar environment; and they may be able to take care of some personal issues that may pop up now and then (especially important for working mothers) (Maloff 1995; Malone and Davidow 1992).

COSTS (DISADVANTAGES) OF THE VIRTUAL WORK ENVIRONMENT

Investment costs in information and telecommunication technologies might be substantial and prohibit the implementation of the virtual work environment in small companies. Hardware, software, networking equipment, training, operating, and maintenance costs are often underestimated by many companies. Technology-related maintenance costs are hidden and may prove costly. For employees not familiar with computer technologies, learning curves might be somewhat steep.

Reliability of the telecommunications system is the most important concern. Since most of the communication is being done electronically, a business may come to a stop if the information system does not work. For example, if the e-mail system does not work, most communication becomes very difficult. The company may start relying more on equipment reliability and availability for its success.

Electronic transfer of data is still very vulnerable to theft, sabotage, and human-created damages. Computer criminals enjoy breaking into corporate computer systems for the sake of being challenged. Virus files create damage. Some criminals tap into electronic transfers for financial benefits. All these potential problems are prevalent today, and vulnerability is even greater in a virtual work environment than in a traditional work environment. Through telecommunication networks, the potential for unauthorized access, abuse, or fraud is not limited to only one location but can occur at many points in the network.

One of the most important disadvantages when a virtual work environment is compared with a typical work environment are the issues of culture, identity, loyalty, and sense of community. Several activities will not happen (or will happen infrequently) in a virtual setting; for example, talking and chatting at coffee breaks, dinners at colleagues' houses, personal interaction, and personal meetings with top managers. Communicating electronically may undermine the richness and serendipity that personal contact brings to workplace interaction (Wallace 1989). The creativity, thought, and clarification may be reduced without direct contact and interaction.

Working at home or any place away from the office may create the feeling of being isolated and alienated from the rest of the organization. Some companies are using a modern homeworking system, in which employees may have the capability to see their colleagues on a video screen or in a window of their computer screen (Barnatt 1995).

Patterson (1994) warns that indispensable values discovered at work might be lost, including "the sense of community, the shared goals, the spirited exchange of ideas, the pride of achievement" (p.87). The absence of these activities might prove to be critical more than previously thought. This disadvantage leads to another concern. That is, drive for success in a virtual work setting may depend more on individual success rather than on group success when compared to a traditional work setting. This leads Verespej (1995) to envision that "There will be less loyalty to the organization, because people will be more wedded to the product they make, the service they perform, or the technology they use than the company they work for" (p.27). This could be the major cost of implementing a virtual work setting.

ISSUES IN THE VIRTUAL WORK ENVIRONMENT

It should be safe to say that there will be many issues and challenges that management will confront in any new work environment. For example, March (1995) claims that organizations of the future will need to be flexible and adapt quickly to change. This, the author claims, has led management to design organizations that are capable of learning and adapting to change.

Several economic, social, and political issues of the future workplace are also discussed in Wallace (1989). For example, the new workplace, he says, is threatening to workers because it creates uncertainty and forces a portion of acquired skills to be obsolete. Workers in the new environment may become very stressed, and most could expect to change jobs six to seven times before they retire. Work, he claims, will be skewed in favor of professional and knowledge work. In addition, there may be a blurring of distinction between work and leisure that may result in more conflict between work and family.

In the same way, management in the virtual work environment will be facing issues and problems that are unique and unprecedented. Imagine how hard it is to manage knowledge workers in a typical organization; it will be doubly hard to manage the same workers when they do not work at the same location. (More detail on knowledge work is discussed in the following section).

The literature reveals some concerns about management issues and challenges in the virtual work environment. For example, some authors anticipate that there will be management complications when employees work at different times and locations. Issues such as loyalty, sense of community, dedication, and cooperation may arise (Menagh 1995; Verespej 1995; Patterson 1994). Some authors discuss the issues of pay and reward. Malone and Davidow (1992) believe that management needs a revised reward system in the virtual work environment. They propose a system that is based on performance. Similarly, Goldman (1994) proposes the use of performance-linked pay as a reward system in the virtual work environment. Verespej (1995) believes that people will be hired not for jobs but for their skills. At the same time, they will be paid for their skills.

Simons (1995) points out the importance of individual independence of each partner. The author claims that management needs to reconcile the needs of the individuals and the needs of the organization. Bottoms (1994) argues that the virtual work environment threatens to disrupt the old management paradigm of market-entry barriers. "Companies not even aligned today may prove to be tomorrow's biggest rival. How can management compete with that?" (p.62).

Handy (1995) and Verespej (1995) emphasize the trust issue in the virtual work environment. The authors believe that management of virtual settings requires a very high level of trust.

Some authors go further by providing some guidelines or suggestions of how to manage virtual corporations. Pape (1996), for example, provides a guideline of how to select virtual workers. Duffy (1994) describes how to survive in virtual corporations. She provides ten critical prescriptions for survival in the virtual corporation. Tomas and Arias (1995) suggest ways to be successful in and reap the benefits of networking or partnering. Harris et al. (1996) determine the proper strategies for individual virtual R&D programs. Semich (1994) specifies the requisite components for virtual factories.

PERFORMANCE MEASUREMENT OF EMPLOYEES

Even though a myriad of articles have been written about the concepts and possible issues of the virtual workplace, only a small portion of them have touched on the issues of performance measurement in the virtual workplace. Performance measurement in the virtual setting can be difficult and challenging. An intensive review of existing literature has revealed little research in this area. This should not come as a surprise since the virtual establishment is a relatively new concept. The practice has been made possible only after the recent development of advanced telecommunications technologies. The existing related work in this area will be discussed to reveal what is currently available.

Jenner (1994) identifies an important question for managers in the virtual work environment: How will they evaluate employees they no longer see face-to-face every day? She believes that managers must move away from quantity of work and move toward quality. She suggests that managers evaluate their employees by employees' ability to successfully complete objectives, their ability to satisfy customer needs, and their knowledge of customer needs. The measurement of employee performance is ultimately driven by how well the employee satisfies the customer.

Klein (1994) helps managers identify whether the company should perform a particular activity by itself or outsource it to its partner. He suggests that if one of the company's partners can add greater value to the end product or service than the company itself or other partners can, then that partner should be given the job. In other words, the partner's performance is evaluated by how much value it creates for the company and how much the company is willing to pay. Value, according to Klein, is what the customer defines, and different customers will have different expectations.

Humble et al. (1995) propose that supervisors manage their employees by results. The authors suggest that supervisors and employees agree on what work is expected, what the final output should be, and when it should be delivered. Managers, they argue, should pay attention to the product and its quality, rather than to the time spent performing work-related tasks.

Another major reason for the slow development of the research may be attributed to the difficulty of the performance measurement and evaluation process. Similar to the traditional work environment, employee performance measurement in the virtual work environment will be more difficult and complicated for knowledge workers than for blue-collar workers. The reason is that knowledge workers produce outputs that are mostly intangible and not easy to quantify. Unlike blue-collar work, knowledge work tends to be highly interdependent, and it is much harder to associate the performance or non-performance with a specific employee. In addition, knowledge work tends to be non-repetitive, non-routine, chaotic, and with no predefined work standard (Lehrer 1983). Therefore, the main reason for the slow development of research in performance measurement of knowledge workers in the virtual work environment may be the perception that the performance measurement and evaluation process is difficult to conduct and that the results from performance measurement can be subjective and therefore considered useless.

2.3 KNOWLEDGE WORK

WORK TYPES

Beruvides and Koelling (1992) and Beruvides (1993) use Kurstedt's (1993) four frameworks to explain and distinguish the three types of work—blue collar work, white collar work, and knowledge work. Kurstedt's four different frameworks are Pursuit, Endeavor, Decision, and Maturity. The summary of Kurstedt's four frameworks is shown in Figure 2.5.

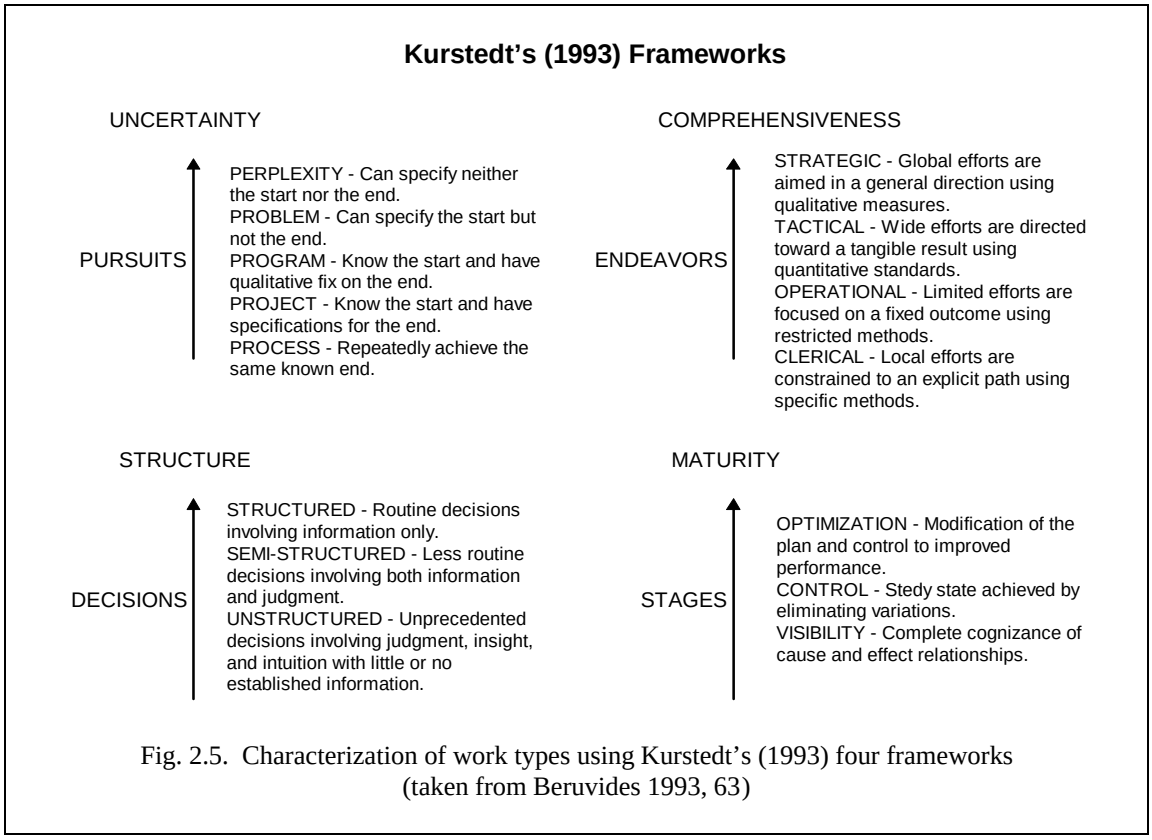


Fig. 2.5. Characterization of work types using Kurstedt's (1993) four frameworks (taken from Beruvides 1993, 63)

According to Kurstedt, the four frameworks can be used to help characterize a domain of responsibility, which is equivalent to characterizing the organizational work. The *Pursuit* framework is composed of five different levels of certainty/uncertainty: process, project, program, problem, and perplexity. The *Endeavor* framework, defined as efforts directed toward final results, is divided into four different levels: clerical, operational, tactical, and strategic.

The level of unstructuredness in decision making divides the *Decision* framework into three different levels: structured, semi-structured, and unstructured. The *Maturity* framework is composed of three different sequential stages: visibility, control, and optimization (Kurstedt 1993). The four frameworks can be used collectively to characterize management systems; domains of responsibility; or, in this case, types of work.

Combining Kurstedt's four frameworks with the other four work characteristics (i.e., nature of work, inputs, outputs, and degree of discretion), Beruvides (1993) differentiates the three types of work (i.e., blue collar work, white collar work, and knowledge work) in detail by using seven work characteristics. His work is shown in Table 2.1.

Table 2.1
Characteristics for the three types of work
(taken from Beruvides 1993, 65)

	TYPE OF WORK		
	Blue Collar Work	**White Collar Work**	**Knowledge Work**
Nature of Work	manual or physical	any nature	any nature
Inputs	clearly definable and directly influential in output	definable and directly influential in output	not as clearly definable and can be, but not necessarily are, influential in output
Outputs	clearly definable (tangible)	mainly tangible with some tangible factors	some tangible factors, but mainly intangible
Degree of Discretion	practically none	little or none	very high
Pursuit Level	process and project	process, project, and program	program, problem, and perplexity
Level of Endeavor	clerical and operational	clerical to tactical	tactical and strategic
Decision Structure	structured	structured and semi-structured	semi-structured to unstructured
Stage of Maturity	visibility to control	visibility to control	control to optimization

BLUE COLLAR WORK

Using Kurstedt's four frameworks, Beruvides and Koelling (1992) define blue collar work as work of a manual or physical nature. The inputs of blue collar work are clearly definable and directly influential to the output, which is definable or tangible. There is no or little discretion permitted in the job task for blue collar workers. Job task pursuits can be described as process

and project levels on the uncertainty scale; endeavors are at clerical and operation levels; decisions are structured; and stages of maturity fall within visibility and control levels.

WHITE COLLAR WORK

Beruvides and Koelling (1992), with the use of Kurstedt's four frameworks, define white collar work as work of any nature (manual, physical, or mental). The inputs of white collar work are definable and directly influential to the output, which is mainly tangible with some factors being intangible. There is no or little discretion permitted in the job task for white collar workers. Job task pursuits can be described as process, project, and program levels on the uncertainty scale; endeavors are at clerical, operation, and tactical levels; decisions are structured to semi-structured; and stages of maturity fall within visibility and control levels.

The literature has shown a rapid growth of employment for employees within this sector. For example, Lehrer (1983) indicates that white collar employees outnumber the blue collar groups by three to two and expects the growth to continue even more. Roach (1991) shows that the growth in white collar jobs has averaged nearly four times the growth of other occupational groups in the US. Davenport et al. (1996) project that, by 2004, professionals and managers will account for 25 percent of all US jobs.

Certain characteristics that differentiate white collar work from traditional blue collar work are discretion, decision making, design, organization, measure of output, periods for work completion, and non-repetitive nature of work cycles (Beruvides and Sumanth 1987; Beruvides 1993). White collar workers or employees include individuals who are executives, managers, administrators, knowledge workers, professionals, technical specialists, sales workers, and support staffs. Roach (1991) divides white collar employees into two major groups: information support staffs and knowledge workers. Information support staffs, he explains, include employees whose functions are involved in the back office, clerical, and selling ends of a business; e.g., technicians, administrative assistants, and sales personnel. Knowledge workers, according to him, include individuals who function in either a creative or supervisory capacity; e.g., executives, managers, and professionals. Note that individuals who may be

called white collar employees may also include individuals who fall under the third category of work type—namely, knowledge workers.

KNOWLEDGE WORK

Using Kurstedt's (1993) four frameworks, Beruvides and Koelling (1992) define knowledge work as work of any nature (manual, physical, or mental). The inputs of knowledge work may not be clearly definable and can be influential to the output, which is mainly intangible with some factors being tangible. There is a high level of discretion permitted in the job task for the knowledge work. Job task pursuits can be described as program, problem, and perplexity levels on the uncertainty scale; endeavors are at tactical and strategic levels; decisions are semi-structured to unstructured; and stages of maturity fall within optimization levels.

Knowledge workers are those who create, design, and develop things or ideas. They, according to Beruvides and Sumanth (1987), "… may plan, schedule, control, direct, supervise, oversee, research, analyze, and make decisions" (p.128). Knowledge workers' tasks involve the exercise of judgment. Two major dimensions, according to the authors, characterize knowledge work: discretion (the judgment required to accomplish tasks) and intangibility of the output produced. "The perception is that outputs are generally intangible, with long time-lags for work completion, and that, often, work cycles are nonrepetitive" (p.128).

Duffy (1995) sees knowledge work as any work that uses or produces knowledge to deliver products or services. Jenner (1994) describes knowledge workers as people who analyze, create, decide, collaborate, and act on information. Drucker (1977) characterizes knowledge workers as those who are paid for putting knowledge, rather than brawn or manual skills, to work; e.g., accountants, engineers, nurses, computer specialists, teachers, and researchers.

In the last two decades, the fastest growing group in a developed economy has consisted of knowledge workers (Drucker 1977). They account for almost one-third of the total workforce of a developed country (Drucker 1993). Business and academic sectors seem to realize and agree upon the emergence and the significance of the new environment—the environment that

is characterized by knowledge work and knowledge workers. March (1995) asserts, "Survival among organizations depends less than previously on access to material resources or markets and more on access to knowledge. The so-called knowledge explosion makes the ability to gain and use knowledge a primary source of competitive advantage" (p.429).

ISSUES IN THE KNOWLEDGE WORK ENVIRONMENT

MANAGEMENT ISSUES

Knowledge workers have become probably the most important part of today's workplace. Drucker (1977, 1993) mentions that a primary task of management in the decades ahead will be to make knowledge workers productive. According to Blacker (1995), employees in today's competitive global environment should be managed as knowledge workers. Knowledge workers are becoming increasingly vital to the success of the dynamic, highly competitive global marketplace that many of today's enterprises must deal with effectively (Ikeler and Vancil 1997). To make knowledge work productive will be the great management challenge for this century (Duffy 1995). Drucker (1995) claims that the productivity of knowledge work will predictably become the economic and social challenge of the knowledge society. Whichever country first succeeds in raising the productivity of knowledge work will economically dominate the twenty-first century (Drucker 1992).

Managing knowledge work and knowledge workers will be very challenging and will need a different mind set. Unlike the other types of workers, knowledge workers own the means and tools of production—their knowledge. They own their knowledge and can take it wherever they go. Knowledge workers cannot be supervised. They are useful for an organization only when they know more than anybody else in the organization. Frequently, there is no one who knows enough about the work of the knowledge workers to appraise what they really contribute. Knowledge employees must act as responsible decision makers and see themselves as executives (Drucker 1993).

Webber (1993) and Duffy (1995) believe that managing a knowledge-based workplace requires a changed mind set. "Improvements in non-routine, knowledge-work have proved much more elusive" (Davis 1996, 68). Lehrer (1983) explains why managing knowledge workers requires different management skills. He argues that professional or knowledge workers work in an environment that is different from the rest of the organization. They provide outputs that are mostly intangible and not easy to quantify. He also claims that since knowledge work tends to be highly interdependent, it is much harder to associate the performance or non-performance of a particular task with a specific individual. In addition, there are no predefined work standards for knowledge work since work in these areas tends to be non-repetitive, non-routine, and chaotic. Ledford (1995) attributes the lack of standards for evaluating knowledge workers to the facts that their work usually takes place in their heads and is abstract, unconventional, creative, diverse, unique, and uncertain.

Since the success of knowledge-based organizations will depend highly on their knowledge workers, the organizations have to market membership as much as they market their products. They have to attract, motivate, satisfy, reward, and retain their good employees. Managers have to know the right mix of knowledge that is needed for a particular position. They have to create an environment that allows knowledge workers to learn—from their own experience; from each other; from customers, suppliers, and partners (Webber 1993). Investment in knowledge will become an important, if not the most important, part of the organization (Drucker 1995).

Performance Measurement Issues

One of the most important aspects in management—performance measurement—has also become a challenge in the knowledge work environment. Beruvides et al. (1988) claim that performance measurement of knowledge work "… has been a subject of significant interest to both research scholars and practitioners for decades." Knowledge workers, they claim, "… present widely divergent challenges with respect to [performance] measurement more so than the traditional blue-collar workers" (p.40).

An example of performance measurement difficulties is pointed out by Schainblatt (1982), who identifies five major obstacles in measuring knowledge workers' performance. The five obstacles are as follows: 1) contribution or output is difficult to define; 2) people tend to measure activities rather than results; 3) due to time delay, the contribution of their work may not show until several periods later; 4) the quality dimension needs to be included in the measure; and 5) the productivity measure needs to include the concept of effectiveness as well as efficiency. Beruvides and Sumanth (1987) identify another challenge of performance measurement in this area. Many people, they say, have confused efficiency and effectiveness with productivity. This confusion, coupled with a tendency of people to measure activities rather than results, makes performance measurement of knowledge work a challenging issue (Beruvides and Sumanth 1987).

Researchers and practitioners have attempted to deal with challenges in performance measurement of knowledge workers for many years, but their success has been relatively small. Beruvides and Sumanth (1987) point out that "Although many have a conceptual understanding of what knowledge work is, few have been able to determine or measure it specifically" (p.128). The results from the performance measurement are not very satisfying; the validity of the results is often a concern. Beruvides and Sumanth (1991) say, "A question often asked is, should white-collar/knowledge work be measured at all, considering the nature and structure (or lack of structure) of such work" (p.22).

Armstrong (1995) explains that those who expressed their dissatisfaction of job evaluation in the organization cited the inflexibility and the inability of the evaluation to deal with knowledge workers as one of the reasons for their dissatisfaction. Traditional approaches, he argues, cannot be used effectively to evaluate knowledge workers. Beruvides and Sumanth (1991) contend, "To measure a white-collar or knowledge worker individually as has been done with blue-collar workers is a mistake. The work is structurally different" (p.23).

Another dissatisfaction and difficulty of job evaluation for knowledge workers' performance may stem from the fact that management tools, including performance measurement tools, for

knowledge work have not been satisfactorily developed. Existing traditional industrial engineering tools and techniques cannot handle the new work environment. Beruvides and Sumanth (1987) explain, "The use of traditional industrial engineering techniques such as time studies, work sampling analysis, and other traditional methods have been applied to 'solving' the problem of white-collar [and knowledge work] productivity measurement. Clearly, these are inadequate, since they ignore many intangible elements of the output generated by a knowledge worker" (p.129). Unlike its blue-collar work counterpart, knowledge work management tools have not been well defined, designed, and studied. Beruvides and Koelling (1993) contend, "The tools used in what we traditionally know as Blue-collar work (B-work) have been well defined, designed, and studied. The work of Frederick Taylor and his extensive studies on shovels, shovel design, and shoveling come to mind. But what about the tools for white-collar and knowledge work (W and K-work)? What are the best tools to use?" (p.230).

PERFORMANCE MEASUREMENT AND IMPROVEMENT OF KNOWLEDGE WORK

Even though performance measurement or evaluation for knowledge workers may be inflexible and difficult at times, it is still possible to measure how knowledge workers add value to the organization (Duffy 1995). Duffy believes that processes can be developed to manage knowledge assets of a company and that managing these knowledge assets improves performance. This notion is supported by Sink and Tuttle (1989), who claim that measuring performance in an organization supports and enhances performance improvement.

Some authors suggest that knowledge workers be measured by their *outputs* or *results*. Lehrer (1983), for example, believes that the first question to ask when attempting to evaluate knowledge workers is the following: What are the outputs of the processes for which the employees are responsible? After the analysis of outputs and objectives, managers can then develop appropriate measures. Drucker (1977, 1980, 1992, 1993) also believes that knowing the goals and objectives is the foremost and most important thing when evaluating knowledge workers. In knowledge work, he argues, defining the task and getting rid of what does not need

to be done or what does not contribute to the goals and objectives are probably the greatest ways to increase productivity. He urges managers to assess their knowledge workers by asking what the expected results of their work are, what they are contributing to the organization, and what the company should hold them accountable for by way of contributions and results.

Evaluating knowledge workers' performance based on their outputs or contributions is not without criticism. According to Beruvides and Sumanth (1987), "The lack of physical output and the intangibles such as creativity, organization, teaching skills, communication skills, planning, intuition, and many others which we might term the 'therbligs of knowledge work,' will probably always present a problem" (p.136). Drucker (1977, 1993) argues that the contributions may not always be measurable; judging them may become controversial. He suggests that knowledge workers must be able to appraise their own contributions because they know their own work more than anyone else knows it. Drucker (1993) claims that in knowledge-based organizations, there is frequently no one who knows enough about the work of knowledge workers to appraise what they actually contribute. Boldly, he says, "Knowledge employees cannot, in effect, be supervised" (p.65).

Alternatively, some authors suggest that knowledge workers be measured for their *potential inputs*. Davenport et al. (1996), for example, mention that knowledge work productivity should be measured on the basis of input, rather than on the effectiveness of the transformation process. Verespej (1995) believes that the future workforce will be hired and paid for the skills they have. Employees will not be hired just to fill job vacancies.

2.4 PROJECT MANAGEMENT

THE CONCEPT OF PROJECT MANAGEMENT

Project management has increasingly received attention from managers and executives as a workable possibility for the organizational form of the future. The traditional and highly bureaucratic organizational structure is becoming obsolete since it cannot respond rapidly enough to the new environment. The traditional form of organizational structure must be replaced with project management, which is believed to be more responsive to the rapidly changing environment (Kerzner 1995). Project management has become and will continue to be an important component in managing organizations of the future. It is estimated that as much as 50 percent of work has been done in a project format in many organizations (Lewis 1995).

To understand project management, one should clearly understand the definitions of a project and project management. A project is defined as

> *A complex effort, usually less than three years in duration, made up of interrelated tasks, performed by various organizations, with a well-defined objective, schedule, and budget (Archibald 1992, 24).*
>
> *A project is a one-time job that has defined starting and ending dates, a clearly specified objective, or scope of work to be performed, a pre-defined budget, and usually a temporary organization that is dismantled once the project is complete (Lewis 1995, 14).*
>
> *[A] project is a temporary endeavor undertaken to create a unique product or service. Temporary means that every project has a definite beginning and a definite end. Unique means that the product or service is different in some distinguishing way from all similar products or services (Duncan 1996, 1.2).*

In general, project management is large-scale problem solving that involves project planning and monitoring. Several authors define project management as

Project management is the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives (Kerzner 1995, 4).

Project management is the planning, scheduling, and controlling of project activities to achieve project objectives (Lewis 1995, 15).

Project management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project (Duncan 1996, 1.3).

Generally, for a project with a specific scope to be completed successfully, it has to accomplish three major components: time, cost or budget, and specifications or performance level. Project success is identified as achieving the desired objectives within the allocated time, under the specified budget, and at the desired performance level. Lewis (1995) refers to the success of project management as good, fast, and cheap (i.e., good performance level, fast delivery, and cheap cost).

PERFORMANCE MEASUREMENT ISSUES

Even though performance evaluation in the project environment may be more difficult than those done in the traditional work environment, it is still necessary if performance improvement is to be achieved. There can be no control unless some form of monitoring and assessment is done. In this section, issues related to performance measurement are discussed: evaluation criteria and performance evaluators.

EVALUATION CRITERIA

Herath et al. (1995) identify beneficial aspects of project evaluation as follows: to ensure that there are no cost or time overruns, to make possible future business planning, and to enable ongoing performance measurement. Project evaluation, or project audit, should not be conducted only at the end of the project; it should be conducted continuously throughout the life of the project. The purpose of project audit is to appraise the project progress and work performance compared to what was originally planned (Lewis 1995).

In conducting a project evaluation, work is broken down into small intervals, phases, or chunks that enable progress to be monitored closely. The process of project evaluation is generally done along some predetermined milestones. For example, some organizations break down work into major milestones according to its life-cycle phases. This process, Kerzner (1995) claims, is important because it provides consistency among projects; and it provides clear checkpoints where management can continue, redirect, or cancel the project.

For each scheduled milestone, some desired objectives are predetermined and mutually agreed upon at the beginning between an employee and his supervisor. The objectives are clearly stated in relation to the three project components: performance, time, and cost. After each scheduled milestone, the project is assessed against the three project components. Managers will determine the following: 1) Did the project attain its stated objectives? 2) Was the project accomplished on time? and 3) Was the project done within the budget?

In addition to the above three criteria, which Archibald (1992) calls "hard" criteria, project personnel may be evaluated against other "soft" and more subjective criteria. These criteria deal more with how the work is accomplished. The soft criteria are important because they can be used as tools to motivate project teams for continuous improvement in all aspects of the project within the limits of time and cost that have been established. "That includes improvement in the way things are done, to do them more quickly, efficiently, and with higher quality results, as well as improvement of the project results themselves" (Archibald 1992, 182). According to Archibald (1992), some of the subjective criteria are attitudes, skills, behavior, and the expectations from clients. Lewis (1995) identifies three additional factors that should be used in determining project success. They are organizational climate, supervision, and peer relations.

PERFORMANCE EVALUATORS

Evaluating project performance is not an easy process. Since project management in the information age becomes more aligned with knowledge work, performance evaluation becomes

increasingly harder and more complex. The process can be increasingly difficult when work cannot be easily quantified. When work is not quantifiable, the evaluation process must be conducted subjectively, usually in a form of an estimate of progress accomplished.

Lewis (1995) advocates the self-control concept in project management. The author claims that the person performing the work (who will become more and more identical to a knowledge worker) knows the progress of his own work at any given time better than anyone else knows his progress. He claims, "The worker is in the best position to establish a course of action and monitor his or her own progress" (p.161). In a project management environment, it is extremely difficult for a supervisor to attempt to evaluate his employee's work. For example, a manager may not be able to assess the earned value of work actually accomplished in a given period by his employee. The employee, not the supervisor, is in the position to assess this information more accurately. Therefore, the person who performs the work should evaluate his own performance. This argument is consistent with Drucker (1993), who argues that no one knows enough about the work of the knowledge workers to appraise what they really contribute. Knowledge workers, he claims, must act as responsible decision makers and see themselves as executives.

2.5 R&D MANAGEMENT

PERFORMANCE MEASUREMENT AND IMPROVEMENT OF R&D OPERATIONS

In today's globalizing and rapidly-changing economy, an effective R&D operation can be a major source of competitive advantage (Werner and Souder 1997). Improving the effectiveness and performance of R&D laboratories is, Szakonyi (1994a, 1994b) claims, the most important issue in R&D management. Measuring the performance of R&D units is important if companies want to improve the performance of R&D operations (Keller and Holland 1982). Despite the importance of the R&D operation and a significant amount of resources invested, most companies have no idea what they are getting from all the money they spend on research and development. Many engineers and scientists have thought that it is impossible to effectively measure R&D performance (Brown and Svenson 1988).

Brown and Svenson (1988) point out that many attempts at measuring R&D performance have been dismal failures. According to the authors, the failures are mainly due to the erroneous beliefs that all measurement systems don't work, that R&D performance measurement discourages creativity and motivation among high-level professionals, and that the results from performance measurement will expose their own inadequacies and lack of productivity. Only about 20 percent of R&D managers measure their R&D operations (Brown and Svenson 1988). R&D performance measurement still remains mainly a dubious art; and this, Werner and Souder (1997) claim, may be due to "… the relative newness of the field, and the lack of well-defined and tested methods" (p.34).

Due to the complex nature of R&D work (non-repetitive, shared responsibility, and highly intangible outputs), performance measurement may be difficult (Keller and Holland 1982; Schainblatt 1982; Moser 1985; Pappas and Remer 1985; Meinhart and Pederson 1989). There are no clear, valid, consistent, quantifiable, and commonly accepted measures of performance that can be satisfactorily applied to R&D units (Keller and Holland 1982; Moser 1985). People

tend to think that performance measurement in R&D is subjective; dynamic; complicated; hard to quantify precisely; expensive; and, therefore, too difficult to conduct (Schainblatt 1982; Brown and Svenson 1988). Schainblatt (1982) concluded after conducting a survey of 34 companies, "There are no currently used systems for measuring the productivity [or the performance] of scientific and engineering groups without substantial flaws" (p.10).

Although R&D performance is difficult to measure, "… many companies are now putting pressure on their scientists and engineers to not only produce new products and processes, but to demonstrate their value to the organization" (Brown and Svenson 1988, 11). R&D managers can no longer hope that top management will just have faith in and invest resources into their operations without having any proof of success. Performance measurement is needed to justify the allocation of organizational resources. In addition, it is an administrative device used for planning, controlling, communicating, and providing a basis of reward and promotion. If used properly, performance measurement can be a motivational tool to enhance R&D performance by giving feedback and setting future goals (Meinhart and Pederson 1989).

THE R&D OPERATION AS A SYSTEM

Brown and Svenson (1988) propose a model that looks at an R&D operation as a system. The system viewpoint emphasizes the importance of components working together in transforming inputs into outputs. An R&D laboratory is perceived as a system constantly interacting with its environment, which represents other sections of the organization. In addition, performance measurement and feedback are also very important components in the system concept. Figure 2.6 depicts Brown and Svenson's model of a typical R&D laboratory.

Inputs (#1) can be funds, people, equipment, facilities, information, etc. that are necessary to fulfill specific requests from marketing, manufacturing, engineering, and other departments. These inputs are used by an R&D laboratory (#2) to generate outputs (#3). An R&D laboratory (or the processing system) transforms inputs into outputs by writing proposals, gathering data,

conducting research, reporting results, etc. Outputs from a typical R&D laboratory can be newly discovered facts, information, knowledge, theories, and principles as well as patents, new products, or improved processes (Brown and Svenson 1988).

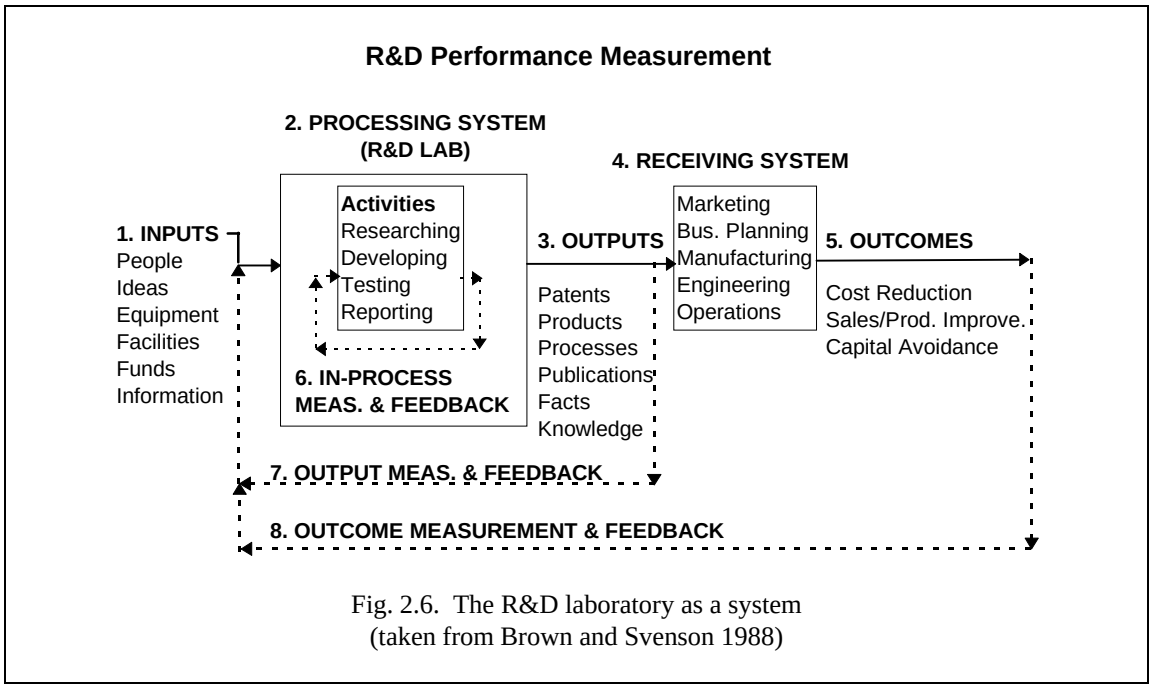


Fig. 2.6. The R&D laboratory as a system
(taken from Brown and Svenson 1988)

Outputs from the R&D unit are used by a receiving department (#4) to generate outcomes (#5) that have value for the organization. Examples of potential receiving systems are marketing, manufacturing, engineering, business planning, operations, and other departments. These departments use the results from the R&D operation to achieve something that is valuable to the organization, such as increased sales, increased market share, higher profit, cost reduction, capital avoidance, improved products/services, new products/services, etc.

There are three important measurement and feedback points in Brown and Svenson's (1988) model: in-process, output, and outcome measurement and feedback. *In-process* (which is often referred to as *process*) measurement and feedback (#6) occurs within the R&D unit itself. R&D managers measure performance and feed back the information to their employees. Examples of process measures are the amount of data produced from the research, the size of budgets, the amount of resources used, the number of drafts required on a research report, etc. *Output*

measurement and feedback (#7) is given by the receivers of the outputs, who may be internal customers (e.g., top management and managers from other departments) or external customers (e.g., journal editorial boards and patent offices). Outputs from R&D units generally are proposals, papers, books written, presentations made, designs produced, products designed, patents created, projects accomplished, research awarded, etc. These outputs are generally measured on quality, quantity, and cost dimensions. *Outcome* measurement and feedback (#8) is assessed according the ultimate value that the R&D unit contributes to the organization as a whole. The measures could be in financial or sales/marketing figures such as cost and benefit ratios, financial returns, sales and market share figures, etc.

From Brown and Svenson's (1988) model, it can be seen that the R&D unit's performance and its contribution may be looked at from inside and outside the unit itself. Internally, R&D performance and contribution may be directly evaluated by R&D managers themselves, and this is called process measurement and feedback (#6). Externally, R&D performance and contribution may be evaluated by its internal or external customers. Customers of the R&D laboratory evaluate the performance of the R&D unit through output (#7) and outcome (#8) measurement and feedback. Because the contribution of the R&D laboratory goes beyond the boundary of the unit itself, it is important to realize that the performance and contribution of the R&D unit will depend highly on how effectively other departments utilize the outputs generated from the R&D unit.

PROCESS, OUTPUT, OR OUTCOME PERFORMANCE MEASUREMENT

A clear understanding about which part of the overall contribution of the technological advance an R&D unit can control is important for performance measurement of the R&D unit. R&D is often shared work between an R&D laboratory itself and many other departments involved (Schainblatt 1982); the R&D unit is only one part of the overall innovation system of the company (Collier 1977).

Collier (1977) claims that the success or failure of an R&D project depends on many parties involved: how well the top management sets the research strategies and objectives; how well the R&D laboratory interprets and carries out those objectives; how well the engineering department makes its designs based on the results the R&D unit generates; how effectively the results are put into manufacturing practice; and how capable the sales department is in marketing and selling the resulting new product or service. Since the outputs from the R&D laboratory are used by other sections in the company and the impacts of that usage are company wide, it is reasonable to assume that R&D units should be evaluated only on the aspects for which they are truly responsible. It would not be fair to evaluate the performance of the R&D unit on something over which it has no control. Performance measures, therefore, should be the measures that the R&D unit can influence (Foster et al. 1985a). Collier (1977) states, "What is needed, then, is a system that measures the performance of the R&D department as independently as possible from the rest of the company …" (p.30).

Referring to Figure 2.6, it is obvious that R&D outcomes are totally beyond the influence of R&D departments and, thus, according to Foster et al.'s (1985a, 1985b) suggestion, should not be used to evaluate R&D performance. This implies that in-process and output, not outcome, measurement should be used to evaluate R&D performance.

Brown and Svenson (1988) disagree with the notion that process measurement should be used. They argue that relying too heavily on process measurement and feedback (which they call internal or behavior measurement) may lead R&D personnel to be overly concerned with the way work is done, rather than focusing on producing valuable results. R&D units that measure their performance based on internal activities or behavior may appear to be doing a great job, without actually contributing anything valuable to the organization.

Brown and Svenson (1988) also warn against a measurement system that is based on questionable outputs. Many companies measure their outputs based on the number of proposals, reports, or books written; papers published; presentations made; designs produced; products designed; patents earned; projects accomplished; and research awarded. Focusing on

output measurement, an R&D laboratory can be very productive, when measured by the quantity of outputs produced; but it still may not contribute anything substantial to the organization. Output measures such as these, Collier (1977) and Szakonyi (1994a) point out, may not bear any relationship to the ultimate goal of the company—producing new and useful products or services to make profits. They measure only a part of quantity or productivity and not quality or innovation at all (Stahl and Steger 1977). Thus, they may not be accurate indicators of performance (Moser 1985).

Brown and Svenson (1988) suggest that a good measurement system should include both measures of behavior or activity as well as measures of outputs and outcomes. They say, "… the primary focus should be on results with secondary focus on behavior" (p.13). Their suggestion is similar to that of Collier (1977), who claims that performance measurement for R&D laboratories should focus on how well the units are creating technological-based opportunities for the company. R&D units, he argues, should be evaluated in relation to two criteria: how well they are accomplishing the predetermined goals and what business opportunities they are creating for the company. The former criterion may be viewed as respondent to the output measurement, while the latter may be viewed as respondent to the outcome measurement (see Figure 2.6).

Collier's (1977) *first* suggestion—that R&D units should be evaluated by how well they are accomplishing their predetermined goals—is open to debate. Meinhart and Pederson (1989) agree with the notion, stating "There seems to be a consensus that some type of MBO approach for research professionals should be employed" (p.19). Pappas and Remer (1985), however, challenge Collier's first suggestion. They claim that if performance measurement is based on how well a person is meeting his goals, there will be an incentive for that person to set easier goals. "This is especially dangerous in an R&D environment where original thought and personally risky ventures should be encouraged rather than thwarted" (Pappas and Remer 1985, 20).

Collier's *second* suggestion—that R&D units should be evaluated by the amount of business opportunities they are creating for the company—needs to be used with caution. Not all R&D results are tangible or create any quantifiable business opportunities. Francis (1992) provides a framework that characterizes the nature of efforts performed by R&D personnel. The author differentiates R&D efforts into six categories as follows: 1) project completed, 2) project begun and still in process, 3) cost avoidance realized, 4) new practice introduced, 5) technology awareness maintained, and 6) internal consulting provided. Francis points out that the last three categories are difficult to measure. For example, how could an effort of staying abreast, such as attending conferences and seminars, reading, etc. be associated with creating business opportunities? How could one accurately identify business opportunities that may be the results from introducing new practices in the company or from providing internal consulting? Thus, it is probable that these last three categories of R&D efforts might be ignored when R&D personnel are being evaluated based on visible business opportunities created.

Even though it may not be easy to identify accurately the value of business opportunities an R&D unit is creating, many authors seem to be in agreement with this approach. That is, many seem to prefer outcome performance measurement over process and output performance measurements. For instance, Schumann et al. (1995) claim that performance measurement for R&D units must be driven by customers. An effective R&D unit, they argue, must be able to identify customer needs and the technologies that can be developed to satisfy those needs. The use of outcome measurement—which Tipping et al. (1995) call "value creation"—enables an assessment of R&D contribution to the customers. Despite many shortcomings associated with outcome measurement, Tenner (1991) claims that it is still important to evaluate the ultimate contribution of R&D units—bottom-line impact perceived by the customers. The author states, "The impact of errors in estimating the value of R&D is minimized through this approach [outcome measurement] since, after all, the ultimate objective is to satisfy the customer, and it is the customer's perceptions that are being measured" (p.31).

2.6 FEEDBACK

THE CONCEPT OF FEEDBACK

The positive effects of feedback on performance in organizations have been widely recognized as essential for learning, training, satisfaction, motivation, and performance (Greller and Herold 1975; Ilgen et al. 1979). Feedback is an important resource for organizations—an essential tool that management can use to motivate, direct, and instruct the performance of subordinates (Nadler 1977; Ashford and Cummings 1983). It is also a crucial element for individuals in work settings (Taylor et al. 1984). Feedback is defined as

> *information about the extent to which one has met job requirements (Greller and Herold 1975, 255).*
>
> *any information about the system functioning which has the potential of being used to change the operation of the system (Nadler 1977, 70).*
>
> *information received by an individual about his or her past behavior. It provides some information about the correctness, accuracy, or adequacy of the response (Ilgen et al. 1979, 351).*
>
> *information that denotes how well individuals are meeting various goals. In the interpersonal realm, feedback involves information about how their behaviors are perceived and evaluated by relevant others (Ashford and Cummings 1983, 372).*
>
> *information about the effectiveness of one's work behavior (Taylor et al. 1984, 82).*

There are many frequently used terms that have a similar, if not the same, meaning as feedback. They are knowledge of results, knowledge of performance, and knowledge of scores. Although some authors attempt to distinguish some of these terms, the results have been unclear. For example, Greller and Herold (1975) imply that feedback is not the same as knowledge of results. However, some researchers have used these terms interchangeably and synonymously (Hall 1990). For example, feedback has sometimes been used synonymously with the term knowledge of results in the social science concept (e.g., Nadler 1977; Locke et al. 1981; Hall 1990). For the present study, only the term feedback will be used.

In this section, two widely cited models of the feedback process are provided. The two models are useful in understanding the concept of feedback since they view the role of feedback recipients from totally different perspectives. The first model, feedback as an organizational resource, views feedback recipients as passive information receivers. The second model, feedback as an individual resource, views feedback recipients as active information seekers.

FEEDBACK AS AN ORGANIZATIONAL RESOURCE

The positive effect of feedback is widely recognized in organizations for its performance-enhancing benefits. An effective feedback system is essential for organizational survival and success (Taylor et al. 1984). Organizations that fail to use feedback for their advantage, Thor (1993b) argues, are missing a major opportunity. Feedback can be used as an essential tool for management to direct and motivate certain behaviors of their subordinates. Upon the receipt of feedback, the subordinates can adjust their behaviors to conform to what is desired by the organization; and, consequently, organizational performance can be enhanced. Subordinates are viewed as information recipients from an environment capable of providing feedback information from different sources (Greller and Herold 1975).

From this perspective, information recipients play a rather passive role (Hall 1990). They are viewed as information receivers (Ashford and Cummings 1983) who simply process incoming information (Ilgen et al. 1979). To understand how feedback influences behaviors and affects performance of feedback recipients, Ilgen et al. (1979) use a model to explain the feedback process—the relationship between the sender, the message, and the recipient. Figure 2.7 depicts the model of their feedback process.

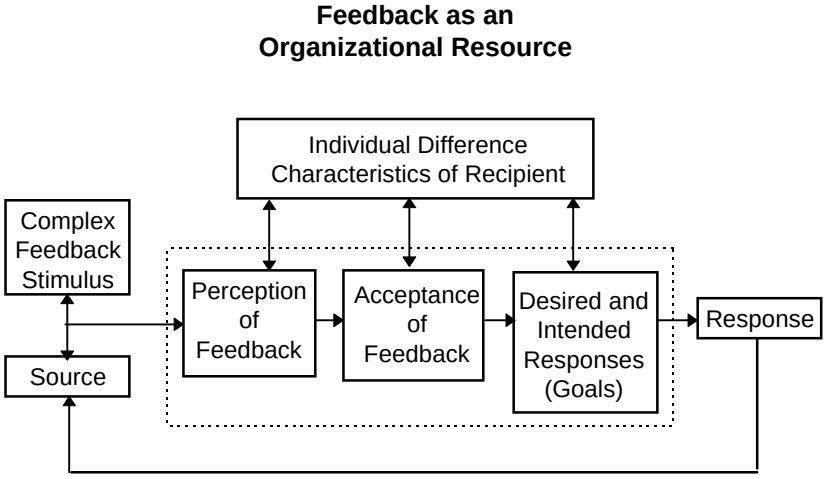


Fig. 2.7. Model of the effects of feedback on recipients
(adapted from Ilgen et al. 1979)

Ilgen et al. (1979) view the feedback process as a special case of the general communications process in which the message (i.e., feedback) was sent from a sender (i.e., source) to a recipient. The model focuses upon the multidimensional nature of feedback as a stimulus, and it also emphasizes how individual-difference characteristics of the feedback recipient can influence how the message of feedback is perceived, accepted, and responded. The feedback sent does not always equal the message received (Donlin 1990). This, according to Hall (1990), can produce the potential for variations in behavioral responses to the same feedback stimulus. Thus, feedback may not exert a universally positive influence on subsequent task performance.

According to the model by Ilgen et al. (Figure 2.7), the recipient's perception and acceptance of the feedback and response to it depend on characteristics of the feedback source, the nature of the message, and the individual-difference characteristics. Source characteristics, including credibility, expertise, reliability, trustworthiness, and power of the source, can affect the feedback process (i.e., how feedback is perceived, accepted, and responded). The authors identify several feedback dimensions, including timing, signs, and frequency of the feedback, that can affect the feedback process. Lastly, the authors claim that individual-difference

characteristics can affect how feedback is sensed and interpreted. (Feedback sources, feedback dimensions, and individual differences will be discussed in detail in a later section.)

FEEDBACK AS AN INDIVIDUAL RESOURCE

Ashford and Cummings (1983) argue that while feedback is generally accepted as an important organizational resource, it may actually be a valuable resource for individuals as well. The authors consider feedback as an individual resource in fulfilling personal goals instead of considering feedback as simply an organizational resource. They mention, "To the extent that performance and other personally held goals are important to the individual, feedback on their behavior aimed at achieving these goals becomes a valuable informational resource" (p.371). Since feedback is a valuable resource, the authors contend that individuals should be more motivated and active in seeking feedback. Ashford and Cummings' model (Figure 2.8) highlights the role of individuals as active feedback seekers, rather than as passive feedback recipients, who search for feedback information from their work environment.

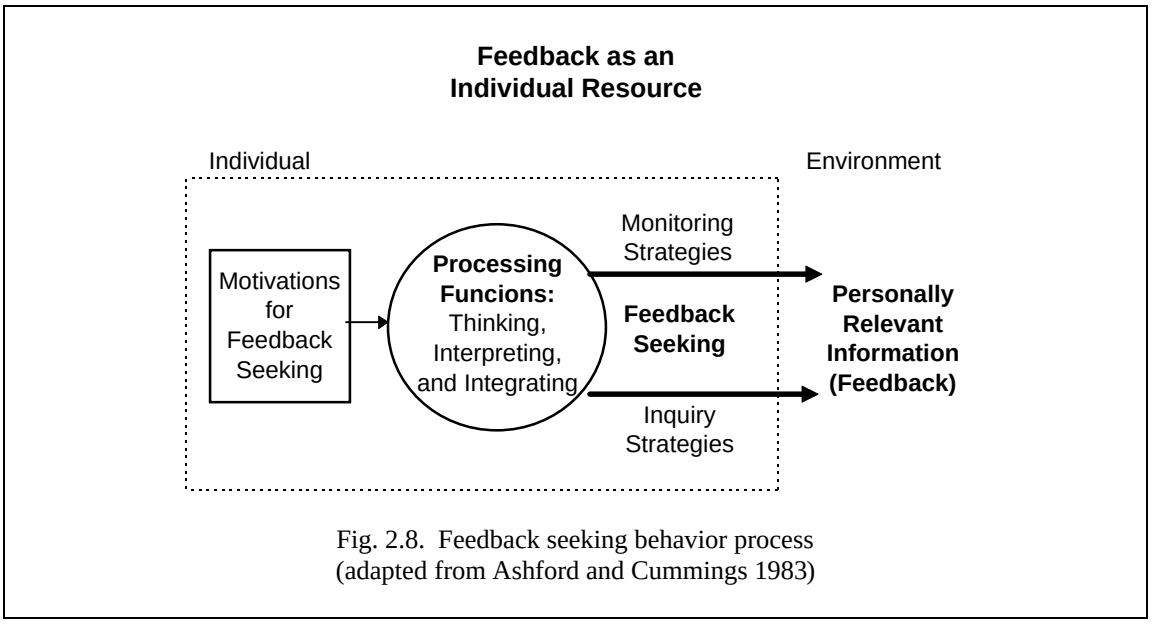


Fig. 2.8. Feedback seeking behavior process
(adapted from Ashford and Cummings 1983)

Figure 2.8 portrays individuals existing within an information environment, which Ashford and Cummings (1983) claim contains a wealth of information regarding the individuals' performance and how well their behavior is being perceived and evaluated by others. Given the value of feedback to individuals, they are motivated to seek feedback from the environment.

The more value this feedback is perceived to have by the individuals, the more actively they will seek feedback from the environment. The authors contend that individuals will use two different strategies when seeking feedback: monitoring and inquiry strategies.

Individuals may passively *monitor* their information environment for relevant feedback information by observing situational cues and the behaviors of others. The meaning of the feedback data is then generated by the processing functions, which involve thinking, integrating, and interpreting feedback data. Ashford and Cummings (1983) imply that this strategy is a rather passive one because it involves a fair amount of self-translation and interpretation that may result in a distorted and biased impression of actual behavior and performance. Thus, the second—and more active—form of feedback-seeking behavior may be used. With a more active role, individuals may actively and directly *inquire* how others perceive and evaluate their behavior and performance.

FEEDBACK WITHIN MANAGEMENT FRAMEWORKS/MODELS

Feedback, because of its potentially positive effect on performance, is commonly viewed as an important component in organizational studies (Ivancevich and McMahon 1982; Pritchard et al. 1988). To understand how feedback fits in the organizational setting, management frameworks/models will be used. Examples of the frameworks that will be discussed in this section are management process and cybernetics frameworks.

FEEDBACK IN THE FRAMEWORK OF MANAGEMENT

Feedback plays an important role in the management process. Kurstedt (1994a) uses a model (Figure 2.9) to present the management process. According to Kurstedt (1993), input is interventions, and output is data or information obtained from a performance measurement system. The interventions can affect one part of the organization, which in turn can affect other parts of the organization. The impacts on the organization will affect the organization's performance, and this is the objective of making the interventions. To complete the

management process, managers need to measure the performance (criteria sets) to yield data and information for future decision making.

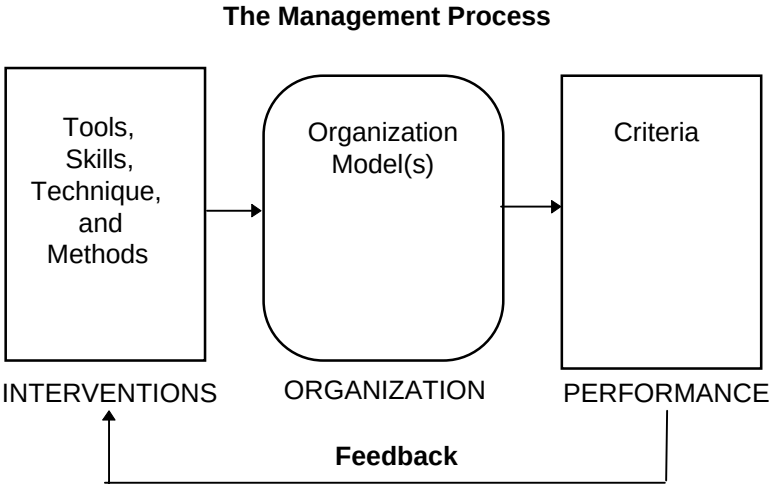


Fig. 2.9. Management viewed as a traditional system model, with interventions as input and data on performance as output (taken from Kurstedt 1994a, 7)

In the management process, managers or decision makers apply interventions to their organizations (models) to obtain performance (criteria sets) to feed back to decision makers for better future interventions. Feedback closes the loop between performance criteria and interventions for continuous performance improvement. It provides the linkages between the changes in performance resulting from the interventions and the interventions made by the managers or decision makers (Kurstedt 1994a).

FEEDBACK IN THE FRAMEWORK OF CYBERNETICS

Feedback is also an important element in cybernetics. Landen and Landen (1990) use the theory and models of cybernetics to understand organizations and their processes of measurement. The concept, elements, and principles of cybernetics apply quite nicely to organizational theory, practice, and measurement. The authors claim that the cybernetic organizational model is intended to help capture the dynamic nature of organizations and the interplay between process and outcome, technology and work systems, attitudes and behavior,

and culture and performance. Cybernetics, according to the article, is composed of input, throughput, output, and feedback. These elements of cybernetics are considered integral parts of an open system. Organizations and their measurement systems should also be viewed as open systems, constantly interacting with the outside environment (see Figure 2.10).

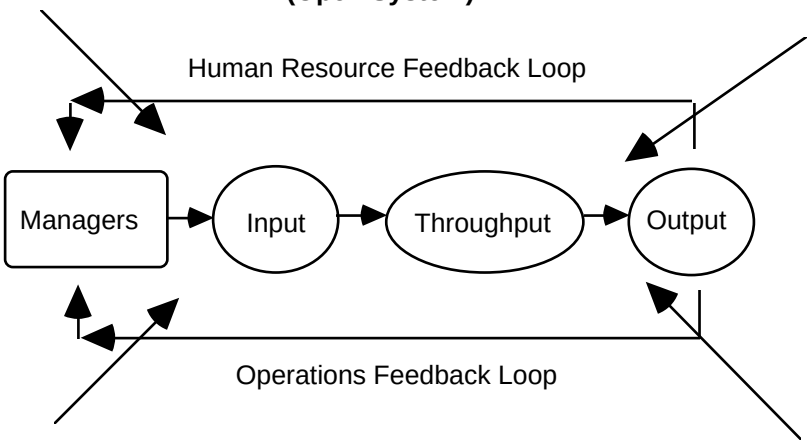


Fig. 2.10. Cybernetics as input, throughput, output, and feedback (adapted from Landen and Landen 1990)

Landen and Landen (1990) argue that "Since organizations are conceived, designed, and structured as systems, they must be managed as systems, and they must be measured as systems" (p.9). All parts/elements must fit together. Powers (1973) identifies necessary elements for the cybernetic concept (see Figure 2.11). It must have a reference signal that specifies the desired state of the system. A sensor must exist to detect the sensor signal and compare it to the reference signal. The error signal (i.e., performance discrepancy) must be fed back into the system to activate the system's effector so that necessary outputs can be generated. The outputs of the control system (i.e., system's responses or reactions) must be able to affect the controlled input quantity (i.e., behaviors that need to be controlled) with respect to the reference condition.

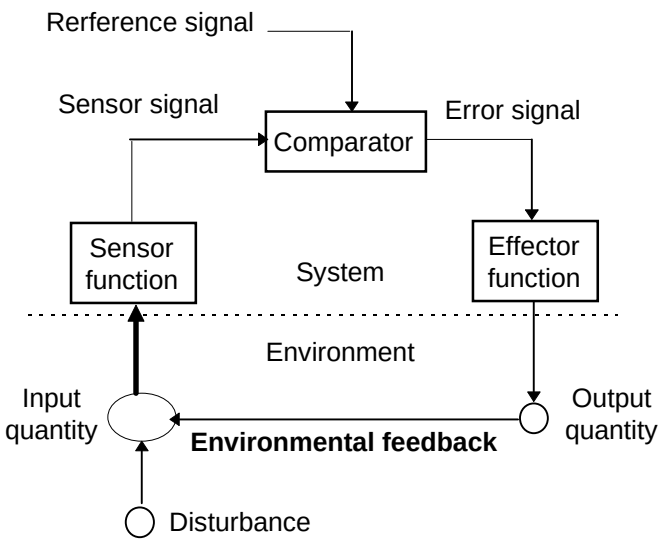


Fig. 2.11. Feedback as an important component of the control-system model (taken from Powers 1973, 352)

The same concept can be applied readily to organizational behaviors. Landen and Landen (1990) argue that in order to succeed, organizations must integrate data and information from the feedback loops into their systems and make appropriate decisions to improve the performance of the organizations. Even though the model shows that those who receive the feedback are usually managers, in contemporary organizations, that label should apply to all members of the organization (particularly, those closest to the sources of performance). In summary, the cybernetics model highlights the significance of the feedback element in the organizational system.

FEEDBACK DIMENSIONS

Feedback seeking is "… far from a straightforward process" (Ashford and Tsui 1991, 253), and "… the motivation to seek feedback is not entirely straightforward" (Ashford and Cummings 1983, 377). Research findings regarding feedback effects on subsequent task performance have

been somewhat inconsistent (Hall 1990). Ilgen et al.'s (1979) model (Figure 2.7) shows how the feedback process depends on the source of feedback, characteristics of the feedback, and individual difference characteristics. This section is intended to focus on the second component—feedback characteristics—and how they influence the recipient's perception, acceptance, and response to feedback. There are many factors that can affect the feedback-seeking process, and their effects are often confounded. Ilgen et al. contend, "… many factors often are confounded with the feedback stimulus, which makes it difficult, if not impossible, to ascertain the effects of feedback per se on behavior" (p.349). Some of the important factors that may affect feedback-seeking and providing processes are discussed in this section.

FEEDBACK SIGNS

Feedback can be positive or negative. Because of individual differences (to be discussed later), it is unlikely that individuals perceive feedback in the same way. Feedback is likely to be perceived as threatening to some, useful and helpful to some, and irrelevant to others (O'Reilly 1983). Ilgen et al. (1979) recognize the influence of feedback signs on the feedback process: "The most important message characteristic that influences acceptance is the sign of the feedback" (p.357). Ilgen et al. contend, "… the more positive the stimulus and the greater the power and credibility of the source, the more accurately the individual senses the feedback sent by the source" (p.356). They argue that almost without exception, positive feedback is readily accepted from any source because it is more pleasant and enhances one's self-image. On the other hand, negative feedback is often misperceived and not accepted because of an unwillingness to accept such knowledge about oneself. When negative feedback is accepted, it usually comes from a high-status or high-credibility source.

Positive feedback has information value. It identifies and describes effective behaviors so that such behaviors may be repeated. However, if individuals frequently receive positive feedback, seeking it actively may not add any useful information. Ashford and Tsui (1991) claim that individuals seeking positive feedback explicitly may not improve the understanding of their own performance. Negative feedback, in contrast, should increase the accuracy of their understanding because negative feedback tends to direct desirable behaviors (Ilgen et al. 1979).

In general, individuals tend to have an inaccurate view of their own performance because they tend to overestimate their own ability. When they ask for feedback from others, people tend to give each other positive feedback spontaneously and withhold negative—but accurate—feedback. Even when people do provide negative feedback, it is likely that they distort it in a positive direction (Ashford and Tsui 1991). Ilgen et al. (1979) point out that supervisors tend to avoid or delay the presentation of negative feedback but promptly provide positive feedback to their subordinates. As a result, giving positive feedback occurs more often than giving negative feedback, and poor performers tend to receive less feedback than high performers receive. This led Ashford and Tsui (1991) to conclude that individuals who actively seek negative feedback should have "… a more tempered view of their abilities, their performance, and their standing in an organization than those who do not do so" (p.254).

Not everyone enjoys receiving negative feedback. Some may avoid seeking negative feedback, despite its error-corrective and uncertainty-reducing properties because such information may threaten their ego and self-esteem (Ashford and Cummings 1983). Evaluative feedback, which Varca and Levy (1984) classify as one of the two types of feedback, passes judgment on past performance and may increase defensiveness of the recipient if it is unfavorable. Their other classification of feedback—descriptive feedback—provides information about past performance. Unfavorable evaluative feedback, they say, may reduce the recipient's pride, resulting in a poor future performance level. Ironically, Ashford and Cummings (1983) point out that "… it is perhaps the poor performers, those that need feedback the most for its utilitarian value, who will be the most reluctant to seek it because of potential ego damage" (p.377).

FEEDBACK TIMING

Ilgen et al. (1979) refer to feedback timing as "… the interval between the individual's behavior and the receipt of the feedback about the behavior" (p.353). According to the authors, if feedback is to be perceived as relevant and accurate, that feedback must be paired with the appropriate response (which could be in the form of rewards or sanctions) to be meaningful. If

feedback is delayed, it may not be perceived as instrumental to a certain response; thus, the feedback may not affect the behavior in question. Ammons (1956) suggests that if feedback serves as a reward for a certain behavior, when that feedback is delayed, it creates a perception that the intended behavior may not be rewarded but that other irrelevant behavior may be rewarded instead. After reviewing several studies, Ammons generalizes his findings as "The longer the delay in giving knowledge of performance [i.e., feedback], the less effect the given information has" (p.287).

Ammons (1956) also makes the point that there may be an optimum delay for every task and every stage of learning. If feedback comes too soon, he argues, the recipient may not be able to use it. Time delay before the feedback is given may allow the performer to make a better assessment of his overall performance when he is finally given the feedback. This, according to the author, is especially important when the task is complex.

Beeson (1973) carried out an experiment to study the effect of feedback timing on test performance. He found that there was no significant difference in test performance under immediate and delayed feedback on any of the one-hour examinations. However, students who received immediate feedback outperformed those who did not receive such feedback on the final examination. The overall performance was slightly higher when students were given immediate feedback. These results thus support both of Ammons' (1956) views: that feedback (on the overall results and the final examination) is more effective when it is less delayed and that the effects of feedback timing depend on the nature of the task. (The results were different for one-hour versus final examinations.)

Macpherson et al.'s (1949) study revealed that the effects of feedback timing on performance depend on the learning stage. In the initial trials of their experiment when the subjects had not yet mastered the tasks, longer feedback intervals (e.g., ten seconds) were more beneficial than somewhat shorter ones (e.g., one second). The subjects became confused when the feedback interval between trials was too short. Once the subjects had mastered all the requirements, shorter feedback intervals were more beneficial in their learning and performance level than

longer ones were. The authors conclude that, in general, the shorter the feedback interval, the higher the performance level.

FEEDBACK FREQUENCY

According to Ilgen et al. (1979), it is generally accepted that the more frequent the feedback, the more accurate the performance information. However, the authors caution against blindly increasing the frequency of the feedback, particularly in cases where feedback is complex to interpret. They mention, "… increasing feedback frequency may not only fail to improve performance but actually may be detrimental to it" (p.367). They point out that very frequent feedback may imply a loss of control to the recipient, and very frequent feedback may lead the recipient to depend overly on external sources for feedback and not to develop his own personal skills at judging his performance. However, the authors conclude that in most situations, "… more frequent feedback would be beneficial" (p.368).

In order to assess the effect of feedback frequency on performance, Chhokar and Wallin (1984) conducted a field study in a heat exchanger manufacturing and repair plant. The findings support Ilgen et al.'s (1979) position that more frequent feedback may not necessarily be better than less frequent feedback. The results showed that more frequent feedback (i.e., once a week) did not lead to a higher performance level than less frequent feedback (i.e., once every two weeks). However, one should be cautious in generalizing the results since there were only two levels of feedback frequency in this study. The authors also warned against decreasing feedback frequency given in the workplace just for the cost-benefit implication because, in general, there is not enough feedback in the workplace.

FEEDBACK SPECIFICITY

Non-specific feedback may have little value. "The more specific the knowledge of performance [feedback], the more rapid the improvement and the higher the level of performance" (Ammons 1956, 287). Ammons argues that the more an individual knows how he is performing, the more likely that person is able to make appropriate corrections when the behavior departs from the desirable level. This, he says, is a directional mechanism of feedback (to be discussed later).

According to Ilgen et al. (1979), the directional function of feedback is most relevant when feedback is specific enough to allow for setting specific goals. For example, Locke's (1968) theory specifies that specific goals produce a higher performance level than "do-your-best" goals. Terborg (1976) argues that the greatest impact of goal specificity is that it can direct behavior. Given a clear, specific, and unambiguous goal, an individual can better understand how to become successful in task performance by expending his effort in the most effective direction. (The benefits of setting specific goals will be discussed in detail in a later section.) In short, the more specific the performance feedback, the more specific a goal can be set and, subsequently, the higher the performance level will be. Figure 2.12 depicts the interaction of feedback and goal specificity.

Feedback and Goal Specificity

	Specific Goals	General Goals
Specific Feedback	Cell #1 Feedback is easily understood and applied to future performance.	Cell #2 Performance evaluation is difficult.
General Feedback	Cell #3 Feedback is interpreted in terms of the performer's frame of reference.	Cell #4 Feedback is difficult to interpret and apply.

Fig. 2.12. Interaction of feedback and goal specificity
(taken from Ilgen et al. 1979, 365)

According to Ilgen et al. (1979), the best condition is one in which individuals receive specific feedback that leads to setting or evaluating specific goals (Cell #1 in Figure 2.12). When feedback is specific but goals are general (Cell #2 in Figure 2.12), task performers will know specifically about their own behaviors; however, the comparison of the specific information to the general goal may lead to some ambiguity about true performance levels. Task performers may be uncertain whether the goal was actually accomplished or not. If goals are specific and task performers receive general feedback (Cell #3 in Figure 2.12), feedback recipients will

interpret the feedback from their own frame of reference. That is, they will convert that general feedback into specific feedback in relation to how well they are meeting the specific goals. When both feedback and goals are general (Cell #4 in Figure 2.12), the authors claim that the feedback will be of little value to the recipients. If the general feedback is positive, the recipients may continue to perform in the same manner; and if the general feedback is negative, they may aimlessly attempt to change their behaviors. To conclude, the best condition is that in which specific feedback is combined with specific goals.

FEEDBACK SOURCES

Ilgen et al. (1979) classify feedback sources into three different sets. The *first* set includes individuals who observe the recipient's behavior or are in a position to evaluate the recipient's behavior. Most frequently, these individuals are the recipient's supervisors, co-workers, subordinates, and clients. Another possible source of feedback information that may fall into this category is the organization itself. Performance information, available resources, and salary may be used by the individual to draw inferences about his own performance (Greller and Herold 1975). The task itself may form a *second* feedback category. Task outputs such as speed, quantity, quality, or condition may allow the performer of that task to draw inferences about the performance level without anyone's actually telling him. The *last* category of feedback sources comes within the individual and is referred to as the "self" (Ilgen et al. 1979). The person who becomes familiar with a pattern of previous actions and performance is able to sense whether his own actions do or do not "feel right" (Greller and Herold 1975). Therefore, the individual's feeling of his own performance may serve as another feedback category.

The characteristics of feedback sources are believed to affect how the recipient perceives, accepts, and responds to the feedback. Ilgen et al. (1979) claim that feedback sources vary in their perceived *credibility*, which is a function of factors such as expertise, trustworthiness, reliability, dynamism (boldness, energy), and personal attraction. The more credible a source has been in the past, the more accurate and useful the future feedback is perceived to be and the more likely it is to be accepted from that credible source.

Feedback sources also vary in their *power* over the recipient. Although the credibility of the feedback source is influential in how the feedback is perceived and accepted, feedback power seems to be more influential in how the feedback recipient responds to the message (Ilgen et al. 1979). Power refers to the extent to which the recipient believes the source to control valued outcomes. According to the authors, the higher the power of the source, when other things are equal, the more likely the recipient will respond in line with the feedback. Power of the source can induce the recipient's compliance even in the absence of feedback acceptance.

How individuals perceive and value feedback sources differently is discussed in Greller and Herold's (1975) and Greller's (1980) studies. The findings from these two studies reveal that individuals do not equally value feedback from different sources and that they attach different values to different feedback sources. The implications can be important for the study of feedback; says Greller (1980), "To the degree that recipients view one source of feedback as more useful than others, they may resist or support changes in the organization's system of feeding back performance information" (p.24).

Greller and Herold (1975) classify feedback sources into five categories: the organization, supervisors, co-workers, one's own feelings, and the task itself. Later, Greller (1980) categorized feedback sources into six similar categories. Formal rewards and informal assignments from the second study were indeed imbedded in one of the first study's categories—the organization. A similarity from these two studies is that feedback sources can be viewed from an employee's perspective as consisting of two primary groups. The first group includes feedback sources that are intrinsic to, under the control of, or psychologically closer to the individual. The second group includes feedback sources that are external to, beyond the control of, or psychologically farther away from the individual. Feedback from one's own feelings and from the task itself falls under the first category, while feedback from co-workers, the supervisor, and the organization falls under the second category.

Greller and Herold's findings (1975) revealed that sources that were intrinsic or psychologically closer to the individual were relied on more heavily than were those sources identified as

external or psychologically distant. The authors found that sources do increase in their informative value as one moves from the company to the individual's own feelings. Individuals, they claim, tend to rely more on their own resources (e.g., judgment, experience, and feelings) than on those external to them.

Greller's (1980) study suggests that supervisors and subordinates may disagree on the value of feedback sources. Supervisors, he argues, consistently underestimate the value their subordinates attach to feedback from the task, feedback from their co-workers, and feedback their subordinates make themselves (in comparison to the work of others). Subordinates do attach a higher value to these feedback sources because they feel they have some control over them. On the other hand, supervisors tend to overestimate the importance of feedback that they provide to their subordinates, formal rewards, and informal assignments. Except the feedback from their supervisors, which is perceived as important to their career, subordinates do attach a lesser value to the other feedback sources because they do not feel they have control over them.

There are two interesting observations worth mentioning from these two studies. *First*, one may argue that co-workers are psychologically closer to the individual than the supervisor is and, therefore, co-workers should provide more informative value to the individual than does the supervisor. The result from Greller and Herold's (1975) study suggests otherwise; the subjects relied more on their supervisor's feedback than on the co-workers'. The authors explain this by indicating, "… while the supervisor is in fact more 'distant' than a person's 'co-workers,' the validity or impact of his information is much greater, and hence, more heavily relied on" (p.249). Greller (1980) argues that the supervisor's comments, feedback, and evaluation are deemed important because they can affect the individual's future career advancement. This corresponds to what Ilgen et al. (1979) call power—the extent to which the recipient believes the source to control valued outcomes. Feedback power can be very influential in how the individual values and responds to the feedback. Power of the source, according to Ilgen et al., can induce the recipient's compliance even in the absence of feedback acceptance.

The *second* observation from Greller and Herold's (1975) and Greller's (1980) research is that intrinsic feedback sources (i.e., task feedback and one's own feelings) are more valuable to the individual than external sources are. Greller and Herold (1975) explain that these feedback sources 1) deliver immediate information without any delay, 2) are less intrusive and provide information only when they are asked for, and 3) have no trust, interpersonal, and communication issues. This corresponds to Ilgen et al.'s (1979) study. Ilgen et al. claim that source credibility, which is a function of trustworthiness and expertise, can affect the feedback process (i.e., how feedback is perceived, accepted, and responded to). Since intrinsic feedback sources (feedback given to oneself or feedback from one's own output) can be trusted and are perceived as a high level of expertise (because individuals tend to overestimate their own ability), these sources are perceived as highly credible sources. As a result, intrinsic feedback sources are perceived, accepted, and responded to favorably.

Feedback Choice

Using feedback may, in many cases, adversely affect work performance. (More on the negative effects of feedback will be discussed later.) Feedback receivers will decide whether or not they want to use the feedback they received. Individuals, according to Ilgen and Moore (1987), will seek feedback about their own performance only when such feedback provides meaningful information for improving performance. They will not seek or use feedback when it is perceived to be irrelevant or when it duplicates information they already possess. For example, for feedback from the task to be credible and useful for individuals, recipients must believe the feedback is in response to their own actions, not to actions of others or of the technology. If the feedback is perceived to be the result of random events unrelated to the recipient's actions, it will be seen as less credible, irrelevant, and useless (Ilgen et al. 1979).

Having freedom to choose or use feedback can affect performance. In an experiment conducted by Ilgen and Moore (1987), subjects were given feedback on either quality, quantity, or both dimensions. These two dimensions are important criteria and are also inversely and dependently related. Observation and comparison were also made between two groups of experimental subjects that were presented with both quality and quantity feedback. One of the

two groups had a choice of receiving feedback, while the other group did not have that choice. The results of the study indicated that allowing feedback choice improved overall performance. The subjects who had the freedom to choose feedback completed the task significantly more quickly than those who did not have such freedom. Yet, the performance of the two groups did not differ significantly on the quality measures. Ilgen and Moore (1987) conclude that "… when performance is evaluated on more than one dimension, it may be useful to provide performers the freedom to choose feedback on each dimension to reduce the possibility of redundancy and minimize the amount of time needed to receive and evaluate feedback (p.406).

INDIVIDUAL DIFFERENCES AND FEEDBACK

Figure 2.7 reveals that individual difference characteristics can affect how individuals perceive, accept, and respond to feedback. According to Ilgen et al. (1979), feedback is perceived and judged in relation to the recipient's frame of reference. As a result, individual differences can significantly affect the sensing and interpreting of feedback. In most cases, task performers who have some ideas and expectations about their own performance generally expect to receive feedback that is consistent with their own expectations. They tend to sense and interpret the feedback stimulus in a fashion consistent to their orientation. In addition, they look for that kind of feedback and ignore the kind that does not fit their frame of reference. Since their expectations may be influenced by their own personal characteristics, it is reasonable to believe that their feedback seeking, sensing, and interpreting processes will also be affected by their individual characteristics.

The same rationale is recognized and supported by O'Reilly (1983), who argues that individuals do not necessarily always behave rationally in seeking feedback. Some may sincerely seek feedback to improve their performance, while others may specifically look for one type of feedback and avoid the other types even if this seeking pattern may hurt their performance. Because of their biases, feedback seekers may direct their information search and processing in ways calculated to maximize the attainment of desired ends. These individuals tend to prefer

information that supports their preferences rather than contrary information, even if such information is higher in quality and accuracy.

Cognitive styles play a very important role in how individuals perceive and use certain types of information. "Decision makers with different cognitive styles prefer different sets of information, and these sets vary dynamically as feedback is incorporated in the decision-making process" (Blaylock and Rees 1984, 74). In addition to cognitive styles, Huber (1983) also includes several factors making up individual differences that may be relevant to designing an information system. These factors are cognitive complexity, response to uncertainty, responsiveness to organizational norms of rationality, need for achievement, risk-taking propensity, academic background, intelligence, previous training, and familiarity with the particular task. These individual differences will affect the perception of feedback by the user, as well as how and when feedback will be used. This may determine the utilization/non-utilization of feedback by the users.

The review of feedback studies by Ilgen et al. (1979) reveals some evidence that individual characteristics such as locus of control, self-esteem, social anxiety, and age affected the perception and acceptance of feedback. They found that internal-locus-of-control individuals viewed the feedback as applicable to their own behavior. These individuals were more likely to accept and respond to feedback than were individuals of the external type. High self-esteem individuals were also found to rely less on environmental feedback and more on their own perception of performance, when compared to those with lower self-esteem. The authors explain that high self-esteem individuals may be more confident in their own ability and thus rely less on environmental feedback. In term of social anxiety, the authors found evidence that individuals who were high in social anxiousness expected more negative feedback than did those with a lower level of social anxiousness. Ilgen et al.'s study also reveals that the recipient's age influenced how feedback was accepted. There was evidence that older feedback recipients used feedback less than younger ones did. The authors explain that older individuals, who generally have more experience, tend to use their own past experience as a source of feedback and reject the feedback from others.

STUDIES OF FEEDBACK IMPACTS

Feedback, just like any other piece of information, may or may not be useful. In fact, there are times when giving or receiving feedback can even be harmful to work performance. In this section, the issues of feedback usefulness/uselessness and the positive/negative impacts of feedback are discussed.

FEEDBACK AND ITS USEFULNESS/USELESSNESS

According to Ilgen et al. (1979), the usefulness of feedback depends on 1) the nature of the feedback stimulus and 2) the feedback recipient. Pitt (1995) sheds some light on the *first* perspective, arguing that many criteria can be used to measure the value or usefulness of information. The same criteria should be applicable to feedback because feedback is basically one type of information. The frequently found criteria from the literature (Napoliello 1987; Hodge 1984; Hicks 1993) are as follows:

1. sufficiency: the information of an appropriate quantity and quality to be useful;
2. completeness: the thoroughness of information in relation to what is needed;
3. currency/relevance: the relevance of information when it is used;
4. timeliness: the degree to which the information is current or up-to-date;
5. accuracy: the information's freedom of error; and
6. reliability/verifiability: the ability to confirm the accuracy of information.

Other criteria that are also found include ease of use, convenience, availability, understandability, simplicity, practicality, descriptiveness, freedom from bias, predictive power, significance, comparability, consistency, and quantifiability (Nadler 1977; Hamiltion et al. 1981; King et al. 1983; Napoliello 1987).

The *second* perspective from Ilgen et al. (1979) indicates that the value or usefulness of feedback is dependent on the feedback recipient's frame of reference, which is judged subjectively. The usefulness of feedback information depends on "… the incremental increase

in information about the behavior over and above the information already possessed by the individual" (p.351). Ashford and Cummings (1983) maintain that the value of feedback for an individual varies and depends on the uncertainty the individual experiences concerning goal attainment. In other words, feedback information is useful only if the recipient is able to convert and translate the message into something meaningful to him, whether by increasing existing knowledge or by eliminating uncertainty (Ilgen et al. 1979).

FEEDBACK AND ITS POSITIVE IMPACTS

Feedback can perform two beneficial roles: motivational and directional (Macpherson et al. 1948; Nadler 1977; Ilgen et al. 1979). A different view of feedback mechanisms is provided by Busby (1997), who studied the benefits of feedback for engineering designers in several manufacturing firms. He claims that feedback can generate positive effects in many different ways, such as 1) feedback increases motivation and improves morale, 2) feedback provides knowledge of performance, 3) feedback enables error correction, and 4) feedback creates learning from experience. When used together, these two views can provide a better understanding of the benefits from feedback.

Feedback for Motivation

Feedback has long been known to enhance performance because it increases the motivational level (Ammons 1956; Ashford and Tsui 1991). Motivation effects stimulate actions (Ilgen and Moore 1987). Feedback provides information to the recipient that, when compared to his own performance standard, creates some affective reaction that has motivational impact. This motivational impact may prompt the feedback recipient to adjust his own performance standard or to put more effort into working on the task (Ilgen and Moore 1987). Higher motivation, according to Pritchard et al. (1988), may inspire the employees to exert more effort and become more persistent in their efforts. Work performance would increase because their efforts would be directed toward the fulfillment of their goals.

In his ergograph (i.e., weight lifting by finger) study, Arps (1917) found the subjects to be more motivated when they were given feedback about how they were doing. Busby (1997) argues

that feedback that helped the designers in his study identify the discrepancy between the actual and the intended outcomes also created a stimulus for them to reduce this discrepancy. According to Busby, the designers got a sense of accomplishment and mastery of what they were doing, leading to a higher level of motivation and morale.

The motivating mechanism of feedback can serve two functions: acting as an incentive (i.e., promise for future rewards or punishment) or serving as reinforcement through the pairing of feedback with extrinsic rewards (Macpherson 1948; Ilgen et al. 1979). Ilgen et al. also identify feedback as intrinsic motivation. Individuals, they claim, seek a sense of accomplishment on a task, which, upon acquisition, can be a powerful reward for them. Feedback, which enables individuals to judge their own performance, can be an important tool to bring about that sense of accomplishment. No sense of accomplishment is possible without the presence and use of feedback information (Ashford and Cummings 1983). Other things being equal, the more the amount of feedback provided on a job, the greater will be the intrinsically motivating potential of the job (Ilgen et al. 1979).

Nadler (1977) characterizes the motivating mechanism of feedback in three different ways. *First*, feedback motivates behavior by disconfirmation. Feedback that provides information inconsistent with the perceptions or beliefs of individuals, according to the author, can motivate the individuals to resolve the inconsistency. *Second*, feedback motivates behavior by creating internal reward expectancies. Since individuals want a sense of accomplishment in their work, feedback is a powerful tool that sends signals to the individuals about whether their work is of good quality or of poor quality that needs to be corrected. *Third*, feedback motivates behavior by creating extrinsic reward expectancies. Individuals who perceive feedback as instrumental for the attainment of certain desired outcomes will change their behavior to conform to the purpose of the feedback given.

Feedback for Direction

Ilgen et al. (1979) claim that the directing mechanism of feedback serves to clarify what specific behaviors are desired to achieve the organizational goal. It directs attention by

determining not only how hard the person will work but also on what aspects of the task he will focus. Ashford and Cummings (1983) term this mechanism the signaling mechanism. Feedback, Ashford and Cummings claim, provides signals to individuals concerning the relative importance of various goals within the organization. It also directs the energy of individuals to those behaviors and goals most valued by the organization. Nadler (1977) calls this mechanism the cueing mechanism. Feedback, Nadler argues, provides individuals with cues of how well or poorly their activity is proceeding when compared to some standard. Three of Busby's (1997) categories of feedback benefits (i.e., knowledge of performance, error correction, and learning) can be classified as the directional mechanism.

Directional mechanism through knowledge of performance. A study by Trowbridge and Cason (1932) shows how the directional mechanism works. In their study, the subjects were told to draw a three-inch line. The authors found that the subjects who were given feedback (either specific or non-specific feedback) performed better than those who were not given any feedback at all. More supporting evidence was found in Waters' (1933) experiment in which subjects were asked to estimate the duration of a 12-second time interval. The author found that improvement was "… roughly proportional to the degree of information given" (p.673). Ammons (1956) claims that task performers generally have some level of knowledge of their own performance; however, that knowledge may not be accurate.

In a similar study done by Macpherson (1948), the subjects were asked to draw a line of a given length, but no feedback information about how long the line was actually drawn was given. Even after repeated practice, the subjects did not show any signs of approaching the length actually requested. However, it was found that several subjects consistently drew lines of some incorrect length. This led Ammons to conclude, "These people were apparently setting up their own standards even though they had no way of knowing whether their responses were wrong, or by how much, or in what direction. The subject's standard failed to correspond with the experimenter's standard; therefore, from the experimenter's point of view, repeated practice revealed no 'improvement' in performance" (p.282). In short, without feedback information, task performers cannot know their own performance accurately. Feedback makes it possible for

the performers to know how they perform in relation to any preset standards or goals; consequently, performance can be improved.

Directional mechanism through error correction. A design error, according to Busby (1997), is the discrepancy between what is intended and what is actually achieved, which is known through the knowledge of performance by feedback. The designers use feedback to identify and attempt to reduce this discrepancy. Feedback seeking, argue Ashford and Tsui (1991), allows managers to detect discrepancies and subsequently to correct behaviors. The directive effects of feedback enable the correction of errors in the appropriate direction (Macpherson et al. 1948; Ammons 1956). Feedback provides "… information about the extent of errors being made so that corrective action can be initiated" (Ivancevich and McMahon 1982, 359).

Directional mechanism through learning. Feedback directs individuals to learn the correct response (Ilgen and Moore 1987). When the correction procedure is not known or obvious, feedback facilitates the learning process of individuals to identify a correct behavior (Nadler 1977). Through feedback, individuals are able to know how well they perform, make any necessary corrections to reduce the discrepancy, and, as a result, learn how to do better next time (Busby 1997). According to Ammons (1956), feedback facilitates learning and enables individuals to reach a higher level of proficiency. Information from feedback can be useful in reducing uncertainty (Ashford and Cummings 1983). Ashford and Tsui (1991) mention that feedback helps direct individuals to correct performance strategies. Individuals, they argue, use feedback as guidance about strategies that could enhance their effectiveness.

Feedback and Its Negative Impacts

Feedback does not necessarily always have positive effects. Feedback may result in decreased performance, induce defensive behavior, and create misdirected effort (Nadler 1977). Feedback that lowers the perceived likelihood of achieving a particular performance level can decrease the recipient's motivation to perform, and the performance may suffer (Ashton 1990). According to Ilgen and Moore (1987), choosing to use feedback often means that the feedback recipient must take time away from the task to study the feedback.

Even though giving feedback can enhance performance, providing excessive feedback does not necessarily increase performance. Additional feedback, Ammons (1956) claims, may have little or no effect when a person is already performing at a high level of performance or when the task is complex. In Crafts and Gilbert's (1935) study, the subjects who were given a triple criterion of trials, errors, and time feedback did not perform significantly better in terms of learning and retention of a stylus maze than those who were not given such a criterion. The complexity of this feedback may have confused the subjects; therefore, they chose only one criterion to concentrate on and disregarded the other two.

Ammons (1956) argues that providing excessive feedback can even create negative effects; it may lead to a decrease in motivation when the person is doing poorly. This may be due to the added pressure induced by feedback. Ashton (1990) points out that feedback increases the pressure on the recipient. This increased pressure can either help or harm performance, depending on the level of preexisting pressure and/or the demands of the decision tasks. Increased attention and effort induced by pressure are positive results from increased pressure, while increasingly intense pressure may result in detrimental psychological impacts, thus harming the performance. The author also claims that for a given level of task difficulty, increased pressure induced by feedback can result in improved performance, no change in performance, or decreased performance. Feedback can have detrimental effects on performance via its impact on anxiety, especially in difficult tasks.

2.7 GOAL SETTING

THE CONCEPT OF GOAL SETTING

Up to this point, the impact of feedback (both positive and negative) has been thoroughly discussed. Just like feedback, goals can serve as a source of motivation and inspiration to employees (Griffin 1990). The goal-setting process is widely used as a motivational technique (Frost and Mahoney 1976; Campion and Lord 1982) and is an important technique with respect to work motivation; it can significantly increase performance (Latham and Baldes 1975; Locke et al. 1981; Naylor and Ilgen 1984).

There are several frequently used concepts that are similar in meaning to that of a goal, including budget, deadline, objective, performance standard, quota, task, and work norm (Locke et al. 1981). Thus, to clearly understand the definition of goals, different definitions are provided. Several researchers define goals as

> *what the individual is consciously trying to do (Locke 1968, 159).*
>
> *levels of performance sought, appear to be common elements in attempts to motivate performance; success is associated with goal achievement, failure with performance below the goal level" (Frost and Mahoney 1976, 328).*
>
> *what an individual is trying to accomplish; it is the objective or aim of an action (Locke et al. 1981, 126).*
>
> *a target state or condition the organization wants to achieve (Griffin 1990, 161).*

Goal setting, Latham and Kinne (1974) argue, influences an intrinsic variable of the job, namely the task itself. Employees should be encouraged to set task goals, and they should be given information feedback about their performance. The combination of the two components, goals and feedback, provide meaning to a task that can have motivational impact. Locke's (1968) theory identifies the motivational impact of goal setting, indicating that the setting of hard and specific goals can lead to higher performance. When an individual consciously accepts a goal

that is specific and challenging, that person is motivated and understands what he has to do to reach that goal. This, according to Latham and Baldes (1975), may provide the person with a sense of achievement, recognition, and commitment in that the person can know how well he is doing, compared to others or to his own performance in the past.

The rationale behind Locke's (1968) theory may also be explained by work on levels of aspiration, which explains that "… if the individual sets a performance goal before carrying out a task, he tends to raise the goal if he is successful …" (Latham and Kinne 1974, 190). There is evidence in Campion and Lord's (1982) study to support this argument. The authors found that success tended to be followed by raising subsequent goals. Individuals who achieve their goals, they argue, are more likely to raise their subsequent goals. The same conclusion was found in Yukl and Latham's (1978) field study of female typists. They conclude, "… the higher the prior performance, the higher the absolute goal set for subsequent performance" (p.321). In addition, Locke (1968) also claims that individuals who set high goals in relation to their previous performance should outperform those who set comparatively low goals. As a result, it is reasonable to expect an increase in performance when a procedure of setting hard, specific goals is introduced into the organization since an initial goal may lead to higher performance, which may lead to another even higher goal, and so on.

GOAL SETTING AND ITS INTERDEPENDENCE WITH FEEDBACK

The interdependence between feedback and goal setting is a very complicated issue. Different researchers view this interdependence differently. In this section, the interdependence between feedback and goal setting viewed from different perspectives is discussed.

FEEDBACK AND GOAL SETTING AS A MOTIVATIONAL MECHANISM

Campion and Lord (1982) recognize the dependency of goal setting upon feedback, arguing, "… difficult and specific goals lead to improved performance as long as they are accepted and performance feedback is provided" (p.265). Nadler (1977) supports the same idea, saying

"Feedback is an important part of goal setting, since it is difficult to set goals for the future in the absence of knowledge about performance in the past and how that performance compares with some standard" (p.75). An opposite view by Ivancevich and McMahon (1982) points out that the motivational effect, previously attributed solely to feedback, may actually be due to goal setting. Ivancevich and McMahon identify the dependency of feedback upon goal setting saying "… feedback will have a positive motivational effect only when it leads to the setting of a difficult performance goal" (p.359). The latter view was previously hypothesized in the work of Locke (1968), who argues that goals are mediators of the effects of feedback on task performance. (Locke's mediating hypothesis is discussed later in this study.)

There is another hypothesis regarding the motivational mechanism of feedback and goal setting that views both components as reciprocally dependent. In their study, Latham and Kinne (1974) found that the wood workers who set performance goals and received feedback of their own performance as well as that of others increased their production level and decreased the absenteeism rate. Latham and Kinne (1974) express, "Thus, to improve one's performance one must first aspire but to aspire one must see that success is possible, that is, clear evidence must be available that others under similar conditions are succeeding" (p.190). From this statement, one could identify two important components that are responsible for improved performance: goals (or aspiration levels) and feedback (or clear evidence).

Taken together, feedback and goals are necessary to improve task performance. Naylor and Ilgen (1984) contend, "… performance is highest in the presence of both goals and feedback" (p.99). To achieve motivational purposes, one cannot exist without the other. Neither feedback nor goals alone are sufficient to improve performance or significantly affect performance (Locke et al. 1981; Campion and Lord 1982). Both components are necessary. The co-presence of feedback and goals is necessary, and only when they are present concurrently can the motivational benefits be attainable.

GOALS AS MEDIATORS OF THE EFFECTS OF FEEDBACK ON PERFORMANCE

Locke (1968) claims that goals mediate the effects of incentives on behavior. The term "incentives" is used to represent environmental events or stimuli that may affect goal-setting effectiveness, including feedback, money, praise and reproof, participation, and competition. Locke asserts, "It appears that a necessary condition for incentives [i.e., stimuli] to affect behavior is that the individual recognize and evaluate the incentive and develop goals, and/or intentions in response to this evaluation" (p.184). Figure 2.13 depicts Locke's thesis, showing the sequence of events leading from environmental stimuli to the establishment of goals and subsequent effects on performance.

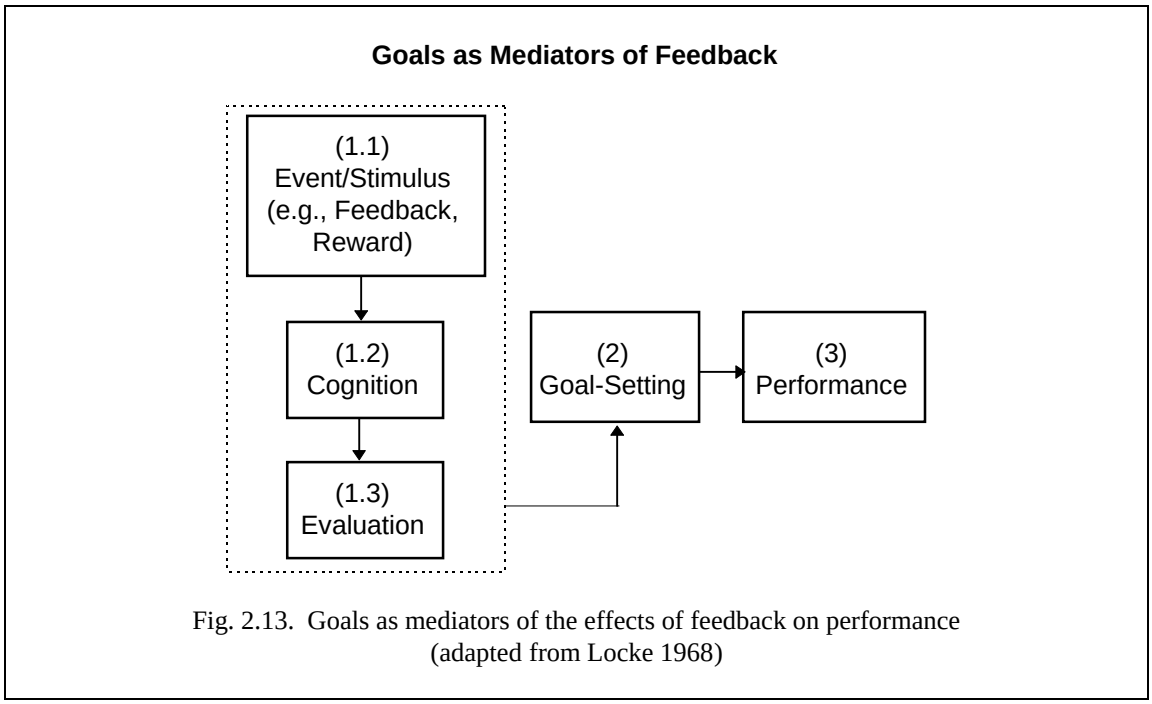


Fig. 2.13. Goals as mediators of the effects of feedback on performance (adapted from Locke 1968)

Locke (1968) mentions that the important aspect about feedback is not merely whether it is given or not given (Step 1.1 in Figure 2.13). It depends on how the recipient perceives (Step 1.2) and evaluates it (Step 1.3) and what goals he sets (Step 2) in response to that feedback. Consequently, performance is shaped by the recipient's responses with respect to his knowledge from the feedback received (Step 3).

Locke (1968) argues that when feedback improves performance, it does so only through its effects on goal setting. It affects the nature of the goals that individuals set on the task (Locke and Bryan 1969). Feedback affects performance only if it is used to set specific goals (Latham et al. 1978). If feedback is given in such a way that it cannot be used to set goals, it will not affect motivation.

COMPARISONS OF FEEDBACK VERSUS GOAL-SETTING EFFECTS ON PERFORMANCE

Several studies comparing the effects of goals and feedback on performance were thoroughly reviewed by Locke et al. (1981). Figure 2.14 illustrates the model for analyzing feedback-goal studies conducted by the authors.

Feedback vs. Goal Setting

	Feedback	No Feedback
Specific, hard goal	Cell #1 Feedback and specific, hard goals	Cell #2 No Feedback and specific, hard goals
No specific goal or do-best goal	Cell #3 Feedback and do-best goals	Cell #4 No Feedback and do-best goals

Fig. 2.14. Model for analyzing feedback-goal studies
(taken from Locke et al. 1981, 133)

From Figure 2.14, Locke et al. (1981) represent the conditions of interest by using four different cells. Cell 1 represents specific, hard goals combined with feedback given; Cell 2, specific, hard goals with no feedback given; Cell 3, Feedback with no specific goals (or do-your-best goals that are equivalent to no assigned goals); and Cell 4, neither specific goals nor feedback given. Two types of studies were found in their review. The first set of the studies consists of comparisons between Cells 1, 3, and 4. The second set consists of comparisons between Cells 1, 2, and 4.

The first set of the studies (Cells 1, 3, and 4 comparisons) confirms Locke's (1968) mediating hypothesis. The findings showed no difference of performance in Cells 3 and 4 (3 = 4), indicating that in the absence of goals, feedback alone is not sufficient to improve performance. Given feedback, goals are sufficient for performance improvement (1 > 3). Thus, goals seem necessary for feedback to significantly affect performance. The results of the second set of the studies (Cells 1, 2, and 4 comparisons) indicate that goals without feedback are not sufficient to improve performance (2 = 4). In one case, the presence of goals without feedback given may even inhibit task performance (2 < 4). Given goals, feedback is sufficient for performance improvement (1 > 2). Therefore, feedback seems necessary for goals to significantly affect performance. (For further details, see Locke et al. 1981.)

FEEDBACK—AND GOAL SETTING—IN THE FRAMEWORK OF CONTROL SYSTEMS

Campion and Lord (1982) modify the control system model proposed by Power (1973) to highlight the significance of feedback, as well as goal setting, in the motivational control system (see Figure 2.15). They view both feedback and goals as principal components of a motivational control system that affect behavior and subsequently task performance.

According to the model, the comparator compares both goals and feedback to identify discrepancies. If a discrepancy or error is sufficiently large, remedial actions are activated to correct system behaviors. Thus, in order to maintain the ongoing process of the motivational control system, both feedback and goals must exist. If either one is missing, no discrepancy can be detected, no discrepancy-reducing action will be initiated, and the whole control system becomes meaningless. As a result, Campion and Lord (1982) conclude that goal setting and feedback should be viewed as a dynamic process in which both components are incorporated into a system that monitors and maintains performance level relative to a desired state by initiating corrective actions, adjusting behaviors, or fine-tuning goals and strategies.

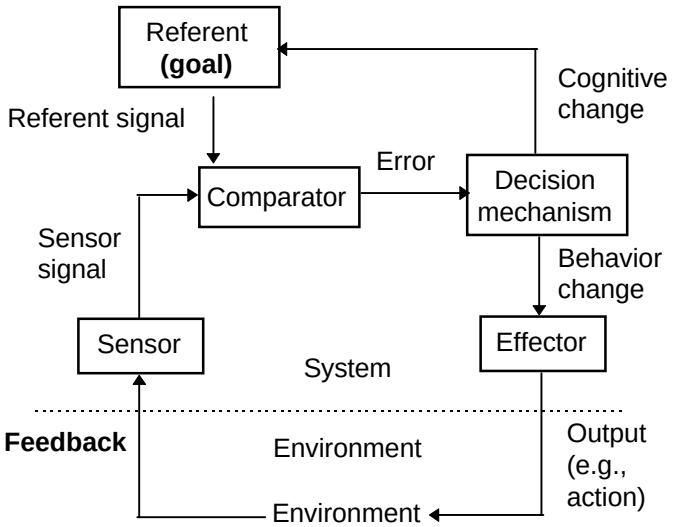


Fig. 2.15. Feedback and goals as important components in the control-system model (taken from Campion and Lord 1982, 267)

FEEDBACK AS AN INFORMAL GOAL-SETTING PROCESS

Feedback and goals are so intertwined that it may not be easy to separate their effects. Giving feedback, Pritchard et al. (1988) argue, could lead to informal goal setting. Even though giving feedback does not tell an individual directly what goal he has to try for, given in the right form it may imply a specific standard/goal to him (Locke 1968). For example, giving feedback in relation to different levels of standards—low and high—will determine the difficulty of the goals implicitly expected from the individual. The forms of feedback given may also influence how an individual perceives and behaves. For example, giving feedback continuously to the individual after each period may suggest the goal of continuous improvement. Giving feedback in comparison to those of other persons may imply new standards for competition. Giving feedback in relation to some external standards may imply a goal (Locke 1968). It is, therefore, important to recognize the effects of goal setting done informally and the effects of formal, public goal setting.

GOAL-SETTING DIMENSIONS/ATTRIBUTES

There are some factors that can help determine whether the process of applying goal-setting strategies will be successful as intended or not. These factors may be categorized into two major groups: goal dimensions or attributes and relevant conditions. The former will be discussed in this section, and the latter will be discussed in the next section.

The main dimensions or attributes of goals, which must necessarily be present, are difficulty and specificity. According to Locke et al. (1981), *difficulty* is the degree of proficiency or level of performance sought, and *specificity* (or clarity) is the degree of quantitative precision with which the aim is specified. Naylor and Ilgen (1984) refer to goal specificity as the extent to which the performance level to be accomplished is explicit as to its content and its clarity.

GOAL DIFFICULTY

Locke (1968) summarizes and integrates 12 research studies of the relationship between goals and task performance. A variety of different tasks was used in these studies. The results from the studies reveal that hard goals produce a higher level of performance than easy goals produce. He claims, "The results are unequivocal: the harder the goal the higher the level of performance" (p.162). Simiarly, Locke et al.'s (1981) review of goal-setting research reveals that 48 previous studies partly or wholly supported the hypothesis that hard goals lead to better performance than easier goals, while only nine studies failed to support it.

Campion and Lord (1982) explain how setting difficult goals results in higher performance levels, as compared to setting easy goals, from the control system perspective (see Figure 2.15). They explain that the difference in performance level is due to the proportion of instances in which difficult goals would detect a discrepancy. If a difficult goal is set and the initial performance level is low, a discrepancy signal is more likely to be detected than if an easy goal is set. Once the discrepancy signal is detected, appropriate responses can be initiated. Thus, difficult goals would produce a more rapid discrepancy detection and have a higher probability of responding to declining performance than would easy goals.

One may wonder just how hard a goal should be set so that the desired level of performance is still achievable. The answer may depend on another related condition that will be discussed later, goal acceptance. According to Yukl and Latham's (1978) model (Figure 2.16), the limiting condition wherein a difficult goal can prevent goal acceptance is represented by the "?-line" connecting the two variables. If an individual is assigned a difficult task he considers unattainable, that individual will reject the goal and performance will suffer. However, if that individual accepts and commits to a goal he deems achievable (e.g., by way of participation during the goal-setting process), the harder the goal to achieve, the higher the performance level. Locke (1968) contends, "… once a hard task is accepted, the only logical thing to do is to try one's hardest until one decides to lower or abandon the goal" (p.168).

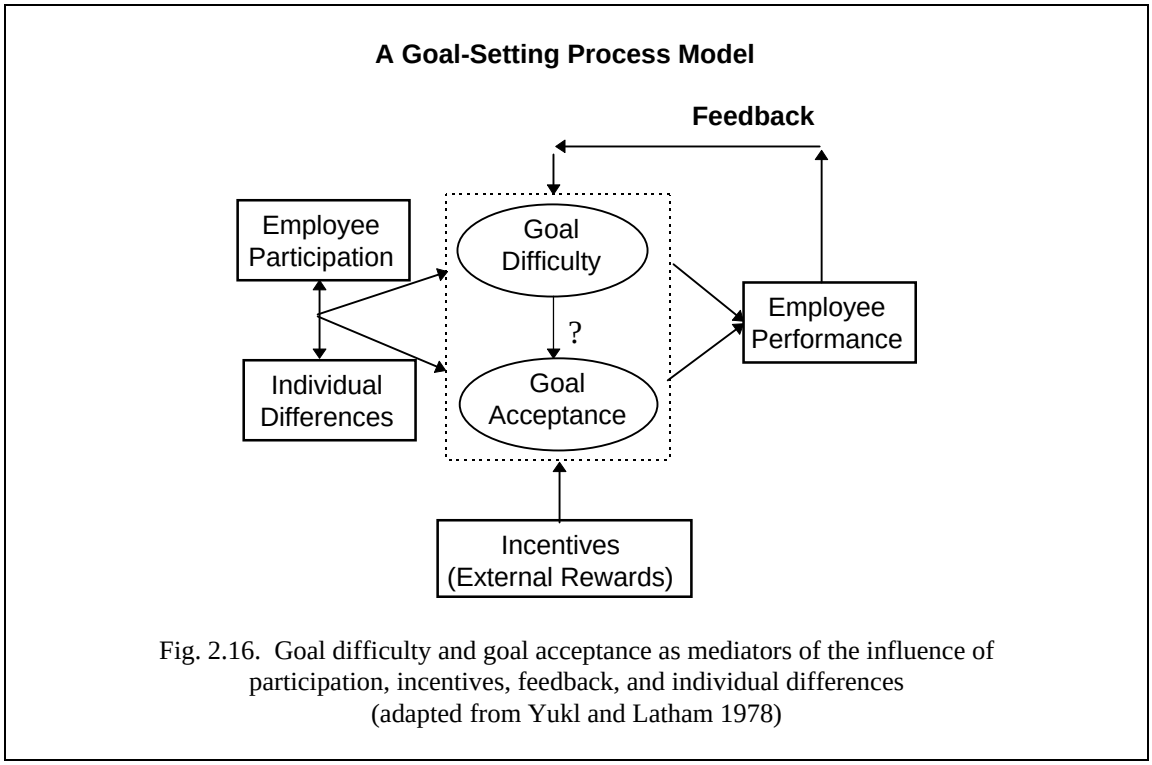


Fig. 2.16. Goal difficulty and goal acceptance as mediators of the influence of participation, incentives, feedback, and individual differences (adapted from Yukl and Latham 1978)

However, one must keep two things in mind: the added pressure from having a difficult goal and the performance ceiling. Added pressure from having a very difficult goal may have negative, psychological impacts against its positive, motivating effects. For instance, although a difficult goal is accepted and committed to by an individual, it is possible that the increased

level of anxiety to reach the goal might adversely impact task performance. Anxiety might lead individuals to worry rather than to concentrate on their task, thus offsetting all the positive effects that, otherwise, should be realized from setting difficult goals.

The performance ceiling is a set performance level beyond which a higher goal is impossible and can even result in an increase in errors. Yukl and Latham's (1978) field study found the evidence of this performance ceiling. They report, "… the higher the prior performance, the smaller the improvement goal set for the subsequent period" (p.321). Potential improvement for a goal depends on the person's ability, the current level of performance, and the nature of the task.

GOAL SPECIFICITY

Goal specificity or goal clarity refers to the extent to which goals are expressed in specific quantitative rather than vague form (Frost and Mahoney 1976). In six of the eight studies reviewed by Locke (1968), the subjects trying for specific, hard goals performed at a significantly higher level than the subjects trying to do their best. Ten out of eleven studies reviewed by Latham and Yukl (1975a) revealed the superiority of setting specific goals. Ninety percent (99 out of 110) of the studies in a review of goal-setting studies by Locke et al. (1981) found that specific, hard goals led to higher performance than easy, do-your-best, or no assigned goals did.

Locke (1968) theorizes that specific goals produce a higher performance level than "do-your-best" goals. Individuals given specific, hard goals, argue Ivancevich and McMahon (1982), should perform better than those who are told simply to do their best. According to Latham et al. (1978), specific goals enable individuals to determine how to translate effort into successful performance by choosing appropriate strategies. Terborg (1976) argues that the greatest impact of goal specificity is that it can direct behavior. Given a clear, specific, and unambiguous goal, an individual can better understand how to become successful in task performance by expending his effort toward the most effective direction.

A "do-your-best" goal, Campion and Lord (1982) point out, is ambiguous and would not function well as a referent signal from a perspective of the control system (see Figure 2.15). Once the referent signal is poor, the discrepancy will be distorted and appropriate actions cannot be initiated. In addition, greater variance in performance among recipients of ambiguous goals may be expected since ambiguous goals may be interpreted differently, thus generating varied referent signals among the recipients. These varied referent signals will most likely create greater variance in performance levels. Therefore, "… specific goals produce better performance than ambiguous goals because they permit the use of more precise feedback from the environment" (Campion and Lord 1982, 268). The industrial implication from the findings in the goal-setting field is very valuable, Ronan et al. (1973) argue. It provides managers a motivational technique through which they can motivate employees to be more productive by setting specific goals, as opposed to simply urging their employees to do their best.

RELEVANT CONDITIONS

In addition to goal difficulty and specificity factors—both of which are goal dimensions or attributes—there are many other relevant factors that may affect the effectiveness of the goal-setting process. These factors, which are discussed in detail in this section, are often confused with goal dimensions/attributes. Naylor and Ilgen (1984) distinguish the often confused difference between goal dimensions/attributes and relevant conditions: "These [relevant] conditions differ from [goal] attributes in that they are not inherent dimensions of goals per se; they are simply conditions surrounding goals that affect the effectiveness of them" (p.98).

Naylor and Ilgen (1984) classify the relevant conditions into three sets. These three sets are 1) sources of goals, 2) conditions within the task performer, and 3) conditions within the task environment. The *first* set is rather straightforward; it simply refers to where goals originated. From the performer's point of view (i.e., the *second* set), the authors indicate that goal acceptance and goal commitment are two conditions that have been shown to have positive

impacts on goal effectiveness. Participation and supportiveness by people involved in the goal-setting process are also mentioned frequently by other researchers. Lastly, the *third* set of relevant conditions for goal development exits in the task environment. According to Locke's (1968) model, shown in Figure 2.13, an environmental stimulus or event can affect behavior and subsequently performance. Naylor and Ilgen (1984) indicate that feedback is an essential condition in the task environment. The other most-often mentioned environmental condition is monetary reward. Locke (1968) uses the term "incentive" to refer to these external stimuli or events. He defines an external incentive as, "… an event or object external to the individual which can incite action" (p.161).

SOURCES

Naylor and Ilgen (1984) claim that goals may originate from two sources, either from the performer of the task himself or from some external sources (e.g., organization, supervisor, and peers). If a goal comes from an external source (e.g., it is assigned to a person by his supervisor), that goal will affect behavior only when it is consciously accepted by the person (Latham and Yukl 1975a). It is important to understand that assigned goals or instructions do not automatically affect individuals' behavior. Locke (1968) says, "… instructions will affect behavior only if they are consciously accepted by the individual and translated into specific goals or intentions" (pp.173-4). To obtain goal acceptance and commitment from individuals, the most-mentioned techniques are to involve the individuals in the goal-setting process and to show support for and help these individuals reach their goals.

ACCEPTANCE AND COMMITMENT

Goal acceptance is defined as, "… the extent to which the task performer believes that the goal is a reasonable one for him or her when that goal is assigned to the person by someone else" (Naylor and Ilgen 1984, 98). Locke et al. (1981) state that, "Goal setting is most likely to improve task performance when the goals are specific and sufficiently challenging, the subjects have sufficient ability … and assigned goals are accepted by the individual" (p.125). This statement indicates that besides the presence of the two goal dimensions/attributes (i.e.,

difficulty and specificity), goals must be accepted in order for them to be effective. Goal acceptance is an important condition for goals to be committed and, consequently, effective.

One of the components in Campion and Lord's (1982) control system (Figure 2.15) is a referent or a goal. This component generates referent signals. Without goal acceptance, the comparator cannot detect a correct discrepancy because the referent signal is distorted. Consequently, the whole system will not work, and goal setting may not have any impact on subsequent behavior.

Naylor and Ilgen (1984) claim that goal commitment is manifested only after goals have been accepted. The level of goal commitment is believed to be a very important factor that influences individuals' behavior. Locke (1968) argues, "The subject's degree of commitment to his goal may play an important role in determining how easily he will give up in the face of difficulty, how likely he will be to 'goof off' when not being pressured from the outside, how likely he will be to abandon hard goals, and how prone he will be to 'leave the field' (i.e., job) in the face of stress" (p.186).

Employee participation in the goal-setting process and supportiveness from supervisors have been recommended as means to obtain employee acceptance and commitment to organizational goals and to reduce resistance to change. A well-run reward system (i.e., money), mentions Locke (1968), may also enhance goal acceptance and commitment. He makes a point that money can help commit individuals to tasks or goals that they would not otherwise undertake. Individual differences, argue Ivancevich and McMahon (1977), may influence how different individuals perceive, accept, and commit to goals. Individuals who have a high degree of self-assurance or have previously had more successful experiences in goal attainment are more likely to perceive difficult goals as challenging rather than impossible (Latham and Yukl 1975a). (These issues are discussed in detail in following sections.)

Figure 2.16 is an explanatory model of goal setting adapted from Yukl and Latham (1978). The model takes into account interrelationships among an individual's performance, performance feedback, participation in goal setting, goal difficulty, goal acceptance, perceived

instrumentality of goal attainment (in obtaining extrinsic rewards), and individual differences. The model incorporates key elements from Locke's (1968) theory and is intended to explain how goal difficulty and goal acceptance may mediate the influence of participation, incentives, feedback, and individual differences. In addition to the factors that have been mentioned here, other factors that may influence goal acceptance and commitment are pressure, supervisors' power, supervisory expertise, rewards and punishments given for goal attainment and non-attainment, incentive contingencies, and intrinsic motivation from the task itself. (Latham and Yukl 1976; Locke et al. 1981).

PARTICIPATION

Participation is an integral component of the goal-setting process; it can facilitate goal acceptance and commitment. According to Locke (1968), having individuals participate during the decision-making process may help motivate and commit the individuals to performance standards/goals to which they otherwise would not commit. However, the literature revealed no consistent results in the performance differences of top-down (autocratic) decision making and participative decision making (Latham and Yukl 1975a; Latham and Saari 1979a; Locke et al. 1981; Naylor and Ilgen 1984).

In a study administered at a manufacturing firm, Carroll and Tosi (1970) did not find employee participation to be an important goal characteristic. They say, "Subordinate participation in setting goals did not result in higher levels of perceived goal success, effort, nor in more favorable attitudes toward the program, or the superior" (p.304). The same result was also reached by Latham and Yukl (1976), who found no significant differences in the performance of typists with participative and assigned goals when those goals were accepted by both groups.

The engineers who participated in goal setting in Latham et al.'s (1978) study were also found to set more difficult goals for themselves than the assigned goals set for their peers. However, the study revealed no significant differences in the performance of the participative and assigned groups. The authors mention that participation is important to the extent that it leads

to setting hard goals that can enhance performance, but goal specificity and goal acceptance can be attained equally easily through assigned and participatively set goals.

In their laboratory study, Latham and Saari (1979b) specifically tested the hypothesis that participation in goal setting may affect performance through its influence on goal difficulty. Their finding reveals that when goal difficulty was held constant across the participative and assigned goal conditions, there were no significant differences in performance or goal acceptance between the two goal-setting groups. This study and the above study by Latham et al. (1978) point to the same conclusion that "… participation in goal setting is important to the extent that it leads to the setting of a higher goal than that which is assigned by a supervisor" (Latham and Saari 1979b, 167).

Another study by Latham and Saari (1979a) revealed that participation in the goal-setting process improved performance. This importance of participation in goal setting, they argue, may be that it not only leads to the setting of higher goals, but it can also increase understanding of the task itself. Participation, Locke et al. (1981) argue, may be used to gain good ideas from the participants as to how to improve performance.

In summary, even though the results of the goal-setting participation may be inconsistent, several tentative conclusions may be drawn. First, participation could lead to greater goal acceptance or facilitate goal commitment to a greater extent than assigned goals could do. Second, participation could lead to setting higher goals than would be the case without participation. Third, participation could lead to a better understanding of task requirements and how to achieve them. Any of these three factors could have positive impacts on performance

SUPPORTIVENESS

Locke et al. (1981) hypothesize that it may be that supportiveness, rather than participation, is crucial in inducing goal acceptance. According to Latham and Saari (1979a), a supportive supervisor is perceived by his subordinate as a person whose primary interest is in building and maintaining the subordinate's sense of personal worth. The more a supervisor is perceived as

supportive, the better will be the effect of the supervisor's behavior on the subordinate's performance.

Carroll and Tosi's (1970) study at a manufacturing facility revealed that subordinates who worked for a supportive supervisor expended greater effort with an increased number of goals. The authors argue that there might have been greater acceptance of work assigned when the supervisor was supportive. The subordinates, they argue, might have been willing to put forth more effort when they felt that their supervisor was dependable and trustworthy and would help them if they needed help.

In their field experiment with typists, Latham and Yukl (1976) found out that typists with assigned goals accepted them as well as typists who participated in goal setting accepted them. They claim that subordinate acceptance and commitment may depend on many factors, including considerate supervision. Considerate supervisors, in their study, were those who set the goals at a reasonable level and avoided criticism when their subordinates failed to attain their goals. It was found that typists who perceived their supervisors to be dependable and trustworthy had better performance.

Supportiveness may be so highly interdependent with participation that it is difficult to distinguish or separate their effects. According to Latham and Saari (1979b), "it would appear that when a manager is truly supportive of his employees, … participation is important in goal setting to the extent that it leads to the setting of high goals" (pp.167-8). Moreover, their interdependence may be confounded even more because participation may entail supportiveness (Locke et al. 1981).

FEEDBACK

There are two generally accepted hypotheses regarding the motivational impacts of feedback and goals. The *first* hypothesis views goals as mediators of feedback effects on behavior (Locke 1968). According to Locke's model, shown in Figure 2.13, goals are mediators of the effects of external incentives—i.e., environmental events or stimuli—on behavior. Goals, he

argues, mediate the effects of feedback (and other stimuli such as praise and reproof, competition, money, and participation) on behavior.

In essence, the effects of feedback on performance should be a function of the goals individuals set in response to them. Feedback affects the nature of the goals that individuals set on the task (Locke and Bryan 1969). Latham and Yukl (1975a) identify four reasons in which feedback can lead to an increase in effort and performance. They are 1) feedback may induce an individual who previously did not have a goal to set a goal to improve performance, 2) feedback may induce a higher level of goals after the previous goal has been achieved, 3) feedback that informs an individual that his current level of effort is inadequate to attain his current goal may result in greater effort or a new goal, and 4) feedback may inform a person of a better way to perform his task.

Locke (1968) uses his mediating hypothesis to explain the effects of praise and reproof (which is another form of feedback) in organizations. The effects of praise or reproof vary substantially, Locke claims, because of their complex interactions with individual characteristics such as age, sex, race, social class, intelligence, etc. For example, some people may react to criticism by setting challenging goals and working harder, while others may lower or abandon their goals by giving up or deliberately doing badly. On the other hand, some people may respond to praise by being motivated and setting new and higher goals, while others may start goofing off by lowering their goals. In any case, the potential effects of praise or reproof on behavior will be a function of what goals the individual sets in response to them.

The effect of competition is also explained in relation to feedback by Locke (1968). The author argues that even though giving feedback does not tell an individual directly what goals he has to try for, if given in the right form, feedback may specify a standard to him. Giving feedback in comparing an individual to other persons, for example, may imply new standards for competition. From Locke's (1968) mediating hypothesis, the potential effects of induced competition on behavior will be dependent upon what goals the individual sets in response to the competition. If the individual is indifferent to the competition, he will not change his goals

and the behavior will not be affected. On the other hand, if the individual is motivated and determined to be competitive, he will adjust his goals and the behavior will be affected.

The *second* hypothesis concerning the motivational impacts of feedback and goals views both components as reciprocally dependent. Locke et al. (1981) believe that this hypothesis is more useful and more accurate than Locke's (1968) position, which views goals as mediators of feedback effects on performance. Several studies in goal-setting research were reviewed by Locke et al. (1981) to determine whether feedback directly influenced performance or whether its effects were mediated by the goal-setting process. The evidence from those early studies indicated that feedback alone was not sufficient to improve task performance directly. To achieve motivational purposes, one cannot exist without the other. Neither feedback nor goals alone are sufficient to improve performance or significantly affect performance (Locke et al. 1981; Campion and Lord 1982). Feedback in relation to the goals is necessary if goals are to enhance performance, just as goals are necessary if feedback is to enhance performance (Locke et al. 1981).

MONETARY REWARDS

As with the effects of feedback (or other stimuli) discussed earlier, Locke's (1968) theory suggests that the effects of monetary reward will be a function of what goals the individual sets in response to them. A well-run incentive system (i.e., money), mentions Locke (1968), can affect the effectiveness of goals. He makes the point that money can help commit individuals to tasks or goals they would not otherwise undertake. In organizations, a well-run incentive program will encourage employees to accept tasks and set goals they would not otherwise accept or set on their own just for the intrinsic enjoyment of the tasks themselves. The effectiveness of using monetary rewards to commit individuals is dependent on many factors, including the amount of the reward and the value the individuals place on the reward. Money can be used to improve performance in relation to a given goal, but the amounts involved must be large rather than small (Locke et al. 1981).

Yukl and Latham (1978) claim, "Specific task goals are more likely to be accepted if goal attainment is perceived to be instrumental for obtaining outcomes of this type, providing that the outcomes are desirable to the employees" (p.309). The finding of their field study of female typists revealed that goal setting led to higher performance for the persons who perceived goal attainment to be instrumental for obtaining extrinsic rewards.

Latham et al. (1978) found that monetary incentives produced significantly higher performance for scientists and engineers in their study than did recognition, but their result did not support Locke's (1968) mediating theory that money affects behavior only to the extent that it affects the individual's goal. Incentives, claim Latham et al. (1978), can have an independent effect on task performance. Terborg's (1976) study revealed that money influenced effort and performance of the subjects, regardless of the effects of goal setting. Terborg reaches the same conclusion: that monetary incentives and goals can independently influence performance.

INDIVIDUAL DIFFERENCES AND GOAL SETTING

Just as individual differences may play an important role in how feedback affects people differently, they also may play an important role in how goal setting affects people differently. It is important to consider "… individual differences as important moderators which may explain why goal setting programs are successful for some individuals but not others" (Ivancevich and McMahon 1977, 93). Supervisors must take into account the characteristics of their individual subordinates before engaging in any kind of goal setting (Carroll and Tosi 1970). Locke et al. (1981) provide a review of individual characteristics that may mediate the impact of goal setting on behavior. Some of the factors will be discussed in this section.

EDUCATION

In a field experiment involving logging crews, Latham and Yukl (1975b) found that less educated crews were more motivated and responded more positively to participative goal setting than to assigned goal setting. Participative goal setting led to higher performance than

assigned goal setting for the uneducated loggers, although there were no significant differences in performance for the educated loggers. Another field experiment by Ivancevich (1976) in the sales setting revealed that participative goal setting was not superior to assigned goal setting. If sales personnel could be assumed an educated sample, Ivancevich claimed that the result of his study was similar to Latham and Yukl (1975b) in that participative goal setting was not superior to assigned goal setting for educated individuals.

In a study involving electronics technicians, Ivancevich and McMahon (1977) found that goal challenge was significantly related to performance for more educated technicians. For less educated technicians, however, goal clarity and goal feedback were significantly related to performance. The authors claim that the more educated technicians may be confident enough from their educational background that they seek goal challenge. The less educated technicians, on the other hand, may focus their attention on clarity and feedback because they want to be perfectly clear about what they are supposed to do and receive feedback on their progress toward that goal.

Need for Achievement

Yukl and Latham (1978) and Locke et al. (1981) contend that need for achievement may affect goal difficulty. They describe that people with high need of achievement prefer challenging tasks. Since a task with a difficult goal is more challenging than the same task with an easy goal, high-need achievers will find more satisfaction in reaching a difficult goal than in reaching an easy goal. At the same time, these same persons would not want the task to be excessively difficult since the goal is unlikely to be reached successfully. Therefore, high-need achievers would set a moderately difficult goal, tend to revise the goal upward after it has been attained, and work hardest when there is performance feedback and when intrinsic rather than extrinsic rewards are emphasized.

Steers (1975) found that need for achievement can influence the relationship between an individual's task-goal attributes and his performance. Goal specificity and performance feedback were significantly related to performance for individuals with high-need achievement,

whereas participation in the goal-setting process was significantly related to performance for individuals with low-need achievement. Yukl and Latham's (1978) field study of female typists also revealed the effect of need for achievement on the goal-setting process. Their study indicated that high-need achievers set more difficult goals than did low-need achievers.

SELF-ESTEEM

Yukl and Latham (1978) found that self-esteem and goal instrumentality (which is defined as "… the extent to which desirable outcomes are perceived to be contingent upon goal attainment") interacted in their effects on performance (p.312). The study revealed that when goal instrumentality was low, high self-esteem typists showed better performance improvement than low self-esteem typists showed. When self-esteem was low, typists who perceived goal instrumentality to be high revealed better performance improvement than those who perceived goal instrumentality to be low.

Other individual characteristics that may moderate the effects of goal difficulty in goal setting or mediate the impacts of goal setting on behavior, mentioned in Latham and Yukl (1975a) and Locke et al. (1981), are needs, attitude, personality, cultural background, job tenure, age, sex, need for independence, higher order need strength, and internal versus external control. Locke et al. (1981) found that the results from the studies of individual differences in goal setting were very inconsistent.

STUDIES OF GOAL-SETTING IMPACTS

Just like feedback, goal setting may or may not be useful. In this section, the positive and negative impacts of goal setting are addressed.

GOAL SETTING AND ITS POSITIVE IMPACTS

The literature reveals that goal setting can be used as a motivational technique to improve task performance. Goal setting when combined with feedback can be a powerful motivational force

to enhance work performance. Ivancevich and McMahon (1982) believe that when these two components are combined and used together, performance, job satisfaction, and commitment are enhanced more than they would be simply by providing feedback alone.

Several studies have been done to identify the motivational benefits of goal setting and to confirm the theory that goal setting is better than non-goal setting. (See e.g., Latham and Kinne 1974; Latham and Yukl 1975a; Ivancevich 1976; Latham and Yukl 1976; Terborg 1976; Ivancevich and McMahon 1982; Pritchard et al. 1988.) Most of the studies related to the goal setting generally come to the conclusions similar to Locke's (1968), who reports

> *If the task was hard, they [the subjects] worked hard; if it was easy they worked less hard. And, in fact, it would have been irrational for them to act otherwise. If an individual genuinely has a difficult goal, it would be self-contradictory for him not to work hard to achieve it. If he did not do so, we would question whether he really had such a goal at all (p.168).* …
>
> *… the subjects trying for specific hard goals performed at a significantly higher level than subjects trying to 'do their best.' Thus, a 'do best' goal does not tend to produce … the highest possible level of performance (p.169).*

To understand how goal setting affects task performance, Locke et al. (1981) classify the motivational mechanisms of goal setting into four mechanisms—three direct and one indirect. Although the classification does have some weaknesses, primarily the lack of precision and the lack of independence of constructs used, it is well accepted (Naylor and Ilgen 1984). The three direct mechanisms are direction, effort, and persistence of action, and the indirect mechanism is the development of strategies.

Goal Setting for Direction

"Most fundamentally, goals direct attention and action" (Locke et al. 1981, 131). Goals indicate what needs to be done (Naylor and Ilgen 1984). Terborg (1976) argues that goal specificity may have its greatest impact on the direction mechanism. Given a clear, specific, and unambiguous goal, an individual can better understand how to become successful in task performance by expending his effort toward the direction that he considers most effective.

The effort needed to accomplish those goals, argue Locke and Bryan (1969), determines not only how hard the person will work but also what aspects of the task he will focus on. That is, on a given complex task, the person has the choice of focusing on different aspects, attributes, or elements. This kind of behavior is normal and prevalent in every organization, in which decision makers faced with many conflicting goals and objectives have to prioritize their goals and focus their energy and resources on only some aspects of their problems.

The study by Locke and Bryan (1969) confirms the belief that goals direct attention and action. In their study, drivers were given feedback on two or more independent (uncorrelated) performance dimensions, but they set goals with respect to only one dimension. The study showed that the performance dimension for which a goal was set showed significantly more improvement than the remaining dimensions for which a goal was not set.

Goal Setting for Effort

Having a stated goal, according to Naylor and Ilgen (1984), carries an implication of the effort needed to accomplish that goal. This implication subsequently influences an individual's effort when performing a given task. Locke et al. (1981) argue that since different goals require different amounts of effort, people adjust—or mobilize—their efforts in proportion to the perceived requirements to reach their goals. Goal difficulty, argues Terborg (1976), may have its greatest impact on the effort mechanism. The harder the goals, the more effort individuals realize they must exert to attain the goals. Difficult goals lead to higher performance than easy goals because people just simply work harder for the former (Locke et al. 1981).

Locke et al. (1981) mention a very important point regarding the positive effects induced by the motivational mechanism of goal setting. They claim that the hypothesis of a positive linear relationship between motivation, induced by setting higher goals, and performance may contradict the fact that individuals may abandon their goals if they become too difficult. (Individuals may become highly anxious when their given goals are too difficult.) In the latter case, the performance should be adversely affected, which should result in lower performance. However, the authors claim that these two cases are different from the motivational

mechanisms of goal setting. Motivational mechanisms assume goal commitment; therefore, the situation in which an individual perceives a goal as too difficult and abandons it does not comply with the assumption. In addition, the state of high anxiety should not be labeled motivation in a positive sense because it represents a negative and conflicting state, rather than a committed state of goal pursuit.

Goal Setting for Persistence

This mechanism is a combination of the previous two mechanisms—goal setting for direction and effort. It is directed effort extended over time (Locke et al. 1981). "In manifesting the required amount of effort over an extended period of time, the goal serves to influence the persistence of the individual at the task" (Naylor and Ilgen 1984, 100). As mentioned earlier, Naylor and Ilgen point out that there are some weaknesses in Locke et al.'s (1981) constructs. Because the persistence mechanism is merely a combination of the first two mechanisms with the introduction of a time dimension, there is some redundancy among constructs and this could be rather confusing.

Goal Setting for Strategy Development (Indirect Mechanism)

This mechanism is indirect in its effect because it involves developing a strategy to accomplish one's goals (Locke et al. 1981). According to Naylor and Ilgen (1984), individuals who set goals may actively attempt to consider the task carefully and decide on the best strategy to accomplish their goals. Individuals who devise a strategy to accomplish their goals do so by considering and evaluating a set of alternative courses of actions and selecting the course that can most likely lead to success. Those who do not set goals may give less consideration to the strategy that will best accomplish their tasks. In their study, Latham and Baldes (1975) found that not only did the truck drivers who set challenging goals expend greater effort in their work, but they also devised better or more creative tactics for attaining their goals. These truck drivers recommended minor modifications on their trucks to enable them to increase the accuracy of their judgments as to the weight of the wood they were carrying.

GOAL SETTING AND ITS NEGATIVE IMPACTS

Even though goal setting can be used as a motivational technique to improve task performance, if it is not being used properly it may create undesirable results. Locke et al. (1981) argue that, "Goal setting is most likely to improve task performance when the goals are specific and sufficiently challenging, the subjects have sufficiently ability … and assigned goals are accepted by the individual" (p.125). This simple statement indicates at least three things. *First*, it indicates that to achieve performance improvement, the content of each goal has to be clear so that people can carry out appropriate actions to reach the goal. If the content is not clear and it is misunderstood, there might be confusion and frustration on what needs to be done. There might be wasted resources and energy spent on doing wrong things.

The *second* indication is that goals should not be too easy to attain; but, at the same time, they must be attainable goals. Setting easy goals may create nothing because people do not have to exert additional effort to reach the goals. Griffin (1990) mentions, "Of course, goals should not be so easily attainable that employees see them as a joke or an insult. Goals must be challenging but within reach." According to Griffin, setting unattainable goals can be detrimental to the organization because "… no matter how well an individual, unit, or organization performs, if goals are not met, many people assume that someone has failed" (p.170). Psychologically and emotionally, asserts Deming (1993), "… a goal that lies beyond the means of its accomplishment will lead to discouragement, frustration, [and] demoralization" (p.41).

A research review by Latham and Yukl (1975a) confirms the argument that setting unattainable goals may decrease the level of task performance. They observed that "Performance improved more for the goals perceived to be easy or challenging than for the goals perceived to be impossible; and for the impossible goals, performance actually decreased" (p.833). One could argue that setting an impossible goal may decrease performance because the goal is not accepted. This leads to the *third* and last indication that goals that are not accepted may have negative impacts on work performance. When assigned a goal that is perceived impossible to reach, the individual rejects the goal and stops trying for that goal (Locke 1968).

THE APPLICATIONS OF GOAL SETTING IN THE ORGANIZATIONAL SYSTEM

Inspired by the research on goal setting, there is some evidence of the effectiveness of goal setting's motivational impacts in organizations. The first evidence of goal-setting application is a motivational program called Zero Defects, and the second is Management by Objectives.

ZERO DEFECTS

Goal setting is the central part of the zero-defects concept. According to Locke (1968), a zero-defects program is intended to reduce errors in workmanship, improve quality work, and increase task performance by persuading individuals to adopt higher goals with regard to quality. "When the basic assumption is that the process can never be operated without error, then the next step is a matter of putting an agreed-upon number [i.e., a standard or goal] on that error" (Crosby 1984, 3). The basic concept of the zero-defects program is that if the inevitability of mistakes or defects is accepted, then the practices for making them will also be undeniably accepted. By setting a higher standard or goal—aiming for the desirability rather than the acceptability levels—people should be more motivated to strive for a higher quality level in their work. Subsequently, this will result in higher work performance.

Locke (1968) also believes that the success of zero-defects programs may be attributed to the goal-setting process occurring during the program. "Without carefully controlled studies, of course, it cannot be determined just what particular aspects of the zero-defects programs are most responsible for the success that they have apparently enjoyed" (p.186). He continues, "But changing the quality goals of individual workers and managers does seem to be the key element; not only does it affect work directly but it apparently stimulates employees to try to discover better methods of doing the work" (p.186).

Zero-defects programs are not without weaknesses. In his book, *Out of the Crisis*, Deming (1986) advocates the elimination of slogans, exhortations, and targets for work in one of his 14 quality-improvement points. He contends, "Do it right the first time. A lofty ring it has. …This is just another meaningless slogan, a cousin of zero defects" (p.66). Deming believes

that an unrealistic slogan, exhortation, or target will not do any good for the company. It may, in fact, create fear, frustration, resentment, and distrust between workers and managers if workers do not see how they could possibly reach the assigned target. Managers must focus on the process and method of reaching the quality goal rather than on the goal itself. Deming (1993) explains, "A numerical goal accomplishes nothing. Only the method is important, not the goal. By what method?" (p.33).

MANAGEMENT BY OBJECTIVES

Management by objectives, or MBO, is collaborative goal setting and planning by a manager and a subordinate. The extent to which the subordinate attains these goals is a major factor in evaluating and rewarding the subordinate's performance (Griffin 1990). Goals are usually set jointly by a subordinate and his supervisor; thus, participation is involved (Locke 1968). In addition, Griffin (1990) argues that MBO is more than just a technique for systematizing the goal-setting process; it actually serves to communicate and implement a wide range of organizational goals and plans across different organizational levels. In their words, Latham and Yukl (1975a) capture the essence of MBO, defining it as, "… an approach to planning and performance appraisal that attempts to clarify employee role requirements, relate employee performance to an organization's goals, improve manager-subordinate communication, facilitate objective evaluation of employee performance, and stimulate employee motivation" (p.830).

The MBO process involves delineating the organizational goals and plans, setting up hierarchies of objectives, translating the organizational goals into smaller goals relevant to the individual's own job, identifying the means and the resources by which each goal is to be reached, agreeing upon the criteria to be used in performance evaluation, periodically reviewing the progress of work toward each goal and making any changes if necessary, and evaluating the individual's own performance. Even though many factors are involved in the MBO program, the central feature of the program is setting specific goals (Locke 1968; Latham and Yukl 1975a; Griffin 1990).

MBO programs are believed to provide many benefits: They enhance the communication channel between employees and their supervisors; during the process, they foster trust and collaboration between people involved; they enhance goal commitment from employees as a result of participation and involvement; and, relating to this study, they improve employee motivation. By the same token, MBO is also criticized for certain shortcomings. Lack of support from top management and ineffective planning can limit the program's effectiveness. Also, if goals are not collaboratively set by both employees and their supervisors, the employees will not commit to and will resent the assigned goals; and, consequently, the MBO program will fail (Griffin 1990).

Opposed to setting numerical goals, Deming also criticizes MBO. "Management by objective leads to the same evil. … Management for fear would be a better name" (Deming 1986, 102). He explains, "It nourishes short-term performance, annihilates long-term planning, builds fear, demolishes team-work, nourishes rivalry and politics. It leaves people bitter, crushed, bruised, battered, desolate, despondent, dejected, feeling inferior …" (Deming 1986, 102). On the surface, one may feel that he totally denounces the process of goal setting; however, after closer scrutiny, one might find that he actually disagrees only with a deficient goal-setting process. That is, he disagrees with the process that yields unrealistic goals that subordinates will neither accept nor commit to. Deming expresses, "… a goal that lies beyond the means of its accomplishment will lead to discouragement, frustration, [and] demoralization. In other words, there must be a method to achieve an aim. By what method?" (Deming 1993, 41). If managers always keep in mind that a goal can be effective only when it is specific, sufficiently challenging, and accepted by their subordinates, then the detrimental effects that Deming mentions can be avoided.

CHAPTER 3: RESEARCH METHODOLOGY

OVERVIEW

The distributed work environment is different from the typical work environment because employees, with the enabling power of information technologies, can communicate with their peers, subordinates, and supervisors electronically regardless of geographical barriers. They need not locate at the same place in order to work together. Both employees and employers in the distributed work environment may work in geographically separate locations; therefore, a new set of problems and challenges will emerge. Managers in the distributed work environment will be facing issues and problems that are unique and unprecedented.

One of the issues that will emerge is how to ensure and improve the performance of employees who cannot be supervised closely because of geographical distance (Grantham and Nichols 1994; Geber 1995). Performance improvement of distributed employees, especially those who perform knowledge work, will be difficult. Imagine how hard it is to define and improve knowledge work in a typical organization. Performance improvement will be harder when supervisors and employees do not work at the same location. This issue is even more complicated for managers in the distributed work environment because much work in the distributed work environment may be classified as knowledge work. Knowledge workers lend themselves most easily to distributed work (Grantham and Nochols 1994; Coates 1997).

What makes performance improvement of knowledge work challenging is that managers and industrial engineers have not invented or defined tools and methods to deal with white collar work or knowledge work as effectively as they have with blue collar work. Lehrer (1983) mentions that the most significant barrier to enhancing knowledge work performance is the lack of adequate conceptual framework for dealing with the many facets of the problem. Lehrer mentions that although there exist some useful and proven approaches for improving knowledge work performance, more research in this area is needed.

This research is intended to address Lehrer's (1983) suggestion—to address and provide a better understanding of the issues of knowledge work performance—more specifically, performance improvement in the distributed work environment. In this research, performance improvement of knowledge work is narrowed to the task level. One way to improve task performance is to identify, study, and improve the factors that may affect task performance in the distributed work environment. Based on an extensive review of the body of knowledge (Chapter 2), two factors, feedback and goal setting, have been chosen to study in thorough detail because of the strong evidence of the effects of these two components. The positive effects of feedback and goal setting are commonly accepted in the literature. The two factors have been extensively studied, both individually and collectively, in the existing literature (about the traditional work environment).

This research seeks to answer the following main research question: *What effects do feedback and goal setting have on knowledge work in the distributed work environment?* To help answer the main research question, this research question is broken down into three related sub-questions. Taken together, the three sub-questions will examine the effects of feedback and goal setting on task performance in the distributed work environment. The main question and its three related sub-questions are summarized in Table 3.1.

Table 3.1
Main question and three related sub-questions for this research

RESEARCH QUESTION	DESCRIPTION
Main Question	What effects do feedback and goal setting have on knowledge work in the distributed work environment?
Sub-Question #1	▪ What effects does feedback have on knowledge work in the distributed work environment? – Feedback versus no feedback – Task feedback versus no feedback – Task feedback with comparisons with others versus task feedback
Sub-Question #2	▪ What effects does goal setting have on knowledge work in the distributed work environment?
Sub-Question #3	▪ What effects does the interdependence of feedback and goal setting have on knowledge work in the distributed work environment? – Both versus Either † – Both/Either versus Neither †

† Both = both feedback and goal setting
† Either = either feedback or goal setting
† Neither = neither feedback nor goal setting

EXPERIMENTAL DESIGN

The experimental design of this research is a 3 X 2 (feedback X goal setting) factorial design. The two levels of the first independent variable—feedback—are no feedback, task feedback, and task feedback with comparisons with others. The two levels of the second independent variable—goal setting—are no goal setting and goal setting. Dependent variables in this research are task performance and feedback and goal beneficial effects. A graphical representation of the experimental design is shown in Table 3.2.

Table 3.2
Experimental design

	GOAL SETTING	
FEEDBACK	No Goal Setting	Goal Setting
No Feedback	Cell #1	Cell #2
Task Feedback	Cell #3	Cell #4
Task Feedback with Comparisons with Others	Cell #5	Cell #6

The experimental design shown in Table 3.2 is used to investigate the effects of feedback and goal setting on task performance and feedback and goal beneficial effects in this study, addressing the research questions discussed in Chapter 1. The relationship between the experimental design and the research sub-questions is as follows.

FEEDBACK

- What are the differences in task performance (Research Question 1.1.1) and in feedback beneficial effects (Research Question 2.1.1) on knowledge work between workers who receive any form of feedback on how well they and/or others are performing their task (i.e., task feedback and/or task feedback with comparisons with others) and those who receive no feedback in the distributed work environment?
  [Cells #3, 4, 5, 6 versus cells #1, 2]
- What are the differences in task performance (Research Question 1.1.2) and in feedback beneficial effects (Research Question 2.1.2) on knowledge work between workers who receive feedback on how well they are performing their task (i.e., task feedback) and those who receive no feedback in the distributed work environment?
  [Cells #3, 4 versus cells #1, 2]
- What are the differences in task performance (Research Question 1.1.3) and in feedback beneficial effects (Research Question 2.1.3) on knowledge work between workers who

receive feedback on how well they and others are performing (i.e., task feedback with comparisons with others) and those who receive feedback on how well they are performing their task (i.e., task feedback) in the distributed work environment?
[Cells #5, 6 versus cells #3, 4]

GOAL SETTING

- What are the differences in task performance (Research Question 1.2.1) and in goal beneficial effects (Research Question 2.2.1) on knowledge work between workers who receive goals and those who do not receive goals in the distributed work environment?
[Cells #2, 4, 6 versus cells #1, 3, 5]

FEEDBACK AND GOAL SETTING

- What are the differences in task performance (Research Question 1.3.1) and in feedback and goal beneficial effects (Research Question 2.3.1) on knowledge work between workers who receive both feedback and goals and those who receive either feedback or goals in the distributed work environment?
[Cells #4, 6 versus cells #2, 3, 5]
- What are the differences in task performance (Research Question 1.3.2) and in feedback and goal beneficial effects (Research Question 2.3.2) on knowledge work between workers who receive feedback and/or goals and those who receive neither feedback nor goals in the distributed work environment?
[Cells #2, 3, 4, 5, 6 versus cell #1]

MATERIALS AND SOFTWARE

THE AUCTION TASK (VERSION 1.1.15)

The Auction Task is a simulation exercise for bidding for several pieces of telecommunications property. It was developed, as a training tool for a telecommunications company's bidding personnel, under the supervision of Dr. Robert T. Sumichrast, Department of Management

Science, Pamplin School of Business, Virginia Tech. A short description of the Auction Task[2] is as follows:

> *This software allows [the company] to evaluate orbital slots within the context of an auction as might be held by the FCC. In addition, the software performs a sequential auction of orbital slots in which [the company's] executive bids against simulated opponents from companies likely to participate in such an auction. The software includes several scenarios which may be selected to simulate auctions with different players, slots to be auctioned, financial parameters, and market conditions (SAWBUC 1997, 1).*

With this task, the subjects of this research were asked to compete with simulated competitors in the bidding process. They had to make several decisions on many issues, including: 1) what properties to bid, 2) when to bid or not to bid, 3) how much to bid, and 4) when to accept or decline the property if it was won. The quality of each subject's decision was reflected in the *total amount of money (or credit) earned* in the bidding process. The primary objective of this task was to win as many properties at the minimum cost possible. The secondary objective of this task was to make other competitors lose as much money as possible. Each subject participated in three auctions (i.e., three problems). Each subject was instructed to finish each auction as quickly and as accurately as possible. Time to finish each auction and total money earned in the bidding process were recorded.

The version of the Auction Task used in this experiment was 1.1.15. Modifications were made to this version to make it suitable for the experiment, as shown in Appendix A. The screen captures of the Auction Task after the modifications are also shown in Appendix A.

MICROSOFT NETMEETING 2.0 AND NOTEPAD 4.0

Microsoft NetMeeting 2.0 is software that allowed the researcher to share applications (i.e., the Auction Task and Notepad) running on his computer with the subject over the network. The researcher and the subject could review the same data or information, see the actions of the other member, and work on the same applications when necessary. Besides being able to

[2] The Auction Task and its manual (SpAIS Manual) were used with permission from Dr. Robert T. Sumichrast.

collaborate on the same tasks, the two parties were also able to see each other in real-time over the network through NetMeeting and video cameras.

Microsoft Notepad 4.0 was used with NetMeeting to present the summary of task performance to the subject after each auction had been completed. NetMeeting enabled the researcher to present information to the subject on a notepad over the network. Notepad was used to present the following information to the subjects who received task feedback: 1) total credit from money saved, 2) total credit from penalty, 3) total credit from driving up the competitors' costs, and 4) a grand total of credit earned. An example of a notepad used to present task feedback to the subjects during the experiment is shown in Appendix A.

MICROSOFT EXCEL 7.0

Three Microsoft Excel spreadsheets were developed by the researcher to compute task performance of the three auctions performed by each subject. The spreadsheets were created in a way that each subject could maximize his simulated money, which represented task performance, in three different ways. *First*, the subject should win as many properties at the minimum cost possible. Each dollar saved by the subject when winning a property was credited to the subject's task performance. *Second*, the subject should try to make the competitors pay as much penalty as possible, and he should try not to be penalized himself. The penalty paid by the competitors was credited to the subject's task performance, while the penalty paid by the subject was a debit to the subject. *Last*, the subject should try to drive up the competitors' costs. For every dollar more the competitors had to pay for their properties, the subject received 25% (or, in one auction, 50%) credit. An illustration of the spreadsheet developed for the experiment is shown in Appendix A.

FACILITIES AND EQUIPMENT

FACILITIES

This experiment simulated the distributed work environment; therefore, the subject and the researcher were required to be in geographically separate locations with no direct visual or auditory contacts between the two persons. The Macroergonomics and Group Decision Systems Laboratory at Virginia Tech was used to conduct the experiment. This lab was arranged so that the subject and the researcher were situated in geographically separate locations when the experiment began. The layout of the facilities used is shown in Figure 3.1.

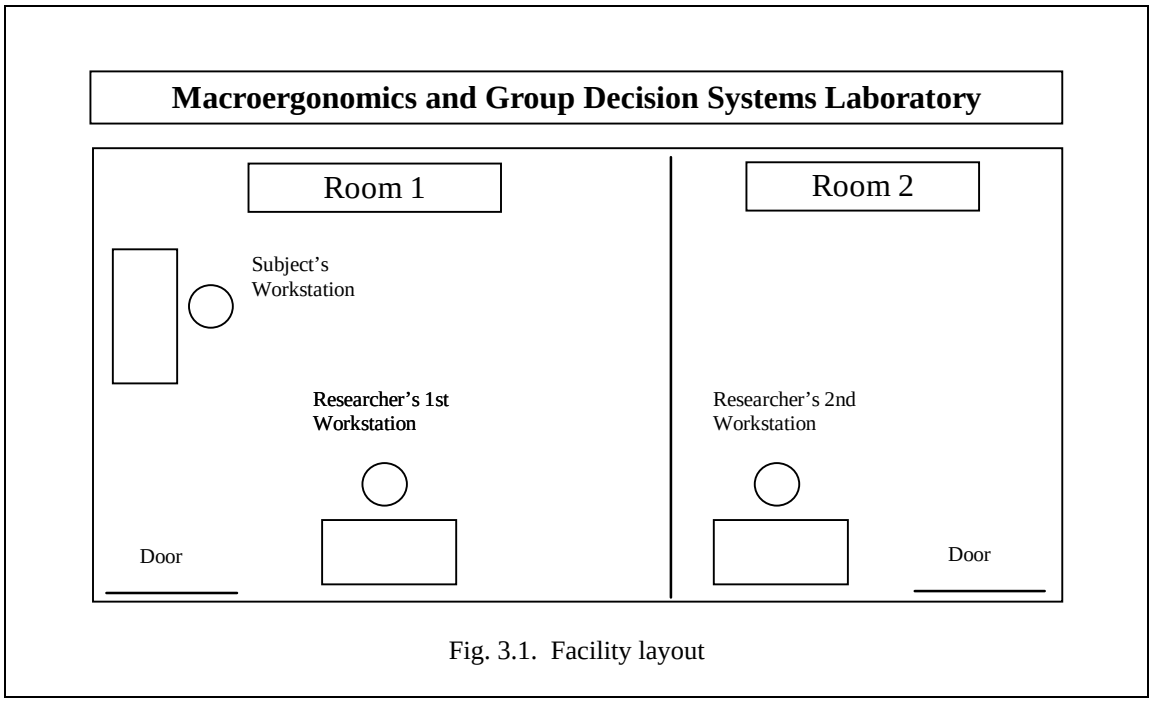


Fig. 3.1. Facility layout

During the training session, both the subject and the researcher were in the same location (Room 1). After the training session ended, the researcher left the room and went to a different location (Room 2). The actual experiment took place while the subject and the researcher were situated in separate rooms, and no direct physical contact was made.

EQUIPMENT

To simulate a distributed work environment, three sets of networked personal computers, video cameras, and Microsoft NetMeeting 2.0 were used to electronically connect the subject with the researcher. This equipment enabled video communication and application sharing between the subject and the researcher. Two telephone sets with speaker phones were used for audio communication. A notebook computer was also used by the researcher in Room 2 to compute task performance. A clock and a calculator were provided to the subject during the experiment. An audio tape recorder was used to record the subject's audio comments after the Auction Task had been finished. A stop watch was used to record the time. Figure 3.2 shows the three workstations used in the experiment.

Fig. 3.2. *Top*, the subject's workstation; *bottom left*, the researcher's first workstation; *bottom right*, the researcher's second workstation

SUBJECTS

Subjects for this study were recruited from the pool of undergraduate and graduate students at Virginia Tech. This experimental design has six cells (Table 3.2), and each cell has six replications; therefore, the actual experiment required a total of 6 X 6 = 36 subjects. Subjects

were randomly assigned to different treatment conditions. The required characteristics for qualified subjects are shown in Table 3.3.

Table 3.3
Subject requirements

CRITERIA	REQUIREMENTS
Age	College students. Age varied from 18 to 40.
Sex	No restriction (male or female).
Education	Undergraduate or graduate students from business, engineering, science, and other related disciplines.
Skills	Subjects must possess some analytical skills to perform the task. An oral interview was held to gain some general idea of the subjects' background and to identify whether the subjects were comfortable with the task. After the training session of the experiment, subjects who did not understand the task (i.e., did not have a basic understanding of the task and lost simulated money in the auction) were dismissed.
Computer Literacy	Minimum knowledge of the Windows environment was required.
Nationality	No restriction; however, English was used for communications. Fluency in English was required.
Task Familiarity	It was not desirable for subjects to be familiar with the Auction Task prior to the experiment. A question was asked whether the subject had been exposed to the Auction Task. If the subjects had been exposed to the Auction Task, they were dismissed.

Of all the prospective subjects, only one was not qualified as a true subject. After the training session, this subject did not possess a basic understanding of the task. The subject failed during the detailed screening period by incurring a loss of $53.1 million of simulated money. This subject was not used in the actual experimental process.

PILOT STUDY

A laboratory pilot study was conducted prior to the actual experiment. Six subjects participated in the pilot study. The required characteristics for the pilot study's subjects were the same as those required for the true subjects and are shown in Table 3.3. The laboratory pilot study was conducted to help the researcher become familiar with the experimental protocol before the

actual study began. The data collected during the pilot study were used as benchmarking information. In addition, the pilot study was conducted to ensure the actual experimental procedures were well planned and executed.

The data collected during the pilot study were used as benchmarking information. The true subjects received this information for comparisons. Table 3.4 shows the results obtained from the pilot study.

Table 3.4
Summary of the results from the pilot study

Subj.	Goal Setting †	Feedback	Money Earned ($Million)		
			Test A	Test B	Test C
#1	With Goal Setting	Task feedback	$105.00	$127.93	$214.50
#2	With Goal Setting	Task feedback with comparisons	$32.02	$144.30	$238.70
#3	No Goal Setting	Task feedback with comparisons	$67.72	$191.90	$161.71
#4	With Goal Setting	Task feedback with comparisons	-$31.57	$147.21	$207.48
#5	With Goal Setting	No feedback	$85.47	$171.03	$129.55
#6	No Goal Setting	No feedback	$59.44	$51.64	-$50.80
Summary					
Highest scores (used as top scores)			$105.00	$191.90	$238.70
Second highest scores (used as goals)			$85.47	$171.03	$214.50
Third highest scores (used as average scores)			$67.72	$147.21	$207.48

† Subjects #1 and #2 were asked to set their own goals. During the pilot study, however, the procedure was changed from self-set goals to assigned goals. Subjects #4 and #5 were assigned goals.

Three sets of information from the pilot study were later used in the actual study (see Table 3.5). The first set of information was the highest score (or money earned) of each auction. This set of information, along with the strategy used by the pilot subject in bidding, was given to the subjects who received information about others' performance. In addition, the subjects who received information about others' performance also received the average score of each auction. Because it was necessary to ensure that the performance benchmark would not be consistently below the true subjects' performance, it was necessary to manipulate this information (by

raising the standard of the performance benchmark) before giving it to the true subjects. As a result, the third highest score was used as the average score even though it was possible to use the fourth highest score or the average of the third and fourth highest scores to represent this information.

Table 3.5
A summary of information from the pilot study used in the actual experiment

Summary	Test A	Test B	Test C
Information about others' performance:			
Highest scores (used as top scores)	$105.00	$191.90	$238.70
Credit from money saved	$18.91	$100.97	$120.70
Credit from penalty	$51.18	$82.56	$110.30
Credit from driving up competitors' costs	$34.91	$8.37	$7.76
Strategy used	(Bid 1 only)	(Bid 1 and 2)	(Bid 1 and 3)
Third highest scores (used as average scores)	$67.72	$147.21	$207.48
Goals:			
Second highest scores (used as goals)	$85	$170	$215
Suggested strategy	(Bid 1 only)	(Bid 1 and 2)	(Bid 1 and 3)

Another set of information used in the actual study was the second highest score. This information, along with the strategy used by the pilot subject in bidding, was given as goals to the subjects who received goals. The rationale behind using this set of information was that the literature pointed out that goals should be specific and difficult (or high). The specificity was not an issue since task performance was quantitative and specific. In this data set, only two data were qualified as high: the highest and the second highest scores. Because the highest score had already been used to represent the top score, the second highest score was, therefore, used to set goals. Given the available data, this was a practical decision because the highest score might have been too high. As a result, goals for Test A, Test B, and Test C problems were set as $85 million, $170 million, and $215 million, respectively (the numbers were rounded).

PROCEDURE

PREPARATION PROCESS

Before each experiment trial was conducted, some preparations needed to be done in advance. For example, the sequence of the three simulated auctions (i.e., Test A, Test B, and Test C) needed to be determined. In the study, the sequence was a balanced design. (Included in Appendix B is the Planned Sequence of the subjects in the study.) In addition, to make each experiment trial run smoothly and consistently, the Preparation Checklist and the Process Checklist were used prior to and during the experiment. (Both of them are included in Appendix B.)

OVERVIEW OF THE LABORATORY EXPERIMENT

Thirty-six subjects participated in the actual experiment. Participation in this experiment was fully voluntary, and the subjects were reimbursed $10 for their time. The experimental process started after the subject entered the room and the researcher gave a brief introduction to the Auction Task. The subject signed the informed consent form and completed the Pre-Experiment Questionnaire. The initial screening process then began. If the subject passed the initial screening process, the training session would continue. After the training session, the subject proceeded to the detailed screening process. If the subject passed the detailed screening process, the researcher would begin the experimental process to collect task performance data (*quantitative* data[3]). After the experiment was completed, the Post-Experiment Questionnaire was administered to collect *semi-quantitative* data, which included feedback and goal utilization and beneficial effects. The retrospective report was administered to collect the same information *qualitatively* while the subject was filling out the Post-Experiment Questionnaire. The process for handling the subjects in this experiment is shown in Figure 3.3. The following sections explain the experimental procedure in detail.

[3] Three types of data were collected in the experiment: quantitative, semi-quantitative, and qualitative data. This classification is used by Pappas and Remer (1985).

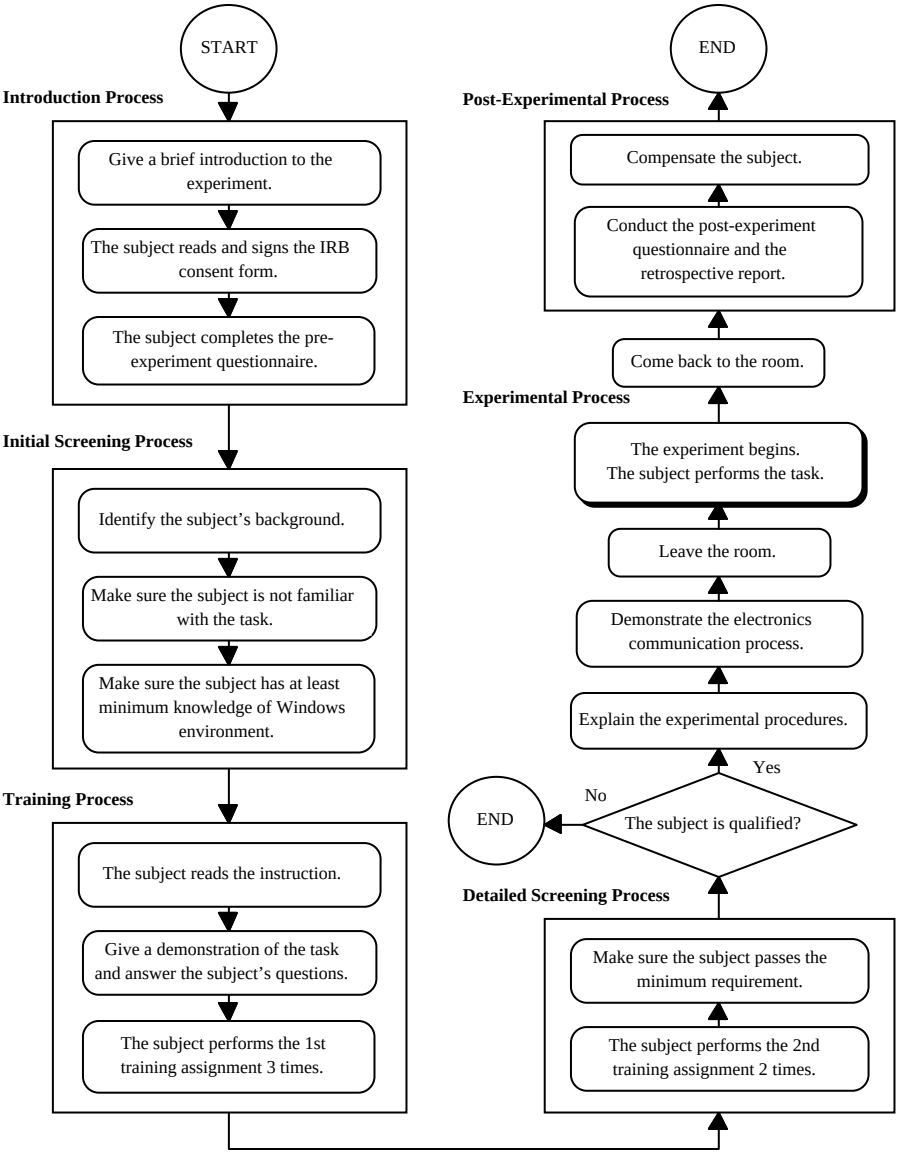


Fig. 3.3. Experimental procedure

INTRODUCTION PROCESS

The subject met with the researcher in Room 1. The researcher led the subject to the subject's own workstation in Room 1 (see Figure 3.1). The researcher briefly described the task to the subject. (See Appendix C for the introduction script.) If the subject felt comfortable to continue, the subject would fill out the informed consent form and complete the Pre-Experiment Questionnaire (see Appendix C). The initial screening process then began.

Initial Screening Process

The initial screening process was conducted to identify whether a prospective subject was qualified as a true subject. The following steps were conducted in the initial screening process:

1. Only subjects from business, engineering, science, or other related disciplines were invited (by advertisement or personal contact). If a potential subject came from a non-science related field, that candidate needed to explain why he might be qualified (e.g., identify useful courses taken, skills possessed, or past experiences that were related to the experiment).
2. The Auction Task was shown to the subject. The subject was asked whether he had been exposed to the task before. If the subject had been exposed to the task before, he would be dismissed.
3. Each subject was asked if he was familiar with the Windows environment. Subjects not familiar with the Windows environment were dismissed.

Training Process

The subjects who passed the initial screening process were qualified to proceed to the training process. The following steps were conducted in the training process:

1. The subject read the instructions of how to perform the Auction Task. (The instructions for the task are included in Appendix C.) Together with the instructions, a copy of the Auction Task's screen capture was given.
2. After the subject had finished reading the instructions, the researcher demonstrated how to perform the most fundamental functions of the task. (The demonstration list was included at the end of the Auction Task instructions.) The researcher answered any questions the subject had.
3. The cost data sheet for the first and second assignments (i.e., Train2Prop and Train3Prop, respectively) was given to the subject. (All cost data sheets are included in Appendix C.) The subject was asked to perform the first training assignment three times. If the subject

did not feel comfortable with the task at any time, he had the freedom to withdraw from the experiment.

Detailed Screening Process

The subjects who were comfortable with the task advanced to the detailed screening process. The following steps were conducted in the detailed screening process:

1. At this stage, the subject was asked to perform the second training assignment (i.e., Train3Prop) two times. The first trial of the assignment was intended to familiarize the subject with the assignment. After the subject had finished the first trial, the researcher informed the subject that the second trial would be used as the screening test and the subject should perform the task as accurately as possible. No time restriction was given.
2. After the second trial period of the assignment, the subjects who did not understand the task (i.e., did not possess basic understandings of the task and did not make a simulated profit in the bidding process) would be dismissed.
3. Those who made a simulated profit in the second trial were qualified as the subjects. The screening period ended at this point, and the qualified subjects continued the pre-experimental process.

Pre-Experimental Process

Subjects who passed the screening process were qualified to continue. The researcher explained the experimental procedures to the subject in detail (see Appendix C). The experimental procedures provided details on what activities the subject would encounter during the actual experiment. Because different subjects were assigned different experimental treatments of feedback and goal setting, different subjects would receive different experimental procedures. If the subject understood the experimental procedures, the subject was given the cost data sheets for the three auctions arranged in the sequence the subject would perform them.

After the experimental procedures had been explained, the researcher demonstrated the electronics communication process using NetMeeting. The demonstration was done

electronically, connecting the researcher's 1st workstation with the subject's workstation. The demonstration included how to start/stop receiving and sending video, how to start/stop collaboration on a shared program, and how to take control of a shared program.

Until now, the researcher and the subject had been in the same room and communicated directly with each other. If the subject was ready to begin the experimental process, the researcher would leave the room at this point. The subject was told to prepare for his first auction assignment while he was waiting for the researcher to contact him. The subject was not told the exact location of the researcher.

EXPERIMENTAL PROCESS

The researcher went to his 2nd workstation in Room 2 (Figure 3.1) and called the subject to begin the experiment. From this point on, both of them were in separate locations and communicated with each other by NetMeeting and telephone speaker phones. Each subject received different treatments and went through slightly different experimental processes. A graphical representation of the experimental process is shown in Figure 3.4.

As shown in Figure 3.4, the treatments of goal setting, task feedback, and comparisons with others were used when applicable. For example, the subjects with the "no goal-setting" and "no feedback" treatments performed the Auction Task without receiving goals or feedback. The subjects with the "goal-setting" and "task feedback with comparisons with others" treatments performed the following sequential activities: received goals, carried out the task, used/received task feedback, and received information of others' performance.

The "no goal-setting" subjects did not receive goals for their task, but the "goal-setting" subjects were given goals before each auction. The goals included task performance goals and suggested strategies as to which properties they should try to win in each auction. Task performance goals, along with suggested strategies (which properties to bid), were assigned to

the subjects on the cost data sheets.[4] (The cost data sheets for the experiment are included in Appendix C. The information used to represent goals is shown in Table 3.5.)

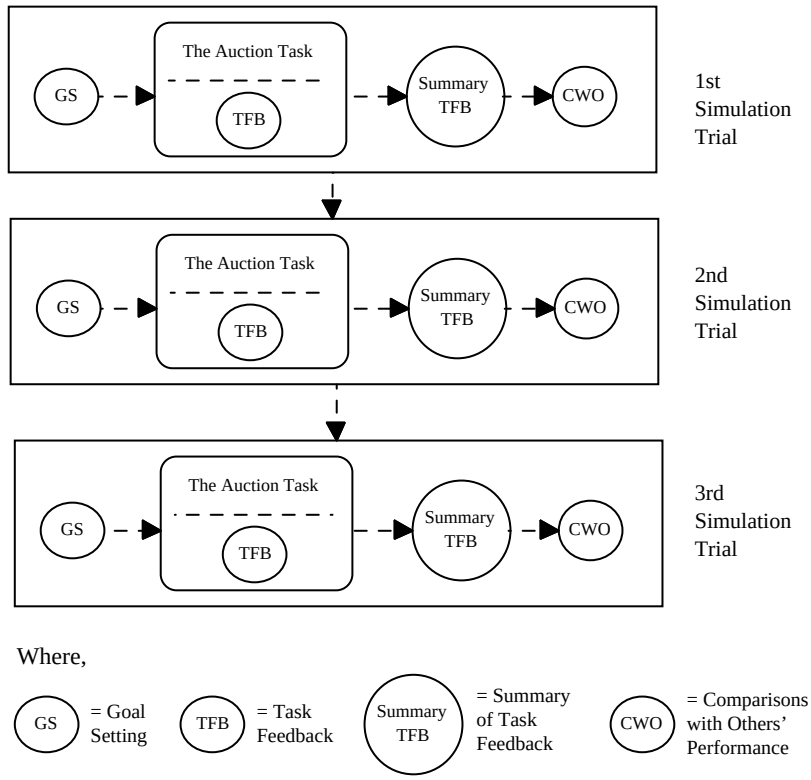


Fig. 3.4. Experimental Process

At this point, the subjects would start carrying out their assigned auction. Although no time restriction was imposed, the subjects were instructed that they should finish each simulated auction as quickly and as accurately as possible. The subjects were timed during the experiment.

[4] Different goals conflict with one another. The goal-setting process may be improved by making sure that goals are consistent (Griffin 1990). During the experiment, specific and difficult goals were assigned to the subjects to make sure that the subjects received the same, consistent goals.

During the bidding process, the subjects under the “task feedback” and “task feedback with comparisons with others” treatments received information about their own performance directly from the task. Task feedback, shown on the screen, provided them the following information: properties won, money spent, and penalty incurred by the subjects as well as the competitors. In addition, a summary of their task performance was given by the researcher at the end of each auction. The summary provided a grand total of credit earned, which was broken down into credit from money saved, credit from penalty, and credit from driving up the competitors' costs. The summary was presented to them through the use of NetMeeting and Notepad. (See Appendix A for an example of task feedback summary.)

The “task feedback with comparisons with others” subjects would then receive information about other people’s performance immediately after they had received task feedback information. The researcher told this information to the subject over the telephone, and it consisted of the following information: 1) the average score, 2) top score, broken down into credit from money saved, credit from penalty, and credit from driving up the competitors' costs, and 3) properties won by the top performer. The information used to represent information about others’ performance (benchmarking information) is shown in Table 3.5.

The “no feedback” subjects were given no feedback. The “no feedback” subjects could not assess task feedback from their computer screen. Their task feedback information had been disabled. (In Appendix A, see the screen captures of the Auction Task for the subjects who received task feedback and for those who did not.) At this point, all subjects would proceed into the next simulated auction. The experiment ended when the subjects completed three simulated auctions (problems).

POST-EXPERIMENTAL PROCESS

When the subject had completed three simulated auctions, the researcher came back to the subject’s workstation and asked the subject to complete the Post-Experiment Questionnaire (see Appendix C). The retrospective report was administered to collect the same information while the subject was filling out the Post-Experiment Questionnaire. The subject was asked to

elaborate on the reason for answering each questionnaire item. Specifically, the subject was asked the question "Why did you select this score?"

Additional questions were asked at the end of the Post-Experiment Questionnaire: 1) "What would have helped you perform better in the bidding: task feedback, information about others' performance, or goals?" 2) "What do you think helped you the most in the bidding: task feedback, information about others' performance, or goals?" and 3) "Why?" The first question was administered to the subjects who did not have all of these items during the experiment (i.e., Cell #1 in Table 3.2). The second question was administered to the subjects who had all of these items during the experiment (i.e., Cell #6 in Table 3.2). When necessary, why-type questions were asked only when clarification was needed.

The conversation between the subject and the researcher was recorded for further analysis. After the subject had finished the Post-Experiment Questionnaire, the researcher compensated the subject for his time in the experiment, and the experiment ended.

DATA COLLECTION

INDEPENDENT VARIABLES (TREATMENTS)

The effects of two variables were studied in this research: feedback and goal setting. Three levels of feedback were examined: 1) no feedback, 2) task feedback, and 3) task feedback with comparisons with others, respectively. With regard to the second variable, goal setting, two levels were used for this treatment: no goal setting and goal setting. (Some may argue that the terms "specific goals" and "vague goals" should be used instead because, knowingly or unknowingly, each individual has a "vague" goal that he has to accomplish his task at his best. However, the terms "goal setting" and "no goal setting" have clear-cut meanings and have been used more often in the literature.)

DEPENDENT VARIABLES (MEASURES)

The level of analysis of this research was at the individual level. The dependent variables for this research were 1) task performance and 2) feedback and goal beneficial effects. Because the main interest of this research was related to task performance, only task performance data were used in hypothesis testing. Data from feedback and goal beneficial effects were used for exploratory purposes; no hypotheses were made about these data.

Task Performance

Task performance in this research was measured *quantitatively* by the total amount of money (or credit) earned in the bidding process. In this experiment, financial figures of money spent and penalties incurred by the subject as well as by the competitors were used to compute the total amount of money earned. As mentioned previously, three Excel spreadsheets were developed to compute task performance for the three simulated auctions.

Feedback and Goal Beneficial Effects

The literature identifies the positive effects of feedback on task performance as essential for error correction, task learning, motivation, and satisfaction (Greller and Herold 1975; Ilgen et al. 1979; Busby 1997). The literature also identifies the positive effects of goals on task performance as essential for task learning, motivation, and commitment (Locke 1968; Latham and Baldes 1975).

At the end of the experiment, all subjects were asked to complete the Post-Experiment Questionnaire. Part of the Post-Experiment Questionnaire was designed to measure the effects that feedback and goals might have on the subjects and to make sure that the data were quantifiable. (The data would become *semi-quantitative*.) Specific questions were asked in relation to the error correction, task learning, motivation, commitment, and satisfaction criteria.

The format of questions was adapted from instruments used by Greller and Herold (1975), Latham et al. (1978), Yukl and Latham (1978), Pitt et al. (1995), Thong and Yap (1995), and Van Aken (1995). On a seven-point Likert-type scale (in which 1 = strongly disagree, 2 =

disagree, 3 = slightly disagree, 4 = indifference, 5 = slightly agree, 6 = agree, and 7 = strongly agree), the subjects were asked to rate the questionnaire items shown in Table 3.6.

Table 3.6
The semi-quantitative measurement of feedback and goal beneficial effects

ITEMS	QUESTIONNAIRE
▪ Error Correction (Busby 1997)	▪ I knew how to correct errors in strategy as the experiment progressed.
▪ Task Learning (Ilgen et al. 1979)	▪ I knew how to perform better as the experiment progressed.
▪ Motivation (Greller and Herold 1975)	▪ I thought the task was motivating.
▪ Commitment (Latham and Baldes 1975)	▪ I was committed to the task.
▪ Satisfaction (Greller and Herold 1975)	▪ I thought the task was satisfying.

While the subject was rating each questionnaire item, the retrospective report was administrated to the subject. Ericsson and Simon (1984) describe the retrospective report as one of the two forms of verbal reports (i.e., concurrent and retrospective verbal reports) that are claimed as being the closest reflection of the cognitive processes. The subjects' responses to the retrospective report offered insight into the effects of feedback and goals and ensured that the measurement would be more complete. (The data would become *qualitative*.) The semi-quantitative and qualitative measurements addressed two measures of the same construct.

EXPLORATORY DATA

Two other types of data were collected at the end of the experiment for exploratory purposes. They were feedback and goal utilization and demographic information.

Feedback and Goal Utilization

The literature mentions that some individuals may decide to use feedback and/or goals when performing their tasks while others may not. Because feedback and goal setting can be interrelated processes, receiving feedback can influence how individuals use subsequent goals (Yukl and Latham 1978), and having goals can also influence how individuals use feedback

(Ilgen and Moore 1987). The purpose of this measurement was to understand how the subjects utilized feedback and/or goals. The measures investigated 1) the use of feedback and goals and 2) the perceived value of feedback and goals.

Part of the Post-Experiment questionnaire was designed to measure feedback and goal utilization. (The data would become *semi-quantitative*.) Specific questions were asked in relation to the use and the perceived value of task feedback, information about others' performance, and goals. The format of questions was adapted from instruments used by Greller and Herold (1975), Latham et al. (1978), Yukl and Latham (1978), Pitt et al. (1995), Thong and Yap (1995), and Van Aken (1995). On a seven-point Likert-type scale, the subjects were asked to rate the questionnaire items shown in Table 3.7.

While the subject was rating each questionnaire item, the retrospective report was administrated to the subject. The subject's responses to the retrospective report offered insight into why, why not, and how the subject used feedback and/or goals and ensured that the measurement would be more complete. (The data would become *qualitative*.) The semi-quantitative and qualitative measurement addressed two measures of the same construct.

Table 3.7
The semi-quantitative measurement of feedback and goal utilization

ITEMS	QUESTIONNAIRE
Use of feedback and goals (Yukl and Latham 1978; Ilgen and Moore 1987)	▪ I used task feedback (information about my performance) when bidding in the auction. ▪ I used the information about others' performance when bidding in the auction. ▪ I tried to achieve the goals.
Perceived value of feedback and goals (Ilgen and Moore 1987; Locke et al. 1981)	▪ Task feedback helped me perform better. ▪ Information about others' performance helped me perform better. ▪ Having goals helped me perform better.

Demographic Information

During the experiment, demographic information of the subjects; such as, age, sex, QCA, major of study, level in school, and familiarity with the task prior to the experiment, was collected. No hypotheses were made for these factors. However, if any of these factors turned out to have mediating effects on feedback and goal setting, the results from the study would become a valuable resource for future research. The Pre-Experiment Questionnaire used to collect demographic information is shown in Appendix C.

DATA ANALYSIS

TASK PERFORMANCE

As mentioned previously, the *quantitative* measure of task performance in this study is the total amount of money (or credit) earned in the bidding process. The main effects of feedback and goal setting on task performance were analyzed using a two-way analysis of variance (two-way ANOVA). In addition, the interaction effects between feedback and goal setting were analyzed. Appropriate post hoc tests were conducted in relation to the research hypotheses. The statistical software package, SAS 6.12 for Windows, was used to analyze these data.

FEEDBACK AND GOAL BENEFICIAL EFFECTS

The *semi-quantitative* data derived from the Post-Experiment Questionnaire were intended to address the beneficial effects of feedback and goals (i.e., error correction, task learning, motivation, commitment, and satisfaction). Similar to the analysis of task performance, the main effects of feedback and goal setting and their interaction effects on feedback and goal beneficial effects were analyzed, using a two-way analysis of variance (two-wayANOVA). Appropriate post hoc tests were conducted in relation to the research questions. The *qualitative* data, derived from the retrospective report, were intended to gain some understanding of the subjects' cognitive process. The qualitative data were transcribed, and the data were used for exploratory purposes. The key findings were used to support the discussions in Chapter 5.

EXPLORATORY DATA

The *semi-quantitative* data for feedback and goal utilization derived from the Post-Experiment Questionnaire were intended to identify 1) the use of feedback and goals and 2) the perceived value of feedback and goals. A Pearson's correlation analysis was performed to identify whether there was any correlation between the subjects' use of feedback and goals and their perceived values of feedback and goals. Another Pearson's correlation analysis was performed to identify whether there was any correlation between task performance and the subjects' utilization of feedback and goals. A one-way analysis of variance (one-way ANOVA) was performed to identify whether feedback utilization affected goal utilization, and vice versa. The content of the *qualitative* data, derived from the retrospective report, was transcribed and used to support the discussions in Chapter 5.

A Pearson's correlation analysis was performed to identify whether there was any correlation between task performance and age, QCA, education level, and familiarity with the auction of the subjects. In addition, two-tailed t-tests were performed to identify whether sex or major of study had any effects on task performance.

CHAPTER 4: RESULTS

OVERVIEW

This research seeks to answer the following main research question: *What effects do feedback and goal setting have on knowledge work in the distributed work environment?* To address this main research question, data on task performance (quantitative data) and feedback and goal beneficial effects (semi-quantitative data) were collected during the laboratory experiment. The data were then analyzed, and the results are presented in this chapter.

The purpose of this chapter is to present the results from quantitative and semi-quantitative data analysis performed in relation to the research questions and the research hypotheses described in Chapter 1. To make a connection between the results from the analysis and the research questions and the research hypotheses, the graphical representation of the experimental design previously shown as Table 3.2 in Chapter 3 is redrawn in Table 4.1.

Table 4.1
Experimental design

	GOAL SETTING	
FEEDBACK	No Goal Setting	Goal Setting
No Feedback	Cell #1	Cell #2
Task Feedback	Cell #3	Cell #4
Task feedback with Comparisons with Others	Cell #5	Cell #6

The interrelationship between research questions/hypotheses and the design in Table 4.1 is shown in Table 4.2.

Table 4.2
The interrelationship between research questions/hypotheses and the design experiment

Research Questions/ Research Hypotheses	Comparisons in Relation to the Study	Comparisons in Relation to the Experimental Design
RQ 1.1.1, RQ 2.1.1 RH 1.1.1	Feedback vs. No Feedback	Cells #3, 4, 5, 6 vs. Cells #1, 2
RQ 1.1.2, RQ 2.1.2 RH 1.1.2	Task Feedback vs. No Feedback	Cells #3, 4 vs. Cells #1, 2
RQ 1.1.3, RQ 2.1.3 RH 1.1.3	TFB + CWO † vs. Task Feedback	Cells #5, 6 vs. Cells #3, 4
RQ 1.2.1, RQ 2.2.1 RH 1.2.1	Goal Setting vs. No Goal Setting	Cells # 2, 4, 6 vs. Cells 1, 3, 5
RQ 1.3.1, RQ 2.3.1 RH 1.3.1	Both vs. Either ††	Cells #4, 6 vs. Cells #2, 3, 5
RQ 1.3.2, RQ 2.3.2 RH 1.3.2	Both/Either vs. Neither ††	Cells # 2, 3, 4, 5, 6 vs. Cell #1

† TFB + CWO = task feedback with comparisons with others
†† Both = both feedback and goal setting
†† Either = either feedback or goal setting
†† Neither = neither feedback nor goal setting

This chapter begins with an overview of the statistical information of the subjects who participated in this experiment. After the overview of the subjects, the standardization procedure of task performance is explained. The chapter then continues with the presentation of the results from the analysis. The presentation starts from the central part of this research, task performance, in relation to Research Question 1 and its research hypotheses. Next, the results from the analysis of feedback and goal beneficial effects are presented in relation to Research Question 2, which has no related hypotheses. Next, the results from the analysis of feedback and goal utilization are presented. Last, the results from additional exploratory analysis related to this study are presented. The conclusions from these results are presented in Chapter 5, and the detailed statistical results are shown in Appendix D.

SUBJECT CHARACTERISTICS

Thirty-six trials of the experiment were conducted in the Macroergonomics and Group Decision Systems Laboratory at Virginia Tech from the beginning of April 1998 to the middle of April 1998. Thirty-six subjects participated in this experiment. Demographic information of all the subjects was collected before the beginning of each experimental trial using the pre-experimental questionnaire. The characteristics of the 36 subjects are summarized in Table 4.3.

Table 4.3
Subject Characteristics

Age	Frequency	Sex	Frequency	Major	Frequency
≤ 20	3	Female	14	Engineering	27
21 - 25	16	Male	22	Others	9
26 - 30	12				
31 - 35	2				
36 - 40	3				

Education Level	Frequency	QCA	Frequency	Familiarity with Auction Concepts	Frequency
Freshman (1)	0	≤ 2.0	1	None (1)	5
Sophomore (2)	3	2.01 - 2.50	2	Very Little (2)	5
Junior (3)	1	2.51 - 3.00	3	Little (3)	15
Senior (4)	7	3.01 - 3.50	9	Fair (4)	7
Masters (5)	10	3.51 - 4.0	21	Familiar (5)	2
PhD (6)	15			Very (6)	2
				Extremely (7)	0

Thirty-six students who were taking classes at Virginia Tech participated in this experiment. Their ages ranged from 19 to 38, with the mean age of 26.06 years and a standard deviation of 4.852 years. Fourteen of the subjects were female, and twenty-two of the subjects were male. The majority of the subjects (27) were engineering students, and the rest (9) were non-engineering students (i.e., 1 architecture, 3 business, 1 chemistry, 3 clothing and textiles, and 1 hotel management students). A total of 11 undergraduate students (i.e., 3 sophomore, 1 junior, and 7 senior students) and a total of 25 graduate students (i.e., 10 Masters and 15 PhD students) participated in this experiment. The mean educational level was 4.92, with a standard deviation

of 1.228. Their QCA ranged from 1.70 to 4.00, with the mean QCA of 3.45 and a standard deviation of 0.528. The subjects' familiarity with auction/bidding concepts prior to the experiment ranged from none to very familiar, with the mean familiarity level of 3.06 and a standard deviation of 1.286.

TESTS OF TASK PERFORMANCE

The purpose of this section is to present the results from data analysis performed to address Research Question 1 and its hypotheses that are described in Chapter 1. Specifically, the analysis addresses the question, "What effects do feedback and goal setting have on task performance?" The results in this section address sub-questions that are hypothesized in this study— specifically, sub-questions that address task performance (i.e., Sub-Questions 1.1.1, 1.1.2, 1.1.3, 1.2.1, 1.3.1, and 1.3.2).

TASK PERFORMANCE

As mentioned in Chapter 3, all of the subjects were required to complete three auctions (or problems) randomly assigned to them during the experiment. The three problems are called Test A, Test B, and Test C; and their statistical results are shown in Table 4.4.

Table 4.4
Statistical summary of the three problems

Statistical Data	Problems		
	Test A	Test B	Test C
Score:			
Maximum score (in millions)	$132.28	$267.20	$243.91
Minimum score (in millions)	-$32.91	-$28.90	$39.09
Average score (in millions)	$55.74	$137.64	$150.98
Standard deviation (in millions)	$39.07	$52.63	$35.44
Time:			
Maximum time used (in minutes)	14	12.5	10.7
Minimum time used (in minutes)	3.50	3.30	3.17
Average time used (in minutes)	7.17	7.37	6.60
Standard deviation (in minutes)	2.63	2.38	2.12

Because the financial parameters of the problems were designed to be different from one problem to another, the scores from each problem were quite different. For example, the average score for Test A was lower than the average scores of the other two problems. However, the difference in scores did not indicate that the three problems were different in their difficulty level. In fact, the three problems were purposely designed to be equivalent in scope, time used, and difficulty--each with 3 properties and 3 participating competitors. (Refer to Chapter 3 for more details about the task.) Although the subjects were not asked whether they felt any problem was more difficult than the others, a one-way analysis of variance (ANOVA) showed no difference in time used to accomplish each problem (see Table 4.5). Hence, there was no reason to believe that any problem was more difficult than the others.

Table 4.5
Summary of analysis of variance of time used to perform the three problems

Variable	**F-Value**	**Pr > F**
Time used	1.01	.3678

As a result, each subject's performance for each problem should be equally weighted. To weight the problems equally, each raw datum was standardized by subtracting its mean and dividing by its standard deviation. The complete raw and standardized data are shown in Appendix D.

Once the raw data were standardized, each subject's task performance could be calculated by totaling the standardized scores from the three problems together. That is,

Task Performance = SS Test A + SS Test B + SS Test C
(SS stands for Standardized Score)

Analysis of Variance of Task Performance

A two-way analysis of variance was performed using feedback and goal setting as the independent variables and task performance as the dependent variable. The results of the analysis are shown in Table 4.6. (Complete printouts of the statistical results are shown in Appendix D.)

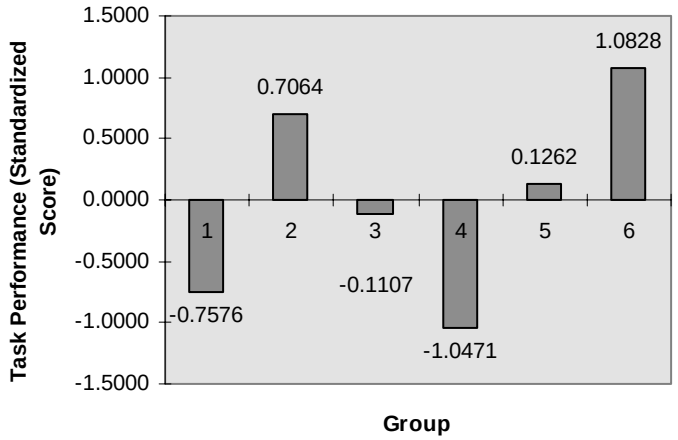
Table 4.6
Summary of analysis of variance of task performance

Source	**F-Value**	**Pr > F**
Feedback	2.63	.0887
Goal Setting	1.38	.2501
Feedback*Goal Setting	3.00	.0650

It should be noted from Table 4.6 that the interaction of feedback and goal setting *approached* significance (p = .0650). Further hypothesis testing is done while acknowledging the interaction.

Interaction Effects

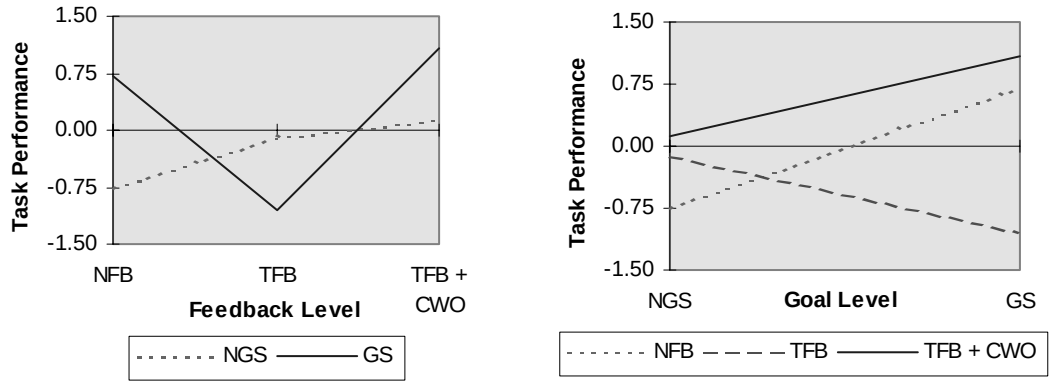
During the experiment, there were six treatment groups of subjects (i.e., 3 levels of feedback X 2 levels of goal setting). The six groups of subjects received treatments according to experimental design cells shown in Table 4.1. Figure 4.1 shows a histogram of task performance means for the six groups of subjects in this study.



1. No Feedback, No Goal Setting
2. No Feedback, Goal Setting
3. Task Feedback, No Goal Setting
4. Task Feedback, Goal Setting
5. Task Feedback with Comparisons with Others, No Goal Setting
6. Task Feedback with Comparisons with Others, Goal Setting

Fig. 4.1. Task performance for the six treatment groups of subjects

The interaction of feedback and goal setting can be plotted, using task performance data from Figure 4.1. Figure 4.2 illustrates the interaction of feedback and goal setting.



Where,
NGS = No Goal Setting
GS = Goal Setting

NFB = No Feedback
TFB = Task Feedback
CWO = Comparisons with Others

Fig. 4.2. Interaction of feedback and goal setting at the three levels of feedback (*left*) and at the two levels of goal setting (*right*)

Due to the nearly significant interaction between feedback and goal setting ($p = .0650$), a one-way analysis of variance for each level of feedback (with goal setting as an independent

variable) and a one-way analysis of variance for each level of goal setting (with feedback as an independent variable) are recommended (Schulman 1997). Simple effects tests were performed, and the results are shown in Table 4.7.

Table 4.7
Summary of the analyses of task performance for the simple effects tests

Simple Effects Tests	F-Value	Pr > F
Goal-Setting Effects:		
– At the no feedback level	3.30	.0992
– At the task feedback level	1.92	.1962
– At the task feedback with comparisons with others level	1.85	.2038
Feedback Effects:		
– At the no goal-setting level	0.59	.5649
– At the goal-setting level	7.13	.0067**

** $p < .01$

The simple effects test revealed a *significant* result ($p = .0067$) of the feedback effect at the "goal-setting" level (i.e., for the subjects who had goals). A Duncan's multiple range test revealed that for the subjects who had goals, task performance was *significantly* lower for the subjects who received task feedback (mean = -1.0471) than for the subjects who received no feedback (mean = 0.7064) and for the subjects who received task feedback with comparisons with others (mean = 1.0828).

FEEDBACK EFFECTS

Figure 4.3 shows a histogram of task performance means for the three levels of feedback in this study.

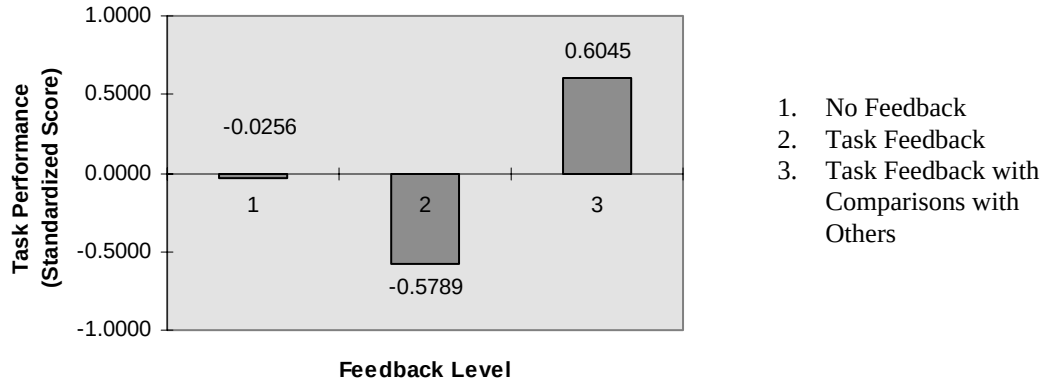


Fig. 4.3. Task performance for the three levels of feedback

Sub-Hypotheses 1.1.1, 1.1.2, and 1.1.3 address the feedback effect at different levels. The results from the statistical analysis of these three sub-hypotheses are shown in Table 4.8. (Each of these t-values shown is for the linear contrast among the six cell means of the experimental design corresponding to the research hypotheses. For example, for Research Hypothesis 1.1.1, the t-value compares the average of cells 3, 4, 5, and 6 versus the average of cells 1 and 2.)

Table 4.8
Summary of the analysis of task performance for Sub-Hypotheses 1.1.1, 1.1.2, and 1.1.3

Source	**T-Value †**	**Pr > T**
1.1.1 Feedback vs. No Feedback	0.10	.4662
1.1.2 Task Feedback vs. No Feedback	-1.07	.8538
1.1.3 Task Feedback with Comparisons with Others vs. Task Feedback	2.29	.0146*

* $p < .05$
† For the designated contrast among the six cell means

Sub-Hypothesis 1.1.1

H_1: Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive any form of feedback on how well they and/or others are

performing their task (i.e., task feedback and/or task feedback with comparisons with others) than for those who receive no feedback.

The task performance mean of the subjects who received any form of feedback was 0.1280, while the task performance mean of the subjects who received no feedback was -0.0256. A linear contrast (Table 4.8) revealed that task performance of the subjects who received any form of feedback was *not* significantly higher than task performance of the subjects who received no feedback (p = .4662).

Sub-Hypothesis 1.1.2

H_1: Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive feedback on how well they are performing their task (i.e., task feedback) than for those who receive no feedback.

A linear contrast (Table 4.8) revealed that task performance of the subjects who received task feedback was *not* significantly higher than task performance of the subjects who received no feedback (p = .8538). Task performance of the subjects who received task feedback (mean = -0.5789) was *somewhat* lower than task performance of the subjects who received no feedback (mean = -0.0256).

Sub-Hypothesis 1.1.3

H_1: Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive feedback on how well they and others are performing (i.e., task feedback with comparisons with others) than for those who receive feedback on how well they are performing their task (i.e., task feedback).

A linear contrast (Table 4.8) revealed that task performance of the subjects who received feedback on how well they and others were performing was *significantly* higher than task performance of the subjects who received feedback on how well they were performing their task (p = .0146). Task performance of the subjects who received feedback on how well they

and others were performing (mean = 0.6045) exceeded task performance of the subjects who received feedback on how well they were performing their task (mean = -0.5789).

GOAL-SETTING EFFECTS

Figure 4.4 shows a histogram of task performance means for the two levels of goal setting in this study.

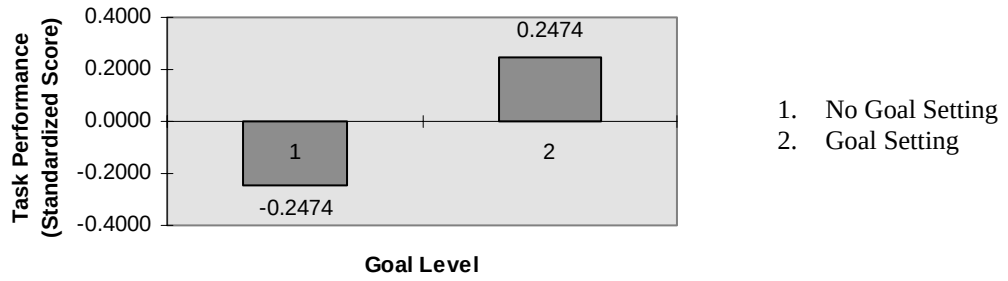


Fig. 4.4. Task performance for the two levels of goal setting

Sub-Hypothesis 1.2.1

H_1: Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive goals than for those who do not receive goals.

A two-way analysis of variance (Table 4.6) revealed *no* significant difference on task performance of the subjects who received goals and task performance of the subjects who did not receive goals (p = .2501) although task performance of the subjects who received goals (mean = 0.2474) was *somewhat* higher than task performance of the subjects who did not receive goals (mean = -0.2474).

FEEDBACK AND GOAL-SETTING EFFECTS

Sub-Hypotheses 1.3.1 and 1.3.2 address the feedback and goal-setting effects. The results from the statistical analysis of these two sub-hypotheses are shown in Table 4.9. (Each of these t-values shown is for the linear contrast among the six cell means of the experimental design corresponding to the research hypotheses.)

Table 4.9
Summary of the analysis of task performance for Sub-Hypotheses 1.3.1 and 1.3.2

Source	T-Value †	Pr > T
1.3.1 Both vs. Either ††	-0.4690	.6800
1.3.2 Both/Either vs. Neither ††	1.6062	.0594

† For the designated contrast among the six cell means
†† Both = both feedback and goal setting
†† Either = either feedback or goal setting
†† Neither = neither feedback nor goal setting

Sub-Hypothesis 1.3.1

H_1: Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive both feedback and goals than for those who receive either feedback or goals.

Figure 4.5 shows a histogram of task performance means for these two categories of subjects.

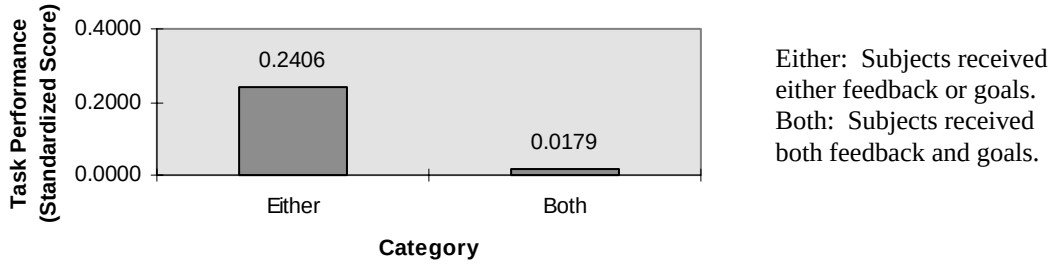


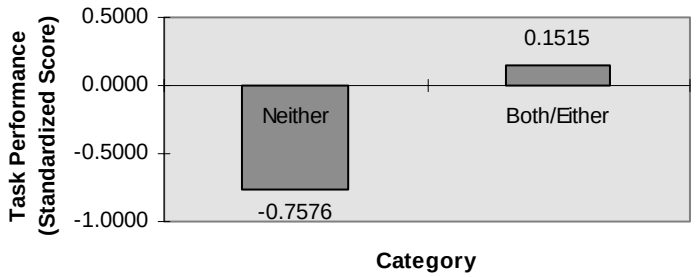
Fig. 4.5. Task performance for the subjects who received either feedback or goals and the subjects who received both feedback and goals

A linear contrast (Table 4.9) revealed that task performance of the subjects who received both feedback and goals was *not* significantly higher than task performance of the subjects who received either feedback or goals (p = .6800). Task performance of the subjects who received both feedback and goals (mean = 0.0179) was *somewhat* lower than task performance of the subjects who received either feedback or goals (mean = 0.2406).

Sub-Hypothesis 1.3.2

H_1: Task performance on knowledge work is significantly higher for workers in the distributed work environment who receive feedback and/or goals than for those who receive neither feedback nor goals.

Figure 4.6 shows a histogram of task performance means for these two categories of subjects.



Neither: Subjects received neither feedback nor goals.
Both/Either: Subjects received feedback and/or goals.

Fig. 4.6. Task performance for the subjects who received neither feedback nor goals and the subjects who received feedback and/or goals

A linear contrast (Table 4.9) revealed that task performance of the subjects who received feedback and/or goals was *not* significantly higher than task performance of the subjects who received neither feedback nor goals at the .05 level (p = .0594) although task performance of the subjects who received feedback and/or goals (mean = 0.1515) *somewhat* exceeded task performance of the subjects who received neither feedback nor goals (mean = -0.7576).

TESTS OF FEEDBACK AND GOAL BENEFICIAL EFFECTS

The purpose of this section is to present the results from data analysis performed to address Research Question 2, "What effects do feedback and goal setting have on feedback and goal beneficial effects?" The results in this section address sub-questions that are not hypothesized

in this study—specifically, sub-questions that address feedback and goal beneficial effects (i.e., Sub-Questions 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.3.1, and 2.3.2).

Feedback and Goal Beneficial Effects

As mentioned in Chapter 3, the literature identifies the positive effects of feedback as essential for error correction, task learning, motivation, and satisfaction. The literature also identifies the positive effects of goals as essential for task learning, motivation, and commitment. The subjects' responses to items 7 through 9 in the post-experimental questionnaire addressed the error correction, task learning, motivation, commitment, and satisfaction effects, respectively. On a seven-point Likert-type scale (in which 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = indifference, 5 = slightly agree, 6 = agree, and 7 = strongly agree), the statistical results of these effects are shown in Table 4.10.

Table 4.10
Statistical summary of responses to the post-experimental questionnaire items 7 - 11

Statistical Data	**Feedback and Goal Beneficial Effects**				
	Error Correction (Q7)	Task Learning (Q8)	Motivation (Q9)	Commitment (Q10)	Satisfaction (Q11)
Average score	5.56	5.69	5.92	6.17	5.67
Standard deviation	1.081	1.117	1.228	0.910	1.095

Analysis of Feedback and Goal Beneficial Effects

A two-way analysis of variance was performed using feedback and goal setting as the independent variables and feedback and goal beneficial effects as dependent variables. The results of the analysis are shown in Table 4.11.

Table 4.11
Summary of analysis of variance of feedback and goal beneficial effects

Two-Way ANOVA Tests	Feedback and Goal Beneficial Effects (Top = F-Value / Bottom = Pr > F)				
	Error Correction (Q7)	Task Learning (Q8)	Motivation (Q9)	Commitment (Q10)	Satisfaction (Q11)
Feedback	0.02 .9779	2.37 .1108	0.75 .4797	0.27 .7619	0.82 .4503
Goal Setting	2.23 .1456	1.92 .1761	4.34 .0458*	0.12 .7294	0.00 1.0000
Feedback - Goal Setting	0.29 .7502	0.28 .7545	0.41 .6703	0.58 .5665	0.06 .9390

* $p < .05$

All but one of the p-values in Table 4.11 indicate no significant difference results. (Only the effect of goal setting on motivation indicated significance at $p = .0458$.) Table 4.12 is a list of means corresponding to Research Question 2.

Table 4.12
Means for the analysis of feedback and goal beneficial effects

Means	Feedback and Goal Beneficial Effects				
	Correction (Q7)	Learning (Q8)	Motivation (Q9)	Commitment (Q10)	Satisfaction (Q11)
Feedback:					
RQ2.1.1 Feedback	5.58	5.83	5.96	6.21	5.71
No feedback	5.50	5.42	5.83	6.08	5.58
RQ2.1.2 Task feedback	5.58	6.25	6.25	6.33	6.00
No feedback	5.50	5.42	5.83	6.08	5.58
RQ2.1.3 TFB + CWO †	5.58	5.42	5.67	6.08	5.42
Task feedback	5.58	6.25	6.25	6.33	6.00
Goal Setting:					
RQ2.2.1 Goal setting	5.28	5.44	5.50	6.22	5.67
No goal setting	5.83	5.94	6.33	6.11	5.67
Feedback & Goal Setting:					
RQ2.3.1 Both ††	5.33	5.08	5.58	6.17	5.75
Either ††	5.61	5.78	6.00	6.28	5.61
RQ2.3.2 Both/either ††	5.50	5.70	5.83	6.23	5.67
Neither ††	5.83	5.67	6.33	5.83	5.67

† TFB + CWO = task feedback with comparisons with others
†† Both = both feedback and goal setting
†† Either = either feedback or goal setting
†† Neither = neither feedback nor goal setting

Since no interaction effect was found in the analysis of variance (Table 4.11), no further analysis is needed for feedback sub-questions (i.e., Sub-Questions 2.1.1, 2.1.2, and 2.1.3). The results from the statistical analysis of Sub-Question 2.2.1 are already shown in Table 4.11. Thus, only Sub-Questions 2.3.1 and 2.3.2 were analyzed using a linear contrast. The results of the analysis are shown in Table 4.13. (Each of these t-values shown is for the linear contrast among the six cell means of the experimental design corresponding to the research questions.)

Table 4.13
Summary of analysis of feedback and goal beneficial effects for Sub-Questions 2.3.1 and 2.3.2

Analysis	**Feedback and Goal Beneficial Effects**				
	Correction (Q7)	Learning (Q8)	Motivation (Q9)	Commitment (Q10)	Satisfaction (Q11)
Feedback & Goal Setting:					
RQ2.3.1 T-Value †	0.45	0.23	0.87	0.10	0.11
Pr > |T|	.5091	.6334	.3587	.7569	.7481
RQ2.3.2 T-Value †	0.45	0.00	0.87	0.88	0.00
Pr > |T|	.5091	.9456	.3587	.3562	1.0000

† For the designated contrast among the six cell means

The results from the above tables indicate that there was *no* significant difference between feedback beneficial effects (i.e., error correction, task learning, motivation, and satisfaction) and goal beneficial effects (i.e., task learning, motivation, and commitment) in all—but one—of the sub-questions. The two-way analysis of variance for Sub-Question 2.2.1 indicated a *significant* difference in motivation between the subjects who received goals and the subjects who did not receive goals ($p = .0458$). Figure 4.7 shows a histogram of the motivation means for the two levels of goal setting in this study.

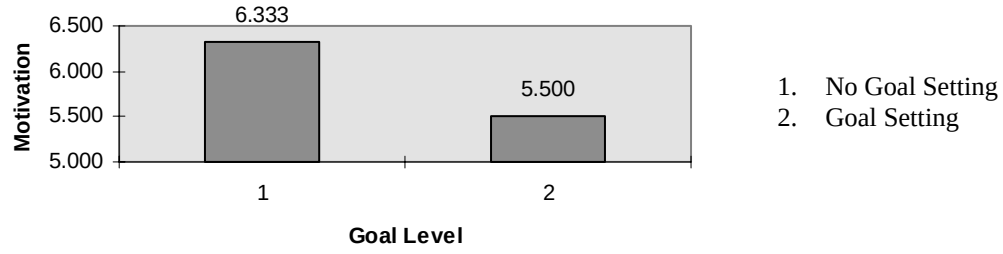


Fig. 4.7. Motivation level for the two levels of goal setting

The motivation level of the subjects who received goals (mean = 5.500) was *significantly* lower than the motivation level of the subjects who received no goals (mean = 6.333).

TESTS OF FEEDBACK AND GOAL UTILIZATION

The subjects' utilization of feedback and goals was collected and analyzed in order to understand how feedback and goal utilization may affect task performance. In addition, the data analysis of feedback and goal utilization was intended to understand how the subjects used feedback and goals during the experiment.

FEEDBACK AND GOAL UTILIZATION

The subjects' responses to items 1, 3, and 5 in the post-experimental questionnaire addressed the subjects' use of task feedback, information about others' performance, and goals, respectively. The subjects' responses to items 2, 4, and 6 in the post-experimental questionnaire addressed the subjects' perceived value of task feedback, information about others' performance, and goals, respectively. The statistical results of the subjects' responses on a seven-point Likert-type scale are shown in Table 4.14.

Table 4.14
Statistical summary of responses to the post-experimental questionnaire items 1-6

Statistical Data	Use			Perceived Value		
	Task Feedback (Q1)	Inf. about Others (Q3)	Goals (Q5)	Task Feedback (Q2)	Inf. about Others (Q4)	Goals (Q6)
Average score	5.5417	5.0000	6.1667	5.1250	4.5833	5.2222
Standard deviation	1.4136	1.8586	0.8575	1.5411	1.6214	1.2154

Note that the use of goals has the largest mean but the smallest standard deviation. The lowest standard deviation indicates that subjects were, more or less, the same in using goals.

A Pearson's correlation analysis was performed to identify whether there was any correlation between the subjects' use of feedback and goals and their perceived values of feedback and goals (items 1 and 2, items 3 and 4, and items 5 and 6 in the post-experimental questionnaire). The results of the analysis are shown in Table 4.15.

Table 4.15
Correlation between the subjects' use of feedback and goals
and their perceived values of feedback and goals

Source	Pearson's Correlation Coefficient	Pr > |R|
Task Feedback (Q1 vs. Q2)	0.7859	.0001****
Information about others' (Q3 vs. Q4)	0.6938	.0123*
Goals (Q5 vs. Q6)	0.1317	.6024

* $p < .05$, **** $p \leq .0001$

The Pearson's correlation analysis (Table 4.15) revealed *significant* results that the subjects' use of task feedback was strongly correlated with their perceived value ($r = 0.7859$, $p = .0001$) and that the subjects' use of information about others' performance was also correlated with their perceived value ($r = 0.6938$, $p = .0123$). However, the subjects' use of goals was not

strongly correlated with their perceived value, and the result was *not* significant ($r = 0.1317$, $p = .6024$).

TASK PERFORMANCE VERSUS FEEDBACK AND GOAL UTILIZATION

A Pearson's correlation analysis was performed to identify whether there was correlation between task performance and any of the feedback and goal utilization items above (items 1 through 6 in the post-experimental questionnaire). The results of the analysis are shown in Table 4.16.

Table 4.16
Correlation between task performance and feedback and goal utilization

Statistical Data	**Use**			**Perceived Value**		
	Task Feedback (Q1)	Inf. about Others (Q3)	Goals (Q5)	Task Feedback (Q2)	Inf. about Others (Q4)	Goals (Q6)
Pearson Corr. Coeff.	0.0770	-0.4096	-0.0161	-0.0964	0.0319	0.1161
Pr > |R|	.7207	.1861	.9494	.6540	.9217	.6465

The results from Table 4.16 indicate *no* significant correlation between task performance and feedback and goal utilization. That is, the subjects' utilization (i.e., use and perceived usefulness) of task feedback, information about others' performance, and goals have no significant correlation with task performance.

THE EFFECTS OF FEEDBACK AND GOAL UTILIZATION

The literature identifies that receiving feedback can influence how individuals use goals and that having goals can influence how individuals use feedback. The analysis of variance was performed to identify whether 1) the levels of feedback affected goal utilization and 2) the levels of goals affected feedback utilization. The results of the analysis of variance and their corresponding means are shown in Table 4.17.

Table 4.17
The effects of feedback on goal utilization and the effects of goal setting on feedback utilization

Statistical Data	Use			Perceived Value		
	Task Feedback (Q1)	Inf. about Others (Q3)	Goals (Q5)	Task Feedback (Q2)	Inf. about Others (Q4)	Goals (Q6)
Means:						
No Feedback	-	-	6.1167	-	-	4.8333
Task Feedback	-	-	5.8333	-	-	5.3333
TFB + CWO †	-	-	6.5000	-	-	5.5000
F-Value	-	-	0.90	-	-	0.46
Pr > F	-	-	.4291	-	-	.6413
Means:						
No Goal Setting	5.5833	6.1667	-	5.3333	5.1667	-
Goal Setting	5.5000	3.8333	-	4.9167	4.0000	-
F-Value	0.02	7.54	-	0.43	1.64	-
Pr > F|	.8889	.0206*	-	.5199	.2287	-

* $p < .05$
† TFB + CWO = task feedback with comparisons with others

The results from Table 4.17 indicate *no* significant effect of feedback levels on goal utilization ($p = .4291$ for use of goals and $p = .6413$ for perceived value of goals). The results also indicate *no* significant effect of goal levels on task feedback utilization ($p = .8889$ for use of task feedback and $p = .5199$ for perceived value of task feedback). Although the results indicate *no* significant effect of goal levels on perceived value of information about others' performance ($p = .2287$), the results indicate a *significant* effect of goal levels on use of information about others' performance ($p = .0206$). The subjects who received goals used information about others' performance less often (mean = 3.8333) than the subjects who did not receive goals used this information (mean = 6.1667).

EXPLORATORY TESTS

Section 4.1 presented the characteristics information of the subjects who participated in the experiment. In this section, further analysis is performed in order to identify whether there was any correlation between the subjects' characteristics and task performance. The data about the

age, QCA, education level, and familiarity with the auction process prior to the experiment from the pre-experimental questionnaire are used in the analysis (without regard to interaction of feedback and goal setting), and the results are shown in Table 4.18.

Table 4.18
Correlation between task performance and the subjects' age, QCA, education level, and familiarity with the auction process prior to the experiment

Statistical Data	**Subjects' Characteristics**			
	Age	QCA	Education Level	Familiarity with Auction
Pearson Corr. Coeff.	0.0920	0.0504	0.1873	0.1824
Pr > |R|	.5935	.7706	.2740	.2869

The results from the analysis revealed no significance. According to Table 4.18, the subjects' age, QCA, education level, and familiarity with the task have *no* significant correlation with task performance of the subjects.

The other two subject characteristics data that were collected during the experiment are the subjects' sex and major. A two-tailed t-test analysis was performed to identify whether there was a difference in task performance between 1) engineering and non-engineering subjects and 2) male versus female subjects. The results of the analysis are shown in Table 4.19.

Table 4.19
Summary of the analysis of task performance on sex and major

Source	**T-Value**	**Pr > |T|**
Engineering vs. Non-Engineering	1.0129	.3183
Male vs. Female	1.9135	.0641

According to Table 4.19, task performance was *not* significantly different (p = .3183) between engineering subjects (mean = 0.1361) and non-engineering subjects (mean = -0.4080). Task performance was also *not* significantly different (p = .0641) between male subjects (mean = 0.3425) and female subjects (mean = -0.5380) at the .05 level.

CHAPTER 5: DISCUSSION

This chapter provides a discussion of the results from Chapter 4. The chapter begins with a summary of important findings presented in Chapter 4. After the summary has been presented, interpretations are made with respect to feedback and goal setting. The subjects' responses in the retrospective report offered insight into the effects of feedback and goal setting. When applicable, the transcript of the retrospective report, administered at the end of the experiment, is used to support discussions. *The transcript is shown in italics followed by the subject's identification number*.[5]

SUMMARY OF RESULTS WITH RESPECT TO RESEARCH HYPOTHESES AND RESEARCH QUESTIONS

The summary of the research sub-hypotheses, which address task performance, is shown in Table 5.1.

Out of the six research sub-hypotheses, only Sub-Hypothesis 1.1.3 was *significant* ($p = .0146$). The other sub-hypotheses were not significant. Because the interaction between feedback and goal setting *approached* significance (Table 4.6), simple effects tests were made. The summary of results from the simple effects tests is shown in Table 5.2 for reference.

[5] The first digit of the subject's identification number identifies what treatment the subject received—that is, the cell number of the experimental design. 1 = no feedback, no goal setting; 2 = no feedback, goal setting; 3 = task feedback, no goal setting; 4 = task feedback, goal setting; 5 = task feedback with comparisons with others, no goal setting; and 6 = task feedback with comparisons with others, goal setting. Six subjects (or replications) were randomly assigned in each cell. (See Table 4.1 for the experimental design of this study.)

Table 5.1
Summary of the analysis of task performance for research sub-hypotheses

Research Hypothesis	Test Statistic	P Value
Feedback:		
1.1.1 Feedback vs. No Feedback	Linear Contrast (T-Test)	.4662
1.1.2 Task Feedback vs. No Feedback	Linear Contrast (T-Test)	.8538
1.1.3 Comparisons vs. Task Feedback	Linear Contrast (T-Test)	.0146*
Goal Setting:		
1.2.1 Goal Setting vs. No Goal Setting	ANOVA (F-Test)	.2501
Feedback and Goal Setting:		
1.3.1 Both vs. Either †	Linear Contrast (T-Test)	.6800
1.3.2 Both/Either vs. Neither †	Linear Contrast (T-Test)	.0594

* $p < .05$
† Both = both feedback and goal setting
† Either = either feedback or goal setting
† Neither = neither feedback nor goal setting

Table 5.2
Summary of the analyses of task performance for the simple effects tests

Simple Effects Test	Test Statistic	P Value
Feedback Effects:		
– At the no goal-setting level	ANOVA (F-Test)	.5649
– At the goal-setting level	ANOVA (F-Test)	.0067**
Goal-Setting Effects:		
– At the no feedback level	ANOVA (F-Test)	.0992
– At the task feedback level	ANOVA (F-Test)	.1962
– At the task feedback with comparisons with others level	ANOVA (F-Test)	.2038

** $p < .01$

According to Table 5.2, the simple effects test revealed *significance* ($p = .0067$) for the feedback effect at the "goal-setting" level (i.e., for the subjects who had goals).

The summary of research Sub-Question 2, which addresses feedback and goal beneficial effects (error correction, task learning, motivation, commitment, and satisfaction), is shown in Table 5.3.

Table 5.3
Summary of the analysis of feedback and goal beneficial effects for research Sub-Question 2

Research Question	Finding
Feedback:	
2.1.1 Feedback vs. No Feedback	n.s.
2.1.2 Task Feedback vs. No Feedback	n.s.
2.1.3 Comparisons vs. Task Feedback	n.s.
Goal Setting:	
2.2.1 Goal Setting vs. No Goal Setting	Motivation (p = .0458)*
Feedback and Goal Setting:	
2.3.1 Both vs. Either †	n.s.
2.3.2 Both/Either vs. Neither †	n.s.

n.s. = non significance, * $p < .05$
† Both = both feedback and goal setting
† Either = either feedback or goal setting
† Neither = neither feedback nor goal setting

According to Table 5.3, only Sub-Question 2.2.1 revealed a significant result on motivation. There was a *significant* difference in motivation between the subjects who received goals and the subjects who did not receive goals (p = .0458). The motivation level of the subjects who received goals (mean = 5.500) was lower than the motivation level of the subjects who received no goals (mean = 6.333).

FINDINGS ON FEEDBACK EFFECTS

In this section, findings on feedback effects are presented. Interpretations are made in response to Sub-Hypotheses 1.1.1, 1.1.2, and 1.1.3, respectively.

SUB-HYPOTHESIS 1.1.1

The findings *did not* support Sub-Hypothesis 1.1.1. Task performance of the subjects who received any form of feedback was *not* significantly higher than task performance of the subjects who received no feedback (p = .4662). The subjects who received any form of feedback (mean = 0.1280) did not perform significantly better than the subjects who received no feedback (mean = -0.0256).

Even though the existing literature provides overwhelming evidence that feedback is better than no feedback (e.g., Arps 1917; Trowbridge and Cason 1932; Waters 1933; Macpherson 1948; Ammons 1956; Busby 1997), the same evidence was not found in this study. An explanation can be made regarding the non-significant result. During the experiment, although the "no feedback" subjects were not given task feedback, they tried to calculate or form opinions about their own performance. Evidence that some of the "no feedback" subjects (i.e., subjects from Cells #1 and #2) formed their own opinions during the experiment was revealed in the retrospective report in which some of the subjects mentioned the following:

> *I figured it out myself. (11)*
>
> *I kept a record of how much money I or my competitors could spend to outbid me. (12)*
>
> *I kept track of how much money or profit I made, and I knew the margin in my current bidding. (16)*
>
> *I just calculated a ballpark area. I kind of guesstimated of how much I was making. That's how I knew I was off stage. (21)*
>
> *I tried to calculate. (24)*

The argument that individuals form their own opinions about their performance when performing a task is supported by Greller and Herold (1975), who classify feedback sources into five categories: the organization, supervisors, co-workers, one's own feelings, and the task itself. According to the authors, individuals often rely on their judgment, experience, and feeling when performing a task. As a result, the subjects' feelings about their own performance might be as informative as task feedback information. Evidence was found indicating that some of the subjects relied on their own feelings during the experiment even though task feedback was given to them. In the retrospective report, some of the subjects who received task feedback during the experiment mentioned the following:

> *The feedback is very nice, but most of it you can calculate in your head. (52)*
>
> *The result from the feedback was close to what I expected when I was doing [the auction]. (56)*
>
> *When I was doing the auction, I kind of knew where I stood. It [task feedback] doesn't really help me out. (65)*

In this study, the "no feedback" subjects did form opinions about their own performance, even though their judgments were, at times, inaccurate. The following quotes were extracted from the retrospective report, revealing that some of the "no feedback" subjects (i.e., subjects from Cells #1 and #2) did form inaccurate opinions about their own performance:

> *I think I did fairly well on it. I did well on case 12. [The subject's assumption was correct.] I made about 80 on the last test. [This assumption was incorrect. The subject made 165.5.] And on test 24, I made about 150. [This assumption was close. The subject made 166.5.] (12)*
>
> *I felt better in the second and third cases than I did in the first case. [The subject's assumption was correct. The subject did better in the second and the third cases.] (15)*
>
> *For the first test, I wasn't sure if I got $85 million, but I know I came out positive. [The subject's assumption was incorrect. The subject lost $15.20 million.] In fact, I know I came out positive on all of these. [This assumption was incorrect. One of the cases came out negative.] I think I got close to 170 for the second one. [This assumption was incorrect. The subject made 257.8.] But again, I'm not sure. I thought I got 215 for the last. [This assumption was incorrect. The subject made only 152.95.] (22)*

Although their opinions were inaccurate at times, the opinions were sufficient for them to carry on their task. The subjects performed the task to the best of their knowledge, whether or not they had accurate information about their performance. The ability of the subjects "… to attend to the most important sources of information and to 'fill in' for information that is incomplete or imprecise" is called "situation awareness" (Entin 1998, 249). Situation awareness, Endsley (1988, 1996) contends, is a person's mental model of the current state of the environment around him.

According to Garland et al. (1996) individuals (in this study, the subjects) spend their efforts in determining just what is occurring in their environment. Individuals form an intuitive understanding of the task situation and a general awareness of their own performance (Garland et al. 1996; Jackson and Klein 1997). Without task feedback, the subjects extracted whatever information available from the environment, integrated the information with previous knowledge to form a coherent mental picture, and used that picture in anticipating future events and carrying out necessary actions (Goettl 1997). The subjects' feelings about their own performance, although not completely accurate, were adequate in developing mental models for taking necessary actions.

Individuals, Jackson and Klein (1997) claim, can serve as their own monitoring devices during task performance. They must do their best to search, integrate, process disparate bits of information from their own senses, form composite pictures of the environment, and make effective decisions (Endsley 1988). This notion corresponds to Drucker's (1993) contention that knowledge workers own the means and tools of production—their knowledge. They make decisions for their own work. They are useful for an organization only when they know their work.

Despite some indications that the "no feedback" subjects formed opinions about their own performance and performed the task to the best of their knowledge, it does not mean that they did not want to have accurate information about their performance. During the study, some of the subjects who did not receive feedback requested some information about their own performance. Some of the "no feedback" subjects (i.e., subjects from Cells #1 and #2) asked the following questions, implying that they wanted to have information about their own performance:

> *Where's the total number? (16)*
>
> *I want to know how much money I made. Does this test tell me how much money I'm making? Did I reach my goal? (21)*
>
> *I really wanted to know how much money I had made. I thought that would make some difference. I'm not sure it would be better, but I think it would be different. (24)*
>
> *What's the result? (25)*
>
> *Did I reach the goal? (26)*

Moreover, some of the "no feedback" subjects (i.e., subjects from Cells #1 and #2) expressed that task feedback would have helped them perform better. They pointed out in the retrospective report:

> *Task feedback, that would have been great. I figured it out myself. It would save me time. (11)*
>
> *It would be good to know how much money I made. That would be good. (12)*
>
> *Feedback will help so that I don't have to keep track myself. (16)*
>
> *Feedback will help me. You don't really know if you really reach the goals or not because you cannot calculate each and every time. (21)*

I would like to know how I did, definitely. (22)

Since I didn't know my result I achieved or feedback, I didn't get the satisfaction. I couldn't plan on that. Feedback would help me perform better. If you know how much you've gained, you can plan your move ahead. (23)

Just curious to know the result. It will tell me how I perform. Feedback would help me perform better. Maybe it might help me correct errors and know how to perform better. (25)

Although feedback did not significantly affect task performance or feedback and goal beneficial effects, some subjects who received and used feedback (i.e., task feedback or information about others' performance) believed that the information helped them perform better.

Some of the subjects who received task feedback mentioned that task feedback helped them perform better. The mean for the perceived value of task feedback was 5.1250 on a seven-point Likert-type scale (see Table 4.14). A Pearson's correlation analysis (Table 4.15) revealed that the subjects' use of task feedback was *strongly correlated* with their perceived value (r = 0.7859, p = .0001). That is, the subjects who used task feedback thought that the information given to them during the experiment helped them perform the Auction Task better. (The analysis did not reflect their thought, however. Table 4.16 revealed *no* correlation (r = 0.0770, p = .7207) between the subjects' use of task feedback and their task performance.)

Perceived benefits of task feedback mentioned in the experiment were 1) strategies development, 2) knowledge of results and performance, 3) motivation, 4) improved decision making, 5) planning, 6) learning, and 7) error correction. The following quotes were extracted from the retrospective report of the subjects who received task feedback (i.e., subjects from Cells #3, #4, #5, and #6) in identifying the perceived benefits of task feedback:

I used that in how far to go or when to drop out of the bidding. (32)

I used it to judge my performance, how well I was doing, and it's kind of motivation to do better. (33)

It helped making decisions, knowing the status. It helped in planning, how much to bid, how the competitors did, how much money we made. (35)

It provided data to make strategies for the next auction. (36)

I used the result to see how I did according to the goal. (41)

It showed me how I was doing, whether I was doing well. (42)

The feedback from the first case helped me perform better in the second and the third cases. (44)

Any information you have can only help you with the strategy. (52)

I learned what I did wrong in the previous bid. (55)

It gave me a benchmark to figure out where I was. When you told me my place, it helped to inspire me to do better. (61)

I kind of saw how my performance was doing. It kind of pushed you to do a little bit better. I'm not in the dark. I see my progress. (62)

Whether or not I do know what I'm doing, I still like to know more information. (63)

I could make my own strategies for the next auction. (66)

Some of the subjects who received information about others' performance also mentioned that the information helped them perform better. The mean for the perceived value of the information was 4.5833 on a seven-point Likert-type scale (see Table 4.14). A Pearson's correlation analysis (Table 4.15) revealed that the subjects' use of information about others' performance was *correlated* with their perceived value ($r = 0.6938$, $p = .0123$). That is, the subjects who used information about others' performance thought that the information given to them during the experiment helped them perform the Auction Task better. (The analysis did not reflect their thought, however. Table 4.16 revealed *no* correlation ($r = -0.4096$, $p = .1861$) between the subjects' use of information about others' performance and their task performance.)

Perceived benefits of information about others' performance mentioned in the experiment were 1) strategies development, 2) benchmark, 3) confidence building, and 4) motivation to outperform others. The following quotes were extracted from the retrospective report of the subjects who received information about others' performance (i.e., subjects from Cells #5 and #6) in identifying the perceived benefits of information about others' performance:

I tried to drive people up more because I thought I was lacking in that area. (51)

It let me know, like the first time, I didn't get anybody to take the penalty. (52)

Once I knew how, what the average was, and how I was doing, if I was close to the average, I knew that I was doing in a right way. If I was told that I was doing very well, I would be very motivated. I wanted to do better than the average. I tried to beat the average. Without this information, I wouldn't know where I stood. It helped to know the range of the experiment. (54)

I learned how other people thought when bidding. (55)

I used the mean of others. If I took enough risk, then I should make it. That helped me to take more risk. (56)

It's nice to know when you're a little bit ahead. You feel more confident about your ability. Like the first one, I felt like I was the king of the world. (61)

Maybe it made you feel more confident. (63)

If I knew how people did before me, then I might have been a little bit more competitive. Here's my goal, I want to beat this number. (65)

In the second auction, it gave me the idea that I should buy the second property to make a lot of money. So, for the third one, I tried to buy the third property. (66)

To some, feedback information might be valuable to them; but to others, the same information might not add any value to them (Ilgen et al. 1979; Ashford and Cummings 1983). As mentioned in Chapter 2, feedback does not necessarily always have positive effects. Ilgen and Moore (1987) point out that individuals will not use feedback when it is perceived to be irrelevant or when it duplicates information they already possess. In the experiment, some subjects provided reasons why task feedback did not help them perform better: 1) irrelevance to the current situation, 2) inability to translate the information into something meaningful, and 3) duplication of information (with one's own feelings). The following quotes were extracted from the retrospective report of the subjects who received task feedback (i.e., subjects from Cells #3, #4, #5, and #6) in identifying the non-benefits of task feedback:

I didn't care about the past performance; it didn't bother me. It was always the current thing going on at that time. I didn't use it. I don't think it helped me perform one way or another. Not because it was bad or good, I just didn't use it. (31)

It gave us some information, but I didn't think much about it. (34)

It didn't really matter how I did in other cases; it mattered in the current case. (43)

I didn't know how to use the information to make it useful. (45)

It didn't help me in analyzing the case. (46)

The feedback is very nice, but most of it you can calculate in your head. (52)

I didn't feel like task feedback helped me a whole lot. I didn't see how or where I was in a position to make other people pay penalties. (53)

I got this stuff after. It wasn't like I was getting feedback while I was doing the auction. I was using the calculator to just punch out what my rough range was. I already had a rough idea of where I was, and I knew based on the Data Sheet what my money range was. I kind of knew the ballpark figure. (65)

Similarly, some subjects who received information about others' performance did not think that the information helped them perform better. Reasons provided were 1) irrelevance to the current situation, 2) inability to translate the information into something meaningful, and 3)

lack of motivational effects. The following quotes were extracted from the retrospective report of the subjects who received information about others' performance (i.e., subjects from Cells #5 and #6) in identifying the non-benefits of information about others' performance:

> *When you told me how other people did, I tried to use that, but sometimes it didn't work. I tried to use it, but the situation was different. I couldn't use it. (51)*
>
> *In the end, I don't think what I knew about other people's performance did really help me because I didn't know how to make use of it. (53)*
>
> *It didn't affect me much. I kind of like, well, that's what they did. (62)*
>
> *I didn't have that information until after the auction. (63)*
>
> *I didn't have any information about it while I was bidding. I was done bidding by the time I got the information. I was pretty motivated to beat everyone else, so it didn't help me that much. (64)*
>
> *The performance came at the end. If I knew how people did before me, then I might have been a little bit more competitive. Here's my goal, I want to beat this number. Instead of, OK, now that you've done it, this is how you're rated with everyone else. I wasn't comparing my performance with anyone while I was doing the auction. (65)*

SUB-HYPOTHESIS 1.1.2

The findings *did not* support Sub-Hypothesis 1.1.2. Task performance of the subjects who received task feedback was *not* significantly higher than task performance of the subjects who received no feedback (p = .8538). Task performance of the subjects who received task feedback (mean = -0.5789) was *somewhat* lower than task performance of the subjects who received no feedback (mean = -0.0256).

While feedback may not improve performance (as mentioned earlier in this chapter), it is also true that feedback may result in decreased performance (Nadler 1977). A simple effects test (Table 5.2) revealed evidence that, under one of the two circumstances, task feedback decreased performance of feedback recipients. The feedback effect at the "goal-setting" level was *significant* (p = .0067). A Duncan's multiple range test revealed that for the subjects who had goals, task performance was significantly lower for the subjects who received task feedback (mean = -1.4071) than for the subjects who received no feedback (mean = 0.7064).

It could be that for the subjects given performance goals, receiving task feedback created additional pressure in performing their task. Ashton (1990) identifies feedback as one of the

three pressure inducers on task performance; the three inducers are incentives, feedback, and justification. The pressure induced by feedback, Ashton points out, can either help or harm performance, depending on the level of preexisting pressure. Increasingly intense pressure may result in anxiety, thus harming performance. Evidence was found in the retrospective report to suggest that task feedback might have induced pressure. Some subjects who received task feedback pointed out the added pressure from task feedback:

> *It kind of pushed you to do a little bit better. (62)*
>
> *Maybe it [knowing one's own performance] made you feel more confident. But if I did very bad, that would be very depressing, and I would want to quit. (63)*

It is possible that the subjects given performance goals (that were specific and difficult) had a higher level of preexisting pressure than the subjects who were not given performance goals. (Evidence was found in the retrospective report, revealing that goals might have induced pressure. The supporting transcript of the retrospective report will be provided later in this chapter.) The literature indicates that having difficult goals creates pressure (Yukl and Latham 1978). Although difficult goals are accepted and committed to by individuals, it is possible that the increased level of anxiety to reach the goals may adversely impact task performance. Anxiety may lead individuals to worry rather than to concentrate on their task, thus offsetting all the positive effects that, otherwise, should be realized from setting difficult goals.

It was revealed in the experiment that for the subjects who received goals that were difficult (to reach), task performance of the subjects who also received task feedback was significantly lower than task performance of the subjects who did not receive task feedback. Combined pressure from difficult goals and task feedback might have decreased the performance level of the subjects who received both goals and task feedback. This notion is supported by Ashton (1990), who points out that feedback can have detrimental performance effects via its impact on anxiety, especially in difficult tasks. "Anxiety is heightened by performance feedback, especially when it reveals poor performance, and, of course, performance is more likely to be poor when the task [or the goal] is difficult" (Ashton 1990, 151).

An explanation can also be made that setting difficult goals and providing task feedback that revealed poor performance heightened the subjects' perceived task difficulty, created additional pressure, induced anxiety, increased mental effort and workload, and, consequently, decreased their task performance. These components are highly interrelated. Task difficulty is the amount of mental effort demanded by successful performance (Ashton 1990). Stress (induced by confusion, frustration, or anxiety) is a cognitive state reflecting the person's perception of and adaptation to the demands of the environment (Cox and Griffiths 1995). Mental workload, according to Reid and Nygren (1988), is a construct that can be explained by three components: time load, mental effort, and stress. Literature reveals that when tasks are moderately difficult to very difficult, increased workload is associated with poorer performance (Charlton 1996).

Different results were found for the subjects who did not have goals. A simple effects test revealed *no* significant result of the feedback effect at the "no goal-setting" level ($p = .5649$). For the subjects who did not have goals, task performance was *somewhat* higher for the subjects who received task feedback (mean = -0.1107) than for the subjects who received no feedback (mean =-0.7576). It could be that, without excessive pressure from having difficult goals, the subjects started realizing positive benefits that came with having task feedback. This possible explanation was found in the existing literature (e.g., Greller and Herold 1975; Ilgen et al. 1979; Busby 1997).

SUB-HYPOTHESIS 1.1.3

The findings *supported* Sub-Hypothesis 1.1.3. Task performance of the subjects who received feedback on how well they and others were performing (mean = 0.6045) was higher than task performance of the subjects who received feedback on how well they were performing their task (mean = -0.5789), and the result was *significant* ($p = .0146$).

An explanation can be made that any potential benefits of feedback started to be realized when the subjects were given task feedback and information about others' performance together. Task performance of the subjects who received both types of feedback (mean = 0.6045) was *significantly* higher ($p = .0146$) than task performance of the subjects who received task

feedback only (mean = -0.5789) and *somewhat* higher[6] (p = .1161) than task performance of the subjects who received no feedback (mean = -0.0256). As discussed earlier in the chapter, perceived benefits of information about others' performance mentioned by the subjects in the experiment were 1) benchmark, 2) confidence building, 3) motivation to outperform others, and 4) strategies development.

For the "goal-setting" subjects, having information about others' performance helped relieve them from added pressure of having high goals. Information about others' performance provided the subjects with average scores, which, in turn, represented new and lower targets/benchmarks to them. As a result, even if the subjects could not reach the high goals, they became satisfied if they could reach their new and lower targets. The subjects became confident and motivated when they performed close to or surpassed the average scores. (Evidence was found in the retrospective report, revealing that some subjects used information about others' performance as their new targets and that they became confident and motivated when they surpassed the average scores. The supporting transcript of the retrospective report was provided earlier in this chapter.)

Increased confidence and motivation, along with better strategies, contributed to the significant result (p = .0067) of the simple effects test of feedback effects at the goal-setting level (see Table 5.2). A Duncan's multiple range test revealed that for the subjects who had goals, task performance was *significantly* higher for the subjects who received task feedback together with information about others' performance (mean = 1.0828) than for the subjects who received task feedback only (mean = -1.4071).

For the "no goal-setting" subjects, although the added benefits of having information about others' performance were *not* significant (p = .5649 for the simple effects test of feedback effects in Table 5.2), task performance was *somewhat* higher for the subjects who received task feedback together with information about others' performance (mean = 0.1262) than for the

[6] A post hoc test was conducted using a linear contrast among the six cell means of the experimental design. See Appendix D for the results of the analysis.

subjects who received task feedback only (mean = -0.1107). The insignificant finding could be the result of diminishing returns of feedback benefits. That is, information about others' performance did not add additional value beyond that of task feedback.

The argument that information about others' performance itself represented targets to the subjects was statistically supported (see Table 4.17). An analysis of variance revealed a *significant* difference on the use of information about others' performance (p = .0206) between the subjects who received goals and the subjects who did not receive goals. The subjects who did not receive goals used information about others' performance (mean = 6.1667) more often than the subjects who received goals used such information (mean = 3.8333). In the absence of performance goals, the subjects compared their own performance with others' performance (average scores), and used the information as their targets.

FINDINGS ON GOAL-SETTING EFFECTS

In this section, findings on goal-setting effects are presented. Interpretations are made in response to Sub-Hypothesis 1.2.1.

SUB-HYPOTHESIS 1.2.1

The findings *did not* support Sub-Hypothesis 1.2.1. There was *no* significant difference on task performance (p = .2501) of the subjects who received goals (mean = 0.2474) and on task performance of the subjects who did not receive goals (mean = -0.2474).

Figure 4.2 and the simple effects test in Table 5.2 revealed some interesting findings. At the "no feedback" level, the result was in the predicted direction although the result was *not* significant (p = .0992). At the "task feedback" level, the result was not in the predicted direction, and the result was *not* significant (p = .1962). At the "task feedback with comparisons with others" level, the result was in the predicted direction although the result was *not* significant (p = .2038). The changing of directions at different levels of feedback implied

that goal setting may have mixed effects—both positive and negative. The mixed effects (positive and negative) of goal setting might have offset each other at different feedback levels, thus resulting in the non-significant result of Sub-Hypothesis 1.2.1.

The existing literature provides overwhelming evidence that goal setting improves performance (e.g., Latham and Baldes 1975; Frost and Mahoney 1976; Locke et al. 1981; Campion and Lord 1982; Naylor and Ilgen 1984; Griffin 1990). In this experiment, some of the subjects who had goals set for them mentioned that goals helped them perform better. (An example of goals in the experiment is the following: The subjects were told to make at least $70 million and were suggested to win Property 1 when performing Test A. See Table 3.5 for more information.) The mean for the perceived value of goals was 5.2222 on a seven-point Likert-type scale (see Table 4.14). Perceived benefits of goal setting mentioned in the experiment were 1) motivation, 2) direction, 3) strategies development, 4) planning, and 5) commitment. The following quotes were extracted from the retrospective report of the "goal-setting" subjects (i.e., subjects from Cells #2, #4, and #6) in identifying the perceived benefits of goals:

> *Without the goal, I wouldn't know how to bid, bid it up or let them win it. Having the goal, it gives me a target where I want to place other competitors, in respect to me. (21)*
>
> *I could decide what strategies to employ. (23)*
>
> *There were some good things in the goal. For example, which properties to choose. Suggestions gave me information to choose 1 and 3, instead of 1 and 2, or 2 and 3. Even though goals were hard to achieve, they helped me for planning. (26)*
>
> *They kind of told me what to shoot for. They helped me to read the data and compare the prices. I might not have taken the advantage of it that much if I didn't have the goals. I couldn't have made that much profits without the goals. (41)*
>
> *If there was no aim, then I wouldn't try hard. (45)*
>
> *It was used as a guideline for which properties to win. It was a target to shoot for. (46)*
>
> *You always have a strong goal in mind to help you perform better. I think if you had just given an ambiguous goal, like do the best as you can, I might have been more conservative when I should have been more liberal in my bidding. I think because I had a goal, a lot of times when I felt like I was behind, I tried a little bit harder to make a little bit more money. So, the goal helped. (61)*
>
> *Goals give something to shoot for. My goal is to do the best ever, and so obviously I want to do better than the goal. I assume that if I did much better than the goal, then I'll be OK. That would take care of itself. (64)*
>
> *The goals were helpful to give me an idea of which one I should be looking at, instead of doing the math myself. Having a combination of different properties also helped. The dollar values were nice, but it just didn't really help me. It helped to see, OK, I needed to start making some money here. … So, it gave you an idea how competitive the auctions were going to be. (65)*

The goal was my reference money. At least, I tried to achieve. The suggestion was the best thing to follow. (66)

When asked, "What would have helped you perform better in the bidding: task feedback, information about others' performance, or goals?" one of the subjects from Cell #1, who did not receive goals, identified that goals would have been beneficial to him. The subject mentioned the following:

Goals probably would motivate me a little more to do better because I would have discipline I needed. (11)

Because goals may have beneficial effects, this may help explain why the directions of the results in two out of the three situations followed the hypothesized direction. That is, the subjects who had goals performed *somewhat* better than the subjects who had no goals at the "no feedback" and the "task feedback with comparisons with others" levels although the results were not significant.

Although the literature indicates that specific goals produce a higher performance level than do-your-best goals, some of the subjects in the experiment believed otherwise. Some of the "goal-setting" subjects (i.e., subjects from Cells #2, #4, and #6) believed that having goals did not help them perform better. They mentioned the following:

If there were no goals, I would try to attain as much as possible. (23)

The best thing to do is to have a positive attitude and hope for the best, and you somehow end up getting the best, or close to the best. (25)

I tried to do my best, but I didn't think about the goal. (46)

When asked, "What would have helped you perform better in the bidding: task feedback, information about others' performance, or goals?" two of the subjects from Cell #1, who did not receive goals, believed that goals would not have helped them perform better. They mentioned the following:

Goals wouldn't help because I tried my best anyway. We wanted to achieve the goals, but we wouldn't know what to do. If we did worse than the goal, we would try harder but it could result in a negative consequence instead. My effort was already 100%, regardless of the goals. Goals might help me if the task was boring. I might just ignore the goals if they were set. (14)

Goals wouldn't help because this is not something you had much control with. It could be by chance. I might try harder, but I might not make more money. Goals could make me try harder, but the result might not be better. (16)

It is possible that goals can decrease performance (Latham and Yukl 1975a). As discussed earlier, difficult goals can induce pressure (Yukl and Latham 1978). In the experiment, some of the subjects believed that the goals they received brought more pressure to the task. The following quotes were extracted from the retrospective report of the "goal-setting" subjects (i.e., subjects from Cells #2, #4, and #6) in identifying the added pressure of goals:

It made me feel pressured. When I couldn't make the profit and reach the goal, I felt depressed. It was too high. Just no goals, and I think I could do better. I felt depressed when I felt I couldn't achieve that goal. (24)

Goals always put you under pressure. (25)

It gave me pressure. (62)

It gave me too much pressure. (66)

It is possible that the added pressure of goals came from the fact that goals created a winning versus losing mentality. In the experiment, the subjects who achieved the goals felt like they won the game while the subjects who failed to achieve the goals felt defeated. The following quotes were extracted from the retrospective report of the "goal-setting" subjects (i.e., subjects from Cells #2, #4, and #6), revealing the evidence that goals created a wining versus losing mentality:

I thought if I didn't win, I wouldn't be able to conduct the rest of your study. (21)

As long as you reach the goal, you're safe. You don't want to fall back less than that position. (23)

Sometimes, they are kind of defeating when you couldn't achieve goals. Sometimes, when the goals are too high, you just feel defeated. If the goals were lower, and then you achieved them, then you felt more confident. If the goals were moderate, not too low but not too high, then you could feel better about it. (42)

If you don't meet your goals, you fail. (62)

I don't want to lose. It's kind of competition; you want to win. (66)

Feeling that reaching a goal was a win and not reaching a goal was a loss, the subjects in the experiment adjusted their strategies. The strategies they adopted affected their risk-tasking behaviors, which, in turn, affected their task performance. (To do well in the Auction Task, the subjects should take risks at a moderate level. Too little or, especially, too much risk could jeopardize their performance.) If the subjects felt they were close to reaching goals, they became conservative in their bidding strategies. On the other hand, if the subjects felt they were far away from reaching goals, they became aggressive in their bidding strategies. This notion is supported by Ashton (1990), who claims that to cope with task difficulty induced by difficult goals and to enhance the likelihood of successful task performance, individuals may resort to varied and high-risk decision strategies that, on average, harm task performance.

Evidence that goals influenced the subjects' bidding strategies during the experiment was revealed in the retrospective report in which some of the "goal-setting" subjects (i.e., subjects from Cells #2, #4, and #6) mentioned the following:

> *When you're within the reach of the goal, you take less risk. I don't know if the goals were right or wrong, or on what basis should the goals be set. If I reached my goals already, I'll play conservatively. If I haven't reached my goals, then I'll play aggressively. (23)*
>
> *Goals could make you feel more competitive, more risky. (42)*
>
> *I tried to achieve the goals. My main goal was to make the most money. I tried to make the most money, without losing any. At least, I would not pay any penalties. I would be satisfied with whatever I made even though I wouldn't make the goal. I wanted to reach the goal, but the most important thing was not to pay penalties. (45)*
>
> *When I achieved the first goal, twenty million dollars above the best, I totally shut everything down after that. There are advantages and disadvantages with the goals. Not only that I reached by a few million, and that's the disadvantage. I had no incentive to do a little bit more. When you're dealing with something like this, play money, you don't want to lose your company a lot of money. So, you want to, OK, I'm done. I had a nice profit. I met the company's expectation. I also made myself a nice little buffer. I've done more than the expectation, so I don't want to risk anything. (61)*
>
> *It made me overaggressive. You want to meet your goals. If you don't meet your goals, you fail. You might want to go all out. You're going to fail one way or the other. Goals made me aggressive. Once you reach the goal or go past it, you don't want to push yourself. You risk yourself of falling back behind. You want to stay where you're at, where it's safe. You play conservatively when you reach your goal because you don't want to lose your position. When you risk more after you reach your goal, theoretically, you set another goal for yourself. Yeah, but once you get there, you want to play it safe depending on how high you want to set it. (62)*

As discussed previously, because information about others' performance represented targets, knowing this information also affected the subjects' risk-taking behaviors. Evidence that information about others' performance influenced the subjects' bidding strategies (to be conservative or risky in their bidding) during the experiment was revealed in the retrospective report. Some of the subjects who received information about others' performance (i.e., subjects from Cells # 5 and #6) mentioned the following:

> *Because I thought I've done very well in the others, but I still was getting about the average, I figured I tried different strategies. So, because I was trying something slightly different, like a trial and error, in the last one, I didn't do too well. (52)*
>
> *I used the mean of others. If I took enough risk, then I should make it. That helped me to take more risk. (56)*
>
> *Knowing other people's performance could cause you to be risky. If everyone else was doing much better, like the average is 200 million and I have 100, and I knew that I'm half way through it, OK, I have to try to risk it, and it could be worse. (63)*

The retrospective report also revealed that information about others' performance would have affected the bidding strategies of the subjects who did not receive the information. Two of the subjects who did not receive information about others' performance mentioned the following:

> *I like to know how well I did compared to others. (22)*
>
> *I don't have an idea how other people performed. I think knowing how other people performed may motivate me to try to make more benefits or to take more risks. I think at this time I was very conservative because I do not want to pay penalties. If I did well, I would keep my own strategy. If not, I would take some risks. With a conservative approach, I can get some money. If I want some extra money, I should take some risks. But this time, I didn't take some risks. I'm not sure that knowing other people's performance would help me perform better or not, but there's a chance that it will change my strategies. (34)*

The notion that goals might have caused negative effects during the experiment was statistically supported. After the experiment was finished, every subject was asked to complete the questionnaire item #9: "I thought the task was motivating." A two-way analysis of variance for Sub-Question 2.2.1 (Table 5.3) indicated a *significant* difference in scores of this item between the subjects who received goals and the subjects who did not receive goals (p = .0458). It can be inferred that the motivation level of the subjects who received goals (mean = 5.500) was lower than the motivation level of the subjects who received no goals (mean = 6.333).

The statistical evidence that goals demotivated some subjects may help explain why the direction of the result in one out of the three situations was contrary to the hypothesis. That is, task performance of the subjects who had goals was *somewhat* less than task performance of the subjects who had no goals at the "task feedback" level although the result was not significant.

From Table 4.14, it is interesting to note that the subjects' use of goals had a larger mean but a smaller standard deviation (mean = 6.1667; SD = 0.8575) when compared to the subjects' use of task feedback (mean = 5.5417; SD = 1.4136) and use of information about others' performance (mean = 5.0000; SD = 1.8586). A very high-value mean and the lowest standard deviation indicate that the subjects' use of goals when performing the task was consistent. The subjects were, more or less, the same in using goals; a small variation in the use of goals was found. Goals had power to induce compliance from the subjects. They might have felt obligated to follow goals when goals were assigned to them. The following quotes were extracted from the retrospective report, revealing evidence that some of the "goal-setting" subjects (i.e., subjects from Cells #2, #4, and #6) felt obligated to follow goals when goals were assigned during the experiment:

> *There were goals that I had to achieve, and I tried the best I could to achieve them. If there were goals that were put in front of me, I would try to achieve them. (22)*
>
> *Because it was written so. I followed the goals because of the obligations. I assumed that I was an employee, then I had to follow the obligations. (24)*
>
> *There were goals that I was supposed to do, so I went for them. (62)*

Although the subjects used goals during the experiment, they did not necessarily think that the goals helped them perform better. Pearson's correlation analysis (Table 4.15) did not reveal any correlation between the subjects' use of goals and their perceived value of goals (r = 0.1317, p = 0.6024). This finding was in contrast with those of task feedback and information about others' performance. The subjects who used task feedback and information about others' performance thought that the information given to them during the experiment helped them perform the Auction Task better.

A question may be raised whether the goals were set too high. The following quotes were extracted from the retrospective report of the "goal-setting" subjects (i.e., subjects from Cells #2, #4, and #6), concerning the difficulty level of the goals:

> *The monetary goals were not realistic. I think it was too low in one case, the first one [Test A], and too high in other cases [Test C and Test B]. (23)*
>
> *It was too high. (24)*
>
> *Even though goals were hard to achieve, they helped me for planning. (26)*
>
> *I think the goals were a little bit tough. On the first one [Test C], it was feasible. On other ones [Test A and Test B], I was unable to do it. It was feasible, but a little bit tough, though. (42)*
>
> *I don't think the goals were too high. (43)*
>
> *The goal is realistic, given a scenario. It's very obvious that you can make that kind of money. You just have to be witty enough to do it. (64)*
>
> *The goal was slightly high. (66)*

The retrospective reports yielded inconsistent results. Some of the subjects thought the goals were slightly high or too high, while others did not think the goals were too high. Even when two subjects indicated which of the three problems were difficult, they were inconsistent in their judgment.

According to Locke (1968), when assigned a goal that is perceived as impossible to reach, the individual rejects the goal and stops trying for that goal. As a result, goals that are not accepted may have negative impacts on task performance. During the experiment, however, there was no evidence that any subjects rejected the goals. In fact, as pointed out earlier, the use of goals was very high and consistent (mean = 6.1667; SD = 0.8575) on a seven-point Likert-type scale. Moreover, there was no evidence that the subjects stopped trying for the goal. In fact, evidence was found, as shown in previous quotes of this section, that the subjects did try to achieve the goals by changing their bidding strategies; consequently, the subjects' determination to reach the goals might be the factor that hurt task performance.

Difficult goals, Locke (1968) asserts, improved task performance in his study of goal-setting effects because "If the task [or goal] was hard, they [the subjects] worked hard; if it was easy they worked less hard" (p.168). However, because the Auction Task was highly cognitive, the

subjects could not work harder physically, but cognitively; and trying to work harder cognitively did not necessarily translate into better performance. In fact, by trying so hard to reach difficult goals, the subjects were compelled to adopt risky bidding strategies that jeopardized their bidding performance.

FINDINGS ON FEEDBACK AND GOAL-SETTING EFFECTS

In this section, findings on feedback and goal-setting effects are presented. Interpretations are made in response to Sub-Hypotheses 1.3.1 and 1.3.2.

SUB-HYPOTHESIS 1.3.1

The findings *did not* support Sub-Hypothesis 1.3.1. Task performance of the subjects who received both feedback and goals was *not* significantly higher than task performance of the subjects who received either feedback or goals ($p = .6800$). Task performance of the subjects who received both feedback and goals (mean = .0179) was *somewhat* lower than task performance of the subjects who received either feedback or goals (mean = .2406).

Ilgen et al. (1979) claim that when feedback is specific but goals are general (i.e., do-your-best goals), task performers will know specifically about their own behaviors; however, the comparison of the specific information to the general goal may lead to some ambiguity about true performance levels. Task performers may be uncertain whether the goal was actually accomplished or not. There was evidence during the experiment to support Ilgen et al.'s claim; the subjects who received only task feedback but not goals (i.e., subjects from Cell #3) inaccurately assessed their own performance. During the study, some of the subjects mentioned the following:

> *I don't think I won at all. [The assumption was incorrect. The subject did well in one case.] (31)*
> *That's good. … Not bad. [The subject inaccurately assessed the subject's own performance.] (33)*
> *I think I lost money. [The assumption was incorrect. The subject made $40 million.] (34)*
> *I know that I did not do well. [The assumption was incorrect. The subject did quite well.] (35)*

On the other hand, during the experiment the subjects who were given goals but not task feedback (i.e., subjects from Cell #2) were unable to evaluate their own performance in relation to how well they were meeting the goals. They asked for information about their performance, such as the following:

> *I want to know how much money I made. Does this test tell me how much money I'm making? Did I reach my goal? (21)*
>
> *I really wanted to know how much money I had made. (24)*
>
> *What's the result? (25)*
>
> *Did I reach the goal? (26)*

Even though some researchers (e.g., Ilgen et al. 1979; Locke et al. 1981) claim that the co-existence of feedback and goals is needed to obtain performance improvement, the findings from this experiment did not support this claim. The non-supporting evidence might have resulted from a high level of pressure induced by having task feedback and goals, as discussed earlier in this chapter.

SUB-HYPOTHESIS 1.3.2

The findings *did not* support Sub-Hypothesis 1.3.2. Task performance of the subjects who received feedback and/or goals was *not* significantly higher than task performance of the subjects who received neither feedback nor goals at the .05 level ($p = .0594$).

Although Sub-Hypothesis 3.1.2 was not supported at the .05 level, the p-value was *nearly* significant. The existing literature related to feedback and goal setting in the traditional work environment shows convincing evidence that having feedback and/or goals improves task performance. In this study (which simulated a distributed knowledge work environment), task performance of the subjects who received feedback and/or goals (mean = 0.1515) was *somewhat* higher than task performance of the subjects who received neither feedback nor goals (mean = -0.7576).

CHAPTER 6: CONCLUSIONS AND RESEARCH IMPLICATIONS

CHARACTERISTICS OF THE EXPERIMENT

This research examined the effects of feedback and goal setting on knowledge work in the distributed work environment. A laboratory experiment was conducted, and it was based on two important premises: 1) The experiment must simulate a distributed work environment and 2) The task must represent knowledge work.

To simulate a distributed work environment, the subject and the researcher were located in geographically separate locations after the experiment began. During the experiment, the subject and the researcher communicated with each other electronically through telephones and networked computers.

Because knowledge work is intangible, cognitive, unstructured, and non-repetitive, the chosen task must have these characteristics. The Auction Task used in the experiment was designed to include these characteristics. The output of the task—the bidding decisions—was *intangible*. The subjects needed to make several decisions that were highly *cognitive* and *unstructured*. (For example, there were many risks involved during the bidding process. To perform well, the subjects needed to understand and decide whether to use bid-to-win or bid-to-lose strategies. Each subject, as well as his simulated competitors, wanted to acquire winnable properties at the minimum cost, make his competitors pay for their acquired properties as much as possible, and trick his competitors into paying penalties while avoiding paying any penalties himself.)

In addition, the subjects were asked to perform three different auctions in the experiment, instead of performing one auction repeatedly three times. This experimental procedure was designed with the *non-repetitive* nature of knowledge work in mind. Some subjects identified the situation in each case as being quite different, thus conforming to the researcher's planned design. The following quotes were extracted from the retrospective report as a support:

I tried to use it [information about others' performance], but the situation was different. (51)
Each case was totally different. (53)
It was difficult in the ability to adapt to the different scenarios. (61)
Every auction is different, and all the values are different. (65)

Not only did the Auction Task have the required characteristics of knowledge work, it also simulated actual work. As mentioned in Chapter 3, the Auction Task was developed as a training tool for a telecommunications company's bidding personnel. The simulated task simulated real-life situations that the company's bidding personnel would encounter throughout their careers. In addition, the feedback and goal-setting treatments were also made to be as realistic as possible. (For more information on the experimental procedures, see Chapter 3.)

Another unique characteristic of the Auction Task was identified by the post-experimental questionnaire. The questionnaire revealed that the mean scores of motivation, commitment, and satisfaction were 5.92, 6.17, and 5.67, respectively, on a seven-point Likert-type scale.[7] It may be inferred from the post-experimental questionnaire that, overall, the subjects were motivated by, committed to, and satisfied with the Auction Task.

CONCLUSIONS

Overwhelming evidence from the existing literature related to feedback and goal setting in the traditional work environment points to the conclusion that feedback and goal setting improve task performance (e.g., Arps 1917; Trowbridge and Cason 1932; Waters 1933; Macpherson 1948; Ammons 1956). The purpose of this research was to investigate whether the effects of feedback and goal setting on task performance, as found in the traditional work

[7] On a seven-point Likert-type scale (in which 1 = strongly disagree and 7 = strongly agree), the subjects were asked to rate the following questionnaire items, respectively: I thought the task was motivating; I was committed to the task; and I thought the task was satisfying.

environment, would be similar for knowledge work in a distributed environment. The findings from this study were mixed. The evidence did not outright support the claim that feedback and goal setting improved task performance; task performance of the subjects was improved only under certain conditions of feedback and goal setting.

Overall, *feedback* was not found to improve task performance. The subjects had mixed feelings about feedback information. Task feedback and information about others' performance provided positive benefits to some of the subjects. Positive benefits of feedback mentioned in the experiment were knowledge of results and performance, benchmark, learning, error correction, strategies development, planning, improved decision making, and motivation.

Feedback did not improve task performance of some subjects. The subjects did not find information of past performance relevant to their current situation; the subjects were unable to use the information in a meaningful way; and the subjects relied more on their own judgments about their own performance (i.e., their situation awareness) than on the feedback. Moreover, feedback was also found to create negative effects because of its added pressure—especially in the presence of goals. Feedback, Ashton (1990) claims, has detrimental performance effects via its impact on anxiety, especially when the task is perceived as difficult (e.g., via the setting of difficult goals). Anxiety is heightened by task feedback, especially when it reveals poor performance; and performance is revealed and perceived as poor when individuals cannot reach the difficult goals assigned to them (Ashton 1990). Increased pressure and a high level of anxiety contributed to a higher level of mental workload, leading to a decrease in performance. Charlton (1996) contends that when tasks are moderately difficult to very difficult, increased workload is associated with poorer performance.

Providing information about others' performance to the subjects increased their performance. The information, when presented to the subjects, functioned as new and lower (or less difficult) targets/benchmarks. These new and lower targets relieved the subjects from excessive pressure created by higher (or more difficult) goals. Once excessive pressure was removed, the subjects were able to utilize potential benefits that came with task feedback and information about

others' performance in their bidding. Consequently, the performance was higher for the subjects who received both task feedback and information about others' performance than for the subjects who received task feedback only.

The study did not support Locke's (1968) theory that *specific and difficult goals* improve task performance. According to Locke, difficult goals induce individuals to put more effort in their work than they would have if difficult goals had not been given. However, because the Auction Task was highly cognitive, more effort did not necessarily translate into better performance although more effort usually results in better performance in most physical work (e.g., blue-collar work). In fact, the added pressure of having difficult goals compelled some subjects to try harder by adopting risky bidding strategies that jeopardized their bidding performance. This notion is supported by Ashton (1990), who points out that to cope with difficult tasks (induced by difficult goals) and to enhance the likelihood of successful task performance, individuals may resort to varied and high-risk decision strategies that, on average, harm task performance. Because goals also created a winning versus losing mentality, the subjects who did not reach the assigned goals felt defeated and became demotivated, thus nullifying other potential benefits of goal setting, such as, direction, strategies development, planning, and commitment.

The notion that the co-presence of *feedback and goals* is necessary to improve task performance was not supported. Having both task feedback and goals did not improve the subjects' performance because of the pressure that both components created. Ammons (1956) indicates that providing feedback can create negative effects, especially when the person is doing poorly. Feedback indicating that the person has a low probability of achieving the goal can harm performance (Ashton 1990). Upon learning from task feedback that they did not achieve their assigned goals, the subjects in the experiment who received both task feedback and goals thought that they were doing poorly (even though it was not necessarily so because the goals were set at high levels). The subjects who viewed not reaching a goal as a loss were forced to make risky bidding decisions; thus, their task performance suffered.

Not having both task feedback and goals at the same time did not hurt the subjects' performance. In the absence of task feedback, the subjects resorted to their own feelings about their performance; and in the absence of specific and difficult goals, the subjects resorted to do-your-best goals. In other words, the subjects resorted to the most important source of information, their situation awareness, and filled in for information that was missing or incomplete (Entin 1998). The subjects' own feelings about their performance and do-your-best goals proved to be sufficient in performing the task. The subjects who did not have both feedback and goals did their best when performing the task and used their own feelings (i.e., awareness of the situation) in judging their performance; as it turned out, their performance was not significantly lower than that of the subjects who had feedback and/or goals.

PRACTICAL IMPLICATIONS

Undoubtedly, today's business work environment is transforming into a new work environment characterized as a knowledge-based, distributed work environment. Drucker (1977, 1993) points out that knowledge workers account for almost one-third of the total workforce of developed countries, and they are the fastest growing group. Coates (1997) contends that by the year 2020, as much as 40 percent of the workforce is expected to work in a distributed work environment. Most work in the distributed work environment may be knowledge work because knowledge workers lend themselves most easily to distributed work (Grantham and Nichols 1994; Coates 1997).

The existing literature on the traditional work environment has identified the beneficial effects of feedback and goal setting. The results of this study extend the literature into the new work environment (i.e., the knowledge-based, distributed work environment). Because the new work environment is different from the traditional work environment, research implications on feedback and goal setting of this study may prove to be valuable to business practitioners in the new work environment.

The target audience of this research, beyond the research community, is managers and supervisors who are involved with knowledge work in the distributed work environment. Managers and supervisors in the knowledge-based, distributed work environment should be aware of the effects of feedback, goal setting, and their interdependence on task performance. Several implications are provided in this section.

Implications of Feedback Effects

Even though the existing literature provides convincing evidence of feedback benefits, the same could not be said in this study, which simulated knowledge work in a distributed work environment. Managers should not be quick to apply the existing knowledge (on the traditional work environment) in their new work environment (i.e., the knowledge-based, distributed work environment).

As found in the study, feedback did have the same positive effects that were identified in the existing literature (see e.g., Greller and Herold 1975; Ilgen et al. 1979; Busby 1997); but in some situations, feedback also had negative effects—namely, added pressure—as pointed out by Ashton (1990). The two effects might have canceled each other out in the experiment; thus, feedback did not improve task performance. Because feedback has mixed results under different circumstances, managers must decide what feedback should be given to the distributed knowledge workers: task feedback, information about others' performance, or no feedback. In addition, because feedback induces pressure that can either help or hinder task performance, depending on the level of preexisting pressure, managers must identify the right timing to provide feedback for their workers.

Implications of Goal-Setting Effects

Locke (1968) concluded his research findings for the traditional work environment, claiming "The results are unequivocal: the harder the goal the higher the level of performance" (p.162). Goal setting in the new work environment, however, may be more complicated than was originally thought. Because trying harder does not necessarily translate into better performance in the knowledge work environment, higher goals may not improve performance in the new

work environment (i.e., the knowledge-based, distributed work environment). Difficult goals in the experiment compelled the subjects to adopt risky, less-than-optimal strategies in their bidding that jeopardized their performance. Similar adverse impacts could occur in other types of knowledge work. For example, innovation and creativity could be stifled if R&D managers insist on some pre-defined financial goals in R&D operations.

The same implication may be extended to Zero Defects and MBO programs since the drive behind these two programs may be attributed to goal-setting effects (Locke 1968). Managers in the new work environment must be very aware of the effects goal setting creates. Blindly setting performance goals for their workers may do more harm than good. Deming (1993) explains, "A numerical goal accomplishes nothing. Only the method is important, not the goal. By what method?" (p.33).

Another finding managers need to be aware of is that goals can create a winning versus losing mentality. As found during the experiment, the subjects believed that reaching a goal was a win while failing to reach a goal was a loss. When the subjects reached or nearly reached goals, they bid conservatively—to make sure that they maintained that winning position. By maintaining the winning position and using conservative bidding strategies, the subjects became too complacent and their bidding performance started to drop. On the other hand, the subjects who felt that they were not achieving goals changed their bidding strategies and bid aggressively to avoid losing. Subject #62 said "It [a goal] made me overaggressive. You want to meet your goals. If you don't meet your goals, you fail. You might want to go all out. You're going to fail one way or the other." Obviously, the results could be very harmful.

The implication from a winning versus losing mentality may be more pronounced in the knowledge-based, distributed work environment than in the traditional work environment. This could be the case because knowledge work is cognitive, and work is done primarily inside the workers' heads. Supervisors would not be able to know what their workers are thinking until the work is finished or the damage has been done. In addition, being in geographically separate locations, supervisors are unable to observe worker behavior. For example, supervisors may

not have any clue whether their workers are becoming too laid back (after reaching goals) or too anxious (from not reaching goals) in their work.

Implications of Feedback and Goal-Setting Effects

In the absence of task feedback, the subjects resorted to their own feelings about their performance; and in the absence of specific and difficult goals, the subjects resorted to do-your-best goals. As it turned out, the subjects' own feelings about their performance and the subjects' intuitive use of do-your-best goals (in other words, their situation awareness) proved to be sufficient in performing the task.

In the study, the subjects in Cell #1 were left to do their work alone without any goals or feedback. No interaction was made with these subjects until they had finished the task. Arguably, the subjects from Cell #1 were treated by what could be called the "laissez-faire" approach. Davenport et al. (1996) refer this approach as a hands-off approach. "The laissez-faire approach might be characterized as finding good knowledge workers and leaving them to their own devices." They continue "… knowledge workers are fully responsible for designing and executing their own work (Davenport et al. 1996, 59). The results revealed that task performance of the subjects who had neither feedback nor goals (Cell #1) was not significantly lower than that of the subjects who had feedback and/or goals (Cells #2 through 6).

This finding raises many questions. Is it possible that knowledge workers are capable of making decisions on their own, that knowledge workers act as responsible decision makers, that knowledge workers know their work more than anybody else, and that knowledge workers cannot be supervised? Drucker (1993) supports these claims. He says "[Knowledge] Workers must be required to take responsibility for their own productivity, and to exercise control over it" (p.92). He contends "The knowledge-based organization therefore requires that everyone take responsibility for that organization's objectives, contribution, and indeed, for its behavior as well" (p.108). Drucker (1993) continues "Knowledge employees cannot, in effect, be supervised. Unless they know more than anybody else in the organization, they are to all intents and purposes useless" (p.65).

If feedback and goal setting do not consistently produce positive effects, should managers stop providing feedback and assigning goals to their workers—if it is more cost effective not to do so? Should managers just let their knowledge workers have full control of their work until the work is finished? If goal setting and feedback do not improve performance, is performance measurement still necessary (considering that these components are highly interrelated)? The issue about performance measurement has been previously raised in R&D operations. "In fact, the very act of measurement is thought to discourage creativity and motivation among high-level professionals. Many feel that management should just 'have faith' that R&D is a good investment, without trying to measure it" (Brown and Svenson 1988, 11). Even though the findings from this study may not answer these controversial issues, at a minimum, the findings deserve managers' attention. These questions still remain unanswered, but managers need to identify what is best for their individual knowledge workers in the distributed work environment.

Another important finding from the study was that individual differences played an important part in how individuals perceived feedback and goals. While some subjects perceived feedback as useful for strategies development, knowledge of results, motivation, improved decision making, learning, and error correction, others did not believe that task feedback was useful. They perceived task feedback as irrelevant to the current situation and a duplication of information, and they found it difficult to translate the information into something meaningful. While some subjects believed that goals helped improve task performance (via motivation, direction, strategies development, planning, and commitment), others did not believe that goals were useful. Therefore, it is critically important to recognize the role of individual differences in the new work environment, even more so, perhaps, than has been done in the traditional work environment.

Managers in the new work environment (i.e., knowledge-based, distributed work environment) should not continue the old paradigm of one-size-fits-all management style. Managing in the new work environment will be very challenging and will require a different mind set.

Managers must keep their distributed, knowledge workers happy; or they will leave the company and take the means and tools of production, their knowledge, wherever they go (Drucker 1993). The challenge to managers working in the new work environment is to apply what they know about individual employees to the task of designing better, and more personalized, management systems, which include—but are not limited to—feedback, goal-setting, and performance measurement systems. For example, managers may want to consider personalizing feedback dimensions (i.e., signs, timing, frequency, specificity, sources, and choice) and goal dimensions (i.e., specificity and difficulty) according to their employees' individual preferences. A primary task of management in the decades ahead, Drucker (1977, 1993) contends, will be to make knowledge workers productive.

LIMITATIONS AND RECOMMENDATIONS

This section starts with the limitations of the study. After the limitations of the study are described, several recommendations for future research are made. The recommendations are divided into two groups: 1) recommended changes to improve the current study and 2) recommended future studies.

LIMITATIONS OF THE CURRENT STUDY

Any implications derived from this research are not necessarily applicable to all types of knowledge work or to all organizations that distribute their work. The implications of the research may be generalized to individuals under the following conditions:

1. workers who perform knowledge work that is non-routine, non-repetitive, and highly cognitive;
2. workers who are motivated to, committed to, and satisfied with their work; and
3. workers who perform individual work in a distributed work environment.

The *first* condition, task-related condition, is necessary because, for example, if the task had been a routine and repetitive task, feedback might have had different effects. The utility of task feedback and information about others' performance would have increased drastically, and the subjects who had feedback should have had significant advantages over the subjects who did not. If the experimental task had been mainly physical or less cognitive, higher goals might have had different effects. The subjects who had goals could have exerted more effort and might have done significantly better than the subjects who did not have goals because working harder would have translated into better performance.

Because the Auction Task may be considered highly cognitive (most decisions involved risk-taking strategies and were made inside the subjects' heads), the findings may be applicable to tasks that are highly cognitive. This factor may be a limiting factor since not all knowledge work in the distributed work environment will involve such a high level of risk-taking decisions. It is possible that the findings of the study may have been different if a different task (e.g., less cognitive) had been used. That is, the effects of feedback and goal setting on different types of knowledge work may be different. (A recommendation for future research will be provided later in the chapter.)

There may be some questions whether the task used in the study was a valid task and whether the user interface was well designed. The ideal task needed to represent knowledge work that is non-routine, non-repetitive, and cognitive. As mentioned early in this chapter, the Auction Task conformed to these characteristics of knowledge work. In addition, the Auction Task also simulated actual work; it was developed to simulate real-life situations that a company's bidding personnel would encounter throughout their careers. The task was designed and tested many times over by the software developer. As a result, the validity and the interface of the Auction Task should not be a concern. In fact, the Auction Task is good enough to be used in any experiment that requires a highly cognitive task. (A recommendation for future research will be provided later in the chapter.)

Questions may be raised whether the presentation of feedback (i.e., task feedback and information about others' performance) was appropriate. Task feedback and its presentation (see Appendix A.2) were designed to simulate real-life situations. The summaries and the presentations of task feedback (see Appendix A.3) and information about others' performance (see Table 3.5) were easy to understand and straightforward; no evidence of confusion was observed during the experiment. The design of the experiment, however, kept feedback dimensions such as specificity, signs, choice, timing, and frequency constant. Feedback was designed to be specific and neutral, and its summary was given to the subjects immediately after each problem/case was completed. It is possible that the findings of the study may have been different if any of these feedback dimensions had been altered. For example, the findings may have been different if feedback summaries had been positive and encouraging instead of neutral in tone, accessible only if needed instead of given to the subjects, or available at any time instead of at the completion of task only. That is, the effects of feedback on task performance may depend on feedback dimensions. (A recommendation for future research will be provided later in the chapter.)

Similarly, questions may be raised whether the presentation of goals was appropriate. The experiment's goals (see Appendix C.5) were designed to be specific and difficult, according to the literature. The assigned goals were very specific; the subjects did not have any problems understanding the assigned goals. In relation to goal difficulty, however, there may be a legitimate concern whether the goals were set too high. Although the retrospective reports yielded inconsistent results regarding this issue (see Chapter 5 for more details), altering the level of goal difficulty could change the findings of the study since goal difficulty was found to relate to pressure, anxiety, mental workload, and task performance. Because the experiment's goals were set with the use of data from the pilot study with only six sample points (see Table 3.4), there could still be room for improvement. Future research should benefit from more data points available from this study, thus addressing this concern effectively. (Recommended changes to improve the current study will be provided in the next section.)

The *second* condition, subject-related condition, is necessary because if the subjects had not been motivated to, committed to, and satisfied with the task, goals should have increased their performance. This notion was supported by Subject #14, who mentioned that goals might have helped the subject perform the task better if the task had been boring.

There may be questions in relation to the subject pool of the experiment. All of the subjects were undergraduate and graduate students at Virginia Tech who voluntarily agreed to participate in the experiment. Not only were all subjects students, but the subject population was also skewed toward graduate, male, and engineering students (see Table 4.3). One may argue that this may not realistically represent a true population. Although this concern is legitimate, exploratory analyses (see Table 4.18 and Table 4.19) revealed no significant effects of age, QCA, education level, familiarity with the auction process, sex, or major on task performance. Nevertheless, a more diverse population pool would lend greater credence to the study. (A recommended change to improve the current study will be provided in the next section.)

Because the subjects were told at the beginning of the experiment that they would receive compensation of $10 if they completed the experiment, there may be concern whether the subjects felt pressured to complete the task. On the other hand, a concern may also be made whether the subjects were not committed to the task and hurried to finish the task in order to receive the compensation. These two issues are common in laboratory experiments that involve human subjects. With the first issue, arguments can be made that there is also pressure for real-life employees to complete their assigned tasks. As a result, the pressure to complete the experiment's task should not be a real concern. There should not be a real concern with the second issue as well. As mentioned earlier in this chapter, it may be inferred from the post-experimental questionnaire that, overall, the subjects were motivated by, committed to, and satisfied with the Auction Task. The subjects reported very high scores on motivation, commitment, and satisfaction.

The *third* condition, work environment related condition, is necessary because it was the condition in which the experiment was conducted. The results could have been different in a different work setting, such as a group, a team, or a traditional work setting.

The third condition is a very limiting condition. Because the experiment was conducted using a knowledge task in the distributed work environment, it is difficult to interpret whether the results were influenced by the knowledge work aspect or the distributed work aspect of the task. As a result, the interpretation in the present study can only be generalized to the new work environment (i.e., the knowledge-based, distributed work environment). More research is needed in this area. (A recommendation for future research will be provided later in the chapter.)

Recommended Changes to Improve the Current Study

At the very least, the same study, if conducted again, should provide more credible research findings. For example, any researcher who follows the experimental process outlined in Chapter 3 and recommendations detailed in this chapter may be able to increase the validity of the findings. Task performance data from the present study (the total sample size = 36) can be used to set performance goals and information about others' performance for the future study. At the least, the new study should be an improvement from the present study where the pilot study sample size was only six.

Although efforts have been made to ensure that the experiment was well planned and went smoothly, it was inevitable that some minor problems would still occur. For example, some of the subjects mistakenly hit a wrong button on their screen. (In the retrospective report, some of the subjects mentioned that they accidentally double clicked a button when they meant to single click it.) However, no major mistakes were reported. Although the problems might not have completely changed the outcome of the study, it is possible that a problem-free experiment could have resulted in more significant findings. In the experiment, each subject received two training problems and solved three testing problems. Ideally, the researcher would like to see more sessions during the experiment; for example, four training problems and four testing

problems might have been ideal. Having more training sessions may have reduced, if not eliminated, these minor problems; and having more testing problems could have increased the validity of the study. However, the experiment could have exhausted the subjects, and the results could have been affected by the fatigue factor.

The experiment was conducted one subject at a time. Each subject received training and performed the task at a different time. Although an attempt was made to ensure that the training was as consistent as possible (by having well-planned procedures and providing instructions for the Auction Task), there was still room for improvement. Ideally, there would be one common training session for all subjects at the same time. This would ensure the highest level of training consistency. Furthermore, if all of the prospective subjects could perform the same task at the same time, that would also increase the consistency level. However, available facilities and equipment would be an issue. The experiment would require at least 37 sets of facilities and equipment (i.e., 37 separate rooms, 37 networked computers, and 37 telephones) for the researcher and 36 subjects simultaneously.

The experiment was designed to simulate a distributed work environment; the subject and the researcher communicated with each other electronically through telephones and networked computers. Although effort had been made to keep the communication and the interaction between the researcher and the subject to a minimum, there is still room for improvement to reduce the communication and the interaction levels. (In the experiment, communications and interactions were made only when feedback was given and when the auction needed to be changed from one case to the next.) If the Auction Task could be programmed to automate these functions, it would substantially cut down the amount of communications and interactions needed and make the experiment's setting more realistic. However, programming and software costs could be prohibitive.

Finally, a total of 36 subjects was used in the study. The researcher would like to have had more data sets. For example, if the sample size had been doubled to 72, a significant result may have been found for Hypothesis 1.3.2 whose p-value was .0594. In addition, the researcher

would like to have had a more diverse sample population, rather than just the student population alone. A more diverse population pool would lend greater credence to the study. However, available resources and costs would be issues.

Recommended Future Studies

The purpose of this research was to investigate whether the effects of feedback and goal setting on task performance, as found in the traditional work environment, would be similar for knowledge work in the distributed environment. The experiment, therefore, was conducted only in the distributed work environment. An experiment conducted in the traditional work (control) environment and the distributed work environment simultaneously would provide very valuable information to the body of knowledge. At a minimum, the study would identify any differences feedback and goal setting would cause in the two different environments.

This research addressed task performance of individuals who performed knowledge work, and the Auction Task was used to represent knowledge work in this study. The same type of research, done in a group or team setting, would be of interest in addressing task performance at a group or team level. Because this study was conducted in a laboratory environment, empirical studies in different environments (e.g., field studies or case studies) would contribute to the body of knowledge concerning feedback and goal setting. More studies in the distributed, knowledge work environment would provide more understanding of the effects of feedback and goal setting. For example, a study of the effects of a laissez-faire management approach versus a micro-management approach in an actual distributed work environment would be very desirable.

Because the Auction Task may qualify as a highly cognitive task, studies of the effects of feedback and goal setting on different types of knowledge work in the distributed work environment would also contribute to the research community. For example, an experiment could be conducted to study the effects of feedback and/or goal setting for different levels of knowledge work.

Feedback dimensions are feedback signs, timing, frequency, specificity, sources, and choice (Ilgen et al. 1979). Goal dimensions are goal difficulty and specificity (Locke 1968; Locke et al. 1981). The existing research has included these variables in the traditional work environment. More studies are needed in the distributed work environment. In the experiment, these factors were kept constant. Studies on the effects of these variables would contribute to the body of knowledge on feedback and goal setting.

During the experiment, it was found that while some subjects viewed feedback favorably, others did not. The same applied to goal setting as well. The findings were aligned with the findings in the traditional work environment—that individual differences affect how individuals use and perceive feedback and/or goals. (See, e.g., Ilgen et al. 1979 on feedback and Locke et al. 1981 on goals.) Further studies on the impact that individual differences and their perceptions of the value of feedback and goals have on knowledge work performance in the distributed work environment would contribute to the body of knowledge on feedback and goal setting.

Because feedback and goals can affect several psychological variables, eliciting the subjects' self-assessment of such variables as situation awareness, task difficulty, pressure felt, risk-taking propensity, anxiety and effort levels, and mental workload may be useful (Ashton 1990). The findings would shed some light on how feedback and goals affect these variables that subsequently impact task performance.

Finally, as mentioned early in this chapter, the Auction Task had the required characteristics of knowledge work (intangible, cognitive, unstructured, and non-repetitive); and it also simulated actual work. In addition, it was very well developed as a training tool for a company's bidding personnel. These attributes make the Auction Task appealing as an experimental task on knowledge work, whether conducted in a traditional or a distributed work environment. The nature of the activity makes it a good candidate for a highly cognitive task.

REFERENCES

Ammons, R.B. 1956. Effects of Knowledge of Performance: A Survey and Tentative Theoretical Formulation. *Journal of General Psychology* 54: 279-299.

Archibald, R.D. 1992. *Managing High-Technology Programs and Projects.* New York, NY: John Wiley & Sons.

Armstrong, M. 1995. Measuring Work: The Vital Statistics. *People Management* 1 (19): 34-35.

Arps, G.F. 1917. A Preliminary Report on 'Work with Knowledge Versus Work without Knowledge of Results.' *Psychological Review* 24: 449-455.

Ashford, S.J. and A.S. Tsui. 1991. Self-Regulation for Managerial Effectiveness: The Role of Active Feedback Seeking. *The Academy of Management Journal* 34 (2): 251-280.

Ashford, S.J. and L.L. Cummings. 1983. Feedback as an Individual Resource: Personal Strategies of Creating Information. *Organizational Behavior and Human Performance* 32: 370-398.

Ashton, R.H. 1990. Pressure and Performance in Accounting Decision Settings: Paradoxical Effects of Incentives, Feedback, and Justification. *Journal of Accounting Research* 28: 148-180.

Barnatt, C. 1995. Office Space, Cyberspace and Virtual Organization. *Journal of General Management* 20 (4): 78-91.

Beeson, R.O. 1973. Immediate Knowledge of Results and Test Performance. *Journal of Educational Research* 66 (5): 224-226.

Beruvides, M.G. 1993. An Investigation of the Universe and Anatomy of Work. Ph.D. diss., Virginia Tech, Blacksburg, VA.

Beruvides, M.G. and C.P. Koelling. 1992. Management Tools: A Technological Issue in White-Collar/Knowledge Work. In *Management of Technology III*, edited by T.M. Khalil and B.A. Bayraktar. Norcross, GA: Industrial Engineering and Management Press.

Beruvides, M.G. and C.P. Koelling. 1993. Technology Space Mapping of Tools: A Management Issue in Understanding Work. In *Productivity & Quality Management Frontiers—IV*, edited by Sumanth, Edosomwan, Poupart, and Sink. Institute of Industrial Engineers.

Beruvides, M.G. and D.J. Sumanth. 1987. Knowledge Work: A Conceptual Analysis and Structure. In *Productivity Management Frontiers—I*, edited by D.J. Sumanth. Amsterdam, North-Holland: Elsevier Science Publishers B.V.

Beruvides, M.G. and D.J. Sumanth. 1991. An Investigation of Critical Issues Related to White-Collar/Knowledge Work Productivity Measurement. In *Productivity and Quality Management Frontiers—III*, edited by Sumanth, Edosomwan, Sink, and Werther. Institute of Industrial Engineers.

Beruvides, M.G., Omachonu K., and D.J. Sumanth. 1988. A Conceptual Framework of Work: The Measurement of White-Collar/Knowledge Productivity. In *Productivity Management*

Frontiers—II, edited by Sumanth, Edosomwan, Sink, and Werther. Geneva: Inderscience Enterprises Ltd.

Betts, M. 1995. Turn Your Company into a Cybercorp. It's Wired. It's Virtual. It's Agile. *Computerworld* 29 (41): 41.

Bird, J. 1996. Stimulating Simulating: What Could be Achieved by Harnessing All the Latest Technology? *Management Today* (January): 62-64.

Blackler, F. 1995. Knowledge, Knowledge Work and Organizations: An Overview and Interpretation. *Organization Studies* 16 (6): 1021-1046.

Blaylock, B.K. and L.P. Rees. 1984. Cognitive Style and the Usefulness of Information. *Decision Sciences* 15: 74-91.

Bottoms, D. 1994. Back to the Future: Revisiting the Promise of the Virtual Corporation. *Industry Week* 243 (18): 61-64.

Brown, M.G. and R.A. Svenson. 1988. Measuring R&D Productivity. *Research Technology Management* 31 (4): 11-15.

Busby, J.S. 1997. Do Organizations Deliver Feedback to Engineering Designers Effectively? Working Paper, School of Industrial & Manufacturing Science, Cranfield University. Cranfield, UK.

Byrne, J.A., R. Brandt, and O. Port. 1993. The Virtual Corporation. *Business Week*, 8 February, 98-103.

Campion, M.A. and R.G. Lord. 1982. A Control Systems Conceptualization of the Goal-Setting and Changing Process. *Organizational Behavior and Human Performance* 30: 265-287.

Carroll, S.J., Jr. and H.L. Tosi. 1970. Goal Characteristics and Personality Factors in a Management-by-Objectives Program. *Administrative Science Quarterly* 15: 295-305.

Charlton, S.G. 1996. Mental Workload Test and Evaluation. In *Handbook of Human Factors Testing and Evaluation*, edited by T.G. O'Brien and S.G. Charlton. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Chhokar, J.S. and J.A. Wallin. 1984. A Field Study of the Effect of Feedback Frequency on Performance. *Journal of Applied Psychology* 69 (3): 524-530.

Coates, J.F. 1997. Emerging HR Issues for the Twenty-First Century. *Employment Relations Today* 23 (4): 1-9.

Collier, D.W. 1977. Measuring the Performance of R&D Departments. *Research Management* 20 (2): 30-34.

Conley, P.F. 1996. Union Clout Seen Withering in Era of Virtual Corporation. *Journal of Commerce and Commercial* 408 (28747): 4A.

Conway, E.C. 1993. Total Quality, an Integrating Concept. In *Handbook for Productivity Measurement and Improvement*, edited by W.F. Christopher and C.G. Thor. Cambridge, Mass: Productivity Press.

Cox, T. and A. Griffiths. 1995. The Nature and Measurement of Work Stress: Theory and Practice. In *Evaluation of Human Work: A Practical Ergonomics Methodology*, edited by J.R. Wilson and E.N. Corlett. Bristol, PA: Taylor & Francis Ltd.

Coyle, J. and N. Schnarr. 1995. The Soft-Side Challenges of the Virtual Corporation. *Human Resource Planning* 18 (1): 41-42.

Crafts, L.W. and R.W. Gilbert. 1935. The Effect of Knowledge of Results on Maze Learning and Retention. *Journal of Educational Psychology* 26: 177-187.

Crosby, P.B. 1984. *Quality Without Tears: The Art of Hassle-Free Management.* San Francisco, California: McGraw-Hill Book Company.

Davenport, T.H., S.L. Jarvenpaa, and M.C. Beers. 1996. Improving Knowledge Work Process. *Sloan Management Review* (summer): 53-65.

Davidow, W. and M. Malone. 1992. *The Virtual Corporation*. New York, NY: Harper Collins Publishers, Inc.

Davis, T.R.V. 1996. Managing Knowledge-Work Support Functions. *Journal of General Management* 22 (1): 68-86.

Davis, T.R.V. and B.L. Darling. 1996. ABC in a Virtual Corporation. Activity-Based Costing at Super Bakery Inc. *Management Accounting* 78 (4): 18-23.

Deming, W.E. 1986. *Out of the Crisis.* Cambridge, Mass: MIT Center for Advanced Engineering Study.

Deming, W.E. 1993. *The New Economics for Industry, Government, Education.* Cambridge, Mass: MIT Center for Advanced Engineering Study.

Donlin, J.M. 1990. Memory for Performance Feedback: A Test of Self-Motivation Theories. Ph.D. diss., Virginia Tech, Blacksburg, VA.

Drucker, P.F. 1977. *People and Performance*. New York, NY: Harper & Row Publishers, Inc.

Drucker, P.F. 1980. *Managing in Turbulent Times*. New York, NY: Harper & Row Publishers, Inc.

Drucker, P.F. 1992. *Making for the Future: The 1990s and Beyond*. New York, NY: Penguin Books Ltd.

Drucker, P.F. 1993. *Post-Capitalist Society*. New York, NY: Harper & Row Publishers, Inc.

Drucker, P.F. 1995. *Managing in a Time of Great Change*. New York, NY: Penguin Books Ltd.

Duffy, F.M. 1995. Supervising Knowledge Work: A Different Kind of Supervision. *Bulletin* (October): 56-66.

Duffy, M. 1994. Ten Prescriptions for Surviving and Thriving in the Virtual Organization. *Public Relations Quarterly* 39 (2): 28-31.

Duncan, W.R. 1996. *A Guide to the Project Management Body of Knowledge.* Upper Darby, PA: Project Management Institute.

Endsley, M.R. 1988. Design and Evaluation for Situation Awareness Enhancement. In *Proceedings of the Human Factors Society 32nd Annual Meeting*. Santa Monica, CA: Human Factors Society.

Endsley, M.R. 1996. Situation Awareness Measurement in Test and evaluation. In *Handbook of Human Factors Testing and Evaluation*, edited by T.G. O'Brien and S.G. Charlton. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Entin, E.B. 1998. Measuring Situation Awareness in an Attack Helicopter Domain: An Exploratory Investigation. In *Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting*. Chicago, IL: Human Factors and Ergonomics Society.

Ericsson, K.A. and H.A. Simon. 1984. *Protocol Analysis: Verbal Reports as Data.* Cambridge, MA: The MIT Press.

Foster, R.N., L.H. Linden, R.L. Whiteley, and A.M. Kantrow. 1985a. Improving the Return on R&D—I. *Research Management* 28 (1): 12-17.

Foster, R.N., L.H. Linden, R.L. Whiteley, and A.M. Kantrow. 1985b. Improving the Return on R&D—II. *Research Management* 28 (2): 13-22.

Francis, P.H. 1992. Putting Quality into the R&D Process. *Research Technology Management* 35 (4): 16-23.

Frost, P.J. and T.A. Mahoney. 1976. Goal Setting and the Task Process: I. An Interactive Influence on Individual Performance. *Organizational Behavior and Human Performance* 17: 328-350.

Garland, D.J., M.R. Endsley, A.D. Andre, P.A. Hancock, S.J. Selcon, and M.A. Vidulich. 1996. Assessment and Measurement of Situation Awareness. In *Proceedings of the Human Factors and Ergonomics Society 40th Annual Meeting*. Philadelphia, PA: Human Factors and Ergonomics Society.

Geber, B. 1995. Virtual Teams. *Training* 32 (4): 36-40.

Goettl, B.P. 1997. Situation Awareness and Executive Control Processes: Quot Homines, Tot Sententiae. In *Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting*. Albuquerque, NM: Human Factors and Ergonomics Society.

Goldman, S.L. 1994. Co-Operating to Compete: From Alliances to Virtual Companies. *CMA - The Management Accounting Magazine* 68 (2): 13-17.

Grantham, C.E. and L.D. Nichols. 1994. Distributed Work: Learning to Manage at a Distance. *The Public Manager: The New Bureaucrat* 23 (4): 31-34.

Greller, M.M. 1980. Evaluation of Feedback Sources as a Function of Role and Organizational Level. *Journal of Applied Psychology* 65 (1): 24-27.

Greller, M.M. and D.M. Herold. 1975. Sources of Feedback: A Preliminary Investigation. *Organizational Behavior and Human Performance* 13: 244-256.

Griffin, R.W. 1990. *Management.* 2nd ed. Boston, MA: Houghton Mifflin Company.

Hall, M.J. 1990. Task Based Performance Feedback and Subsequent Worker Performance. Ph.D. diss., Virginia Tech, Blacksburg, VA.

Handy, C. 1995. Trust and the Virtual Organization. *Harvard Business Review* (May - June): 40-50.

Harris, R.C., R.C. Insinga, J. Morone, and M.J. Werle. 1996. The Virtual R&D Laboratory. *Research-Technology Management* 39 (2): 32-36.

Herath, H.S.B., C.S. Park, and G.C. Prueitt. 1995. Monitoring Projects Using Case Flow Control Charts. *The Engineering Economist* 41 (1): 27-51.

Hicks, J.O. 1993. *Management Information Systems.* St. Paul, MN: West Publishing Company.

Hodge, B. et al. 1984. *Management Information Systems.* Reston, Virginia: Prentice-Hall Company.

Huber, G.P. 1983. Cognitive Style as a Basis for MIS and DSS Designs: Much Ado About Nothing? *Management Science* 29 (5): 567-579.

Humble, J.E., S.M. Jacobs, and M.V. Sell. 1995. Benefits of Telecommuting for Engineers and Other High-Tech Professionals. *IM* (March - April): 15-19.

Ikeler, B. and R. Vancil. 1997. Digital Delivers Unique Desktop Services for Enterprise Knowledge Workers. *PR Newswire,* 21 January, 121.

Ilgen, D.R. and C.F. Moore. 1987. Types and Choices of Performance Feedback. *Journal of Applied Psychology* 72 (3): 401-406.

Ilgen, D.R., C.D. Fisher, and M.S. Taylor. 1979. Consequences of Individual Feedback on Behavior in Organizations. *Journal of Applied Psychology* 64 (4): 349-371.

Ivancevich, J.M. 1976. Effects of Goal Setting on Performance and Job Satisfaction. *Journal of Applied Psychology* 61 (5): 605-612.

Ivancevich, J.M. and J.T. McMahon. 1977. Education as a Moderator of Goal Setting Effectiveness. *Journal of Vocational Behavior* 11: 83-94.

Ivancevich, J.M. and J.T. McMahon. 1982. The Effects of Goal Setting, External Feedback, and Self-Generated Feedback on Outcome Variables: A Field Experiment. *Academy of Management Journal* 25 (2): 359-372.

Jackson, T.S. and K.W. Klein. 1997. Body Consciousness and Situation Awareness in Perceptual Motor Systems. In *Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting*. Albuquerque, NM: Human Factors and Ergonomics Society.

Jenner, L. 1994. Are You Ready for the Virtual Workplace? *HRFocus* (July): 15-16.

Keller, R.T. and W.E. Holland. 1982. The Measurement of Performance Among Research and Development Professional Employees: A Longitudinal Analysis. *IEEE Transactions on Engineering Management* 29 (2): 54-58.

Kerzner, H. 1995. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. 5th ed. New York, NY: Van Nostrand Reinhold.

King, W.R. and B.J. Epstein. 1983. Assessing Information System Value: An Experimental Study. *Decision Sciences* 14 (1): 34-45.

Klein, M.M. 1994. The Virtue of Being a Virtual Corporation. *Best's Review - Property-Casualty Insurance Edition* 95 (6): 92-96.

Kurstedt, H.A., Jr. 1993. Management Systems Theory, Applications, and Design. Unpublished ISE 4015 & 4016 Course Note Package, Management Systems Laboratory, Virginia Tech, Blacksburg, VA.

Kurstedt, H.A., Jr. 1994a. Management Systems Engineering or Management Science: Another Way of Looking at Management. Unpublished ISE 4016 Class Lecture, Virginia Tech, Blacksburg, VA.

Kurstedt, H.A., Jr. 1994b. Management Systems Engineering: The Engineering Approach to Quality. Unpublished ISE 4016 Class Lecture, Virginia Tech, Blacksburg, VA.

Landen, D.L. and G.A. Landen. 1990/91. Understanding—and Improving—Organizations Through Cybernetics. *National Productivity Review* 8 (1): 11-22.

Latham, G.P. and G.A. Yukl. 1975a. A Review of Research on the Application of Goal Setting in Organizations. *Academy of Management Journal* 18 (4): 824-845.

Latham, G.P. and G.A. Yukl. 1975b. Assigned Versus Participative Goal Setting with Educated and Uneducated Woods Workers. *Journal of Applied Psychology* 60 (3): 299-302.

Latham, G.P. and G.A. Yukl. 1976. Effects of Assigned and Participative Goal Setting on Performance and Job Satisfaction. *Journal of Applied Psychology* 61 (2): 166-171.

Latham, G.P. and J.J. Baldes. 1975. The Practical Significance of Locke's Theory of Goal Setting. *Journal of Applied Psychology* 60 (1): 122-124.

Latham, G.P. and L.M. Saari 1979a. Importance of Supportive Relationships in Goal Setting. *Journal of Applied Psychology* 64 (2): 151-156.

Latham, G.P. and L.M. Saari 1979b. The Effects of Holding Goal Difficulty Constant on Assigned and Participatively Set Goals. *Academy of Management Journal* 22 (1): 163-168.

Latham, G.P. and S.B. Kinne, III. 1974. Improving Job Performance Through Training in Goal Setting. *Journal of Applied Psychology* 59 (2): 187-191.

Latham, G.P., T.R. Mitchell, and D.L. Dossett. 1978. Importance of Participative Goal Setting and Anticipated Rewards on Goal Difficulty and Job Performance. *Journal of Applied Psychology* 63 (2): 163-171.

Ledford, G. 1995. Paying for the Skills, Knowledge, and Competencies of Knowledge Workers. *Compensation and Benefits Review* 27 (4): 55-62.

Lehrer, R. 1983. *White Collar Productivity*. New York, NY: McGraw-Hill Book Company.

Lewis, J.P. 1995. *The Project Manager's Desk Reference: A Comprehensive Guide to Project Planning, Scheduling, Evaluation, Control, and Systems.* Chicago, IL: Irwin Professional Publishing.

Locke, E.A. 1968. Toward a Theory of Task Motivation and Incentives. *Organizational Behavior and Human Performance* 3: 157-189.

Locke, E.A. and J.F. Bryan. 1969. The Directing Function of Goals in Task Performance. *Organizational Behavior and Human Performance* 4: 35-42.

Locke, E.A., K.N. Shaw, L.M. Saari, and G.P. Latham. 1981. Goal Setting and Task Performance: 1969-1980. *Psychological Bulletin* 90 (1): 125-152.

Louis, M.R. 1991. Designing Performance Appraisal Systems [Review of Designing Performance Appraisal Systems—Aligning Appraisals and Organizational Realities]. *The Academy of Management Review* 16 (2): 469-475.

Macpherson, S.J., V. Dees, and G.C. Grindley. 1948. The Effect of Knowledge of Results on Learning and Performance. II. Some Characteristics of Very Simple Skills. *Quarterly Journal of Experimental Psychology* 1 (2): 68-78.

Macpherson, S.J., V. Dees, and G.C. Grindley. 1949. The Effect of Knowledge of Results on Learning and Performance. III. The Influence of the Time Interval between Trials. *Quarterly Journal of Experimental Psychology* 1 (4): 167-174.

Maloff, J. 1995. The Virtual Corporation. *Internet World*, July, 46-50.

Malone, M. and W. Davidow. 1992. Virtual Corporation. *Forbes*, 7 December, 103-106.

March, J.G. 1995. The Future, Disposable Organizations and the Rigidities of Imagination. *Organization* 2: 427-440.

McGoon, C. 1995. 10 Years from Now. *Communication World* 12 (1):18-22.

Meinhart, W.A. and J.A. Pederson. 1989. Measuring the Performance of R&D Professionals. *Research Technology Management* 32 (4): 19-21.

Menagh, M. 1995. Virtues and Vices of the Virtual Corporation. *Computerworld,* 13 November, 134.

Meyer, H.H. 1991. A Solution to the Performance Appraisal Feedback Enigma. *The Academy of Management Executive* 5 (1): 68-76.

Moser, M.R. 1985. Measuring Performance in R&D Settings. *Research Management* 28 (5): 31-33.

Nadler, D.A. 1977. *Feedback and Organization Development: Using Data-Based Methods.* Reading, MA: Addison-Wesley Publishing Company.

Napoliello, M.F. 1987. Study of Managerial Computer Users. Ph.D. diss., Virginia Tech, Blacksburg, VA.

Naylor, J.C. and D.R. Ilgen. 1984. Goal Setting: A Theoretical Analysis of a Motivational Technology. *Research in Organizational Behavior* 6: 95-140.

O'Reilly, C.A. III. 1983. The Use of Information in Organizational Decision Making: A Model and Some Propositions. *Research in Organizational Behavior* 5: 103-139.

Olson, F. 1983. *White Collar Waste: Gain the Productivity Edge.* Englewood Cliffs, NJ: Prentice-Hall Inc.

Ott, R.L. 1993. *An Introduction to Statistical Methods and Data Analysis.* 4th ed. Belmont, CA: Duxbury Press.

Pape, W.R. 1996. Hire Power. *Inc. Technology*, 1996 (4): 23-24.

Pappas, R.A. and D.S. Remer. 1985. Measuring R&D Productivity. *Research Management* 28 (3): 15-22.

Patterson, J. 1994. Welcome to the Company that Isn't There. *Business Week*, 17 October: 86-87.

Pitt, L.F., R.T. Watson, and C.B. Kavan. 1995. Service Quality: A Measure of Information Systems & Effectiveness. *MIS Quarterly* 19 (2): 173-187.

Powers, W.T. 1973. Feedback: Beyond Behaviorism. *Science* 179: 351-356.

Pritchard, R.D., L.G. Weiss, A.H. Goode, and L.A. Jensen. 1990. Measuring Organizational Productivity with ProMES. *National Productivity Review* 9 (3): 257-269.

Pritchard, R.D., S.D. Jones, P.L. Roth, K.K. Stuebing, and S.E. Ekeberg. 1988. Effects of Group Feedback, Goal Setting, and Incentives on Organizational Productivity. *Journal of Applied Psychology Monograph* 73 (2): 337-358.

Reid, G.B. and T.E. Nygren. 1988. The Subjective Workload Assessment Technique: A Scaling Procedure for Measuring Mental Workload. In *Human Mental Workload*, edited by P.A. Hancock and N. Meshkati. Amsterdam, North-Holland: Elsevier Science Publisher B.V.

Roach, S. 1991. Pitfalls on the New Assembly Line: Can Services Learn from Manufacturing? *Technology and Productivity: The Challenge for Economic Policy*. Washington, DC: OECD Publications.

Ronan, W.W., G.P. Latham, and S.B Kinne, III. 1973. Effects of Goal Setting and Supervision on Worker Behavior in an Industrial Situation. *Journal of Applied Psychology* 58 (3): 302-307.

Schainblatt, A.H. 1982. How Companies Measure the Productivity of Engineers and Scientists. *Research Management* 25 (3): 10-18.

Schulman, R.S. 1997. STAT 5666 Class Materials. Unpublished STAT 5666 Class Lecture, Virginia Tech, Blacksburg, VA.

Schumann, P.A., D.L. Ransley, and D.C.L. Prestwood. 1995. Measuring R&D Performance. *Research Technology Management* 38 (3): 45-54.

Semich, J.W. 1994. Information Replaces Inventory at the Virtual Corp. *Datamation* 40 (14): 37-42.

Sheridan, J.H. 1996. The Agile Web: A Model for the Future? *Industry Week*, 4 March, 31-33.

Simons, T. 1995. Virtual Reality: Creation of a Virtual Corporation. *Inc*. 17 (14): 23-24.

Sink, D.S. and T.C. Tuttle. 1989. *Planning and Measurement in Your Organization of the Future*. Norcross, GA: Industrial Engineering and Management Press.

Souder, W.E. 1969. The Validity of Subjective Probability of Success Forecasts by R&D Project Managers. *IEEE Transactions on Engineering Management* 16 (1): 35-49.

Stahl, M.J. and J.A. Steger. 1977. Measuring Innovation and Productivity—A Peer Rating Approach. *Research Management* 20 (1): 35-38.

Steers, R.M. 1975. Task-Goal Attributes, n Achievement, and Supervisory Performance. *Organizational Behavior and Human Performance* 13: 392-403.

Szakonyi, R. 1994a. Measuring R&D Effectiveness—I. *Research Technology Management* 37 (2): 27-32.

Szakonyi, R. 1994b. Measuring R&D Effectiveness—II. *Research Technology Management* 37 (3): 44-55.

Tackett, R. 1996. Management: Remote Workers: Planning for the Tele-Revolution. *LAN Times* 13 (19): 76.

Taylor, J.C. and D.F. Felten. 1993. *Performance by Design: Sociotechnical Systems in North America.* Englewood Cliffs, NJ: Prentice-Hall Inc.

Taylor, M.S., C.D. Fisher, and D.R. Ilgen. 1984. Individuals' Reactions to Performance Feedback in Organizations: A Control Theory Perspective. *Research in Personnel and Human Resources Management* 2: 81-124.

Tenner, A.R. 1991. Quality Management Beyond Manufacturing. *Research Technology Management* 34 (5): 27-32.

Terborg, J.R. 1976. The Motivational Components of Goal Setting. *Journal of Applied Psychology* 61 (5): 613-621.

Thong, J. and C.S. Yap. 1995. CEO Characteristics, Organizational Characteristics and Information Technology Adoption in Small Business. *Omega* 23 (4): 429-442.

Thor, C.G. 1983. Productivity Measurement in White Collar Groups. In *White Collar Productivity*, edited by R.N. Lehrer. San Francisco, California: McGraw-Hill Book Company.

Thor, C.G. 1993a. A Complete Productivity and Quality Measurement System. In *Handbook for Productivity Measurement and Improvement*, edited by W.F. Christopher and C.G. Thor. Cambridge, MA: Productivity Press.

Thor, C.G. 1993b. Ten Rules for Building a Measurement System. In *Handbook for Productivity Measurement and Improvement*, edited by W.F. Christopher and C.G. Thor. Cambridge, Mass: Productivity Press.

Tipping, J.W., E. Zeffren, and A.R. Fusfeld. 1995. Assessing the Value of Your Technology. *Research Technology Management* 38 (5): 22-39.

Tomas, J and J. Arias. 1995. Do Networks Really Foster Innovation? *Management Decision* 33 (9): 52-56.

Trowbridge, M.H. and H. Cason. 1932. An Experimental Study of Thorndike's Theory of Learning. *Journal of General Psychology* 7: 245-260.

Valovic, T. 1993. *Corporate Networks: The Strategic Use of Telecommunications.* Norwood, MA: Artech House.

Van Aken, E.M. 1995. Determinants of Team Effectiveness for Cross-Functional Organizational Design Teams. Ph.D. diss., Virginia Tech, Blacksburg, VA.

Varca, P.E. and J.C. Levy. 1984. Individual Differences in Response to Unfavorable Group Feedback. *Organizational Behavior and Human Performance* 33: 100-111.

Verespej, M.A. 1995. A Workforce Revolution?. *Industry Week*, 21 August, 21-27.

Virginia Tech Space And Wireless BUsiness Center (SAWBUC). 1997. *Spectrum Auctions Integrated System Manual*. Blacksburg, VA: Virginia Tech.

Wallace, M. 1989. Brave New Workplace. *Work and Occupations* 16 (4): 363-391.

Waters, R.H. 1933. The Specificity of Knowledge of Results and Improvement. Abstract in *Psychological Bulletin* 30: 673.

Webber, A. 1993. What's So New About the New Economy? *Harvard Business Review* (January - February): 24-42.

Werner, B.M. and W.E. Souder. 1997. Measuring R&D Performance—State of the Art. *Research Technology Management* 40 (2): 34-42.

Yukl, G.A. and G.P. Latham. 1978. Interrelationships among Employee Participation, Individual Difference, Goal Difficulty, Goal Acceptance, Goal Instrumentality, and Performance. *Personnel Psychology* 31: 305-323.

APPENDICES

Note: Some of the information in the appendices was applicable to certain subjects, depending on what treatments (i.e., the cell numbers of the experiment design) the subjects were assigned to. (See Table 4.1 for the experimental design of this study.) When appropriate, effort was made to identify the corresponding cell numbers.

A.1 THE AUCTION TASK PREPARATIONS

The Auction Task
Version 1.1.15, December 14, 1997

Delete Unwanted Scenarios
Delete the SingleProperty 2 scenario
Delete the AllCompanies scenario

Create Train2Prop Scenario
Open Single Property scenario
Properties = 101, 62
Companies:
- Hughes
- AT&T: W; Market Information: Penetration 4%, Growth Rate 4%; Service to be Provided: Direct to Home (DTH)
- Echostar: L; Aggressiveness: 0.25
- Competitor 7: L; Aggressiveness: 0.25

Spreadsheet = Complementarities.xls
Seconds per Round = 600 seconds
Audio Option = off
Phase Information: Minimum Bid Increment Percents = 0.05
Save as **Train2Prop** scenario

Create Train3Prop Scenario
Open BaseLine scenario
Properties = 101, 62, 78
Companies:
- Hughes
- Echostar: L; Aggressiveness: 0.25
- Competitor 7: L; Aggressiveness: 0.25

Spreadsheet = Complementarities.xls
Seconds per Round = 600 seconds
Audio Option = off
Phase Information: Minimum Bid Increment Percents = 0.05
Save as **Train3Prop** scenario

Create TestCompete (Test A) Scenario
Open Train3Prop scenario
Companies:
- Hughes
- GE: W; Market Information: Penetration 8%, Growth Rate 6%; Services to be Provided: Direct to Home (DTH), Video and Data Services (VDS)
- Echostar: L; Aggressiveness: 0.50
- Competitor 7: L; Aggressiveness: 0.50

Spreadsheet = Complementarities.xls
Seconds per Round = 600 seconds
Audio Option = off

Phase Information: Minimum Bid Increment Percents = 0.05
Save as **TestCompete** scenario

Create Test12 (Test B) Scenario
Open TestCompete scenario
Companies:
    Hughes
    GE
    Echostar: L; Aggressiveness: 0.25
    Competitor 7: L; Aggressiveness: 0.25
Spreadsheet = Complementarities12.xls
Seconds per Round = 600 seconds
Audio Option = off
Phase Information: Minimum Bid Increment Percents = 0.05
Save as **Test12** scenario

Create Test24 (Test C) Scenario
Open Test12 scenario
Companies:
    Hughes
    GE
    Echostar: L; Aggressiveness: 0.25
    Competitor 7: L; Aggressiveness: 0.25
Spreadsheet = Complementarities24.xls
Seconds per Round = 600 seconds
Audio Option = off
Phase Information: Minimum Bid Increment Percents = 0.05
Save as **Test24** scenario

Disable Unwanted Functions
For both FB and NFB,
    Hide Submit Late button and make Submit button large
    Hide everything in the Analysis block (upper right), except:
        For FB, enable Value Analysis button
        For NFB, hide Value Analysis in a way that subjects don't know

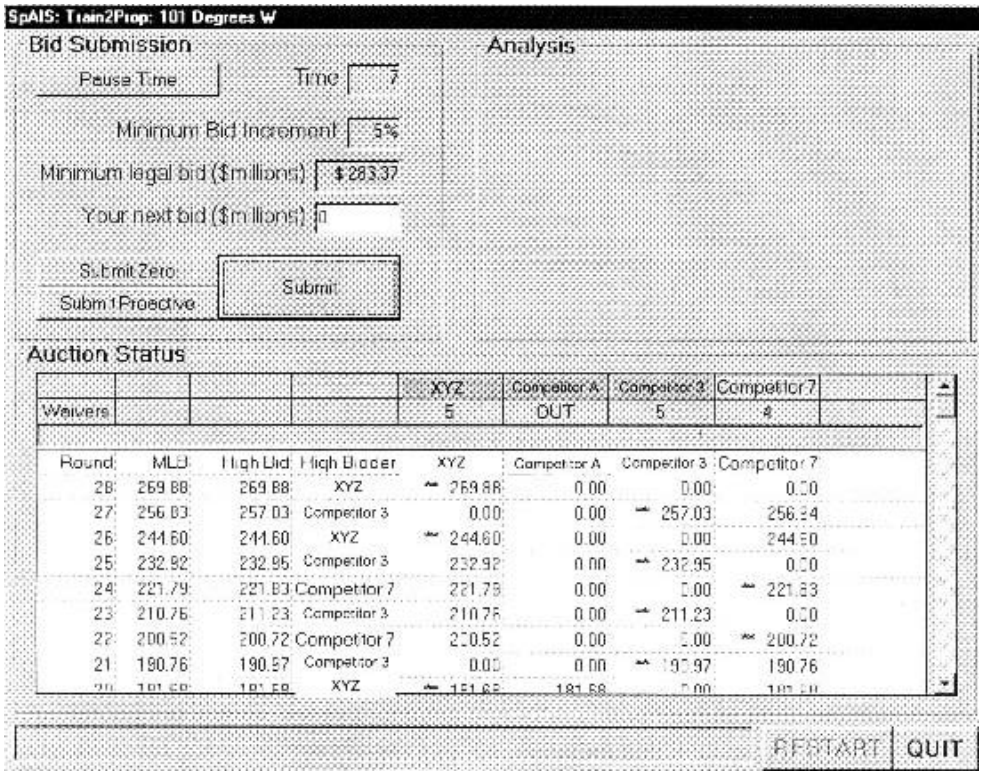
For NFB,
    Disable Amount Grid
    Disable Penalty messages:
        In Auction.Bas module, go to General and choose AnnouncePenalty
        In AnnouncePenalty, remark out the line:
            response = MsgBox (Message, 0, Player(k).Name)

A.2 THE AUCTION TASK SCREEN CAPTURES

(Cells #1, 2)

CASE: Train2Prop

PROPERTY: 101 Degrees W

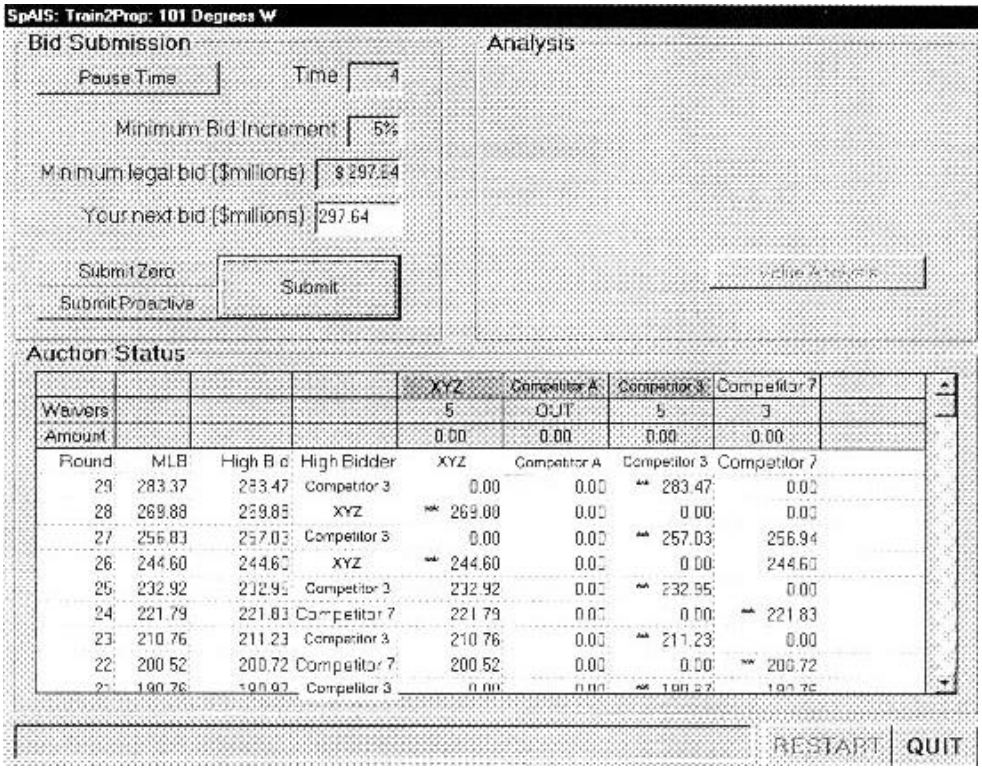


** indicates the highest bidder of that round.

(Cells #3, 4, 5, 6)

CASE: Train2Prop

PROPERTY: 101 Degrees W



** indicates the highest bidder of that round.

A.3 NOTEPAD USED TO PRESENT TASK FEEDBACK

(Cells #3, 4, 5, 6)

Case 1:

Total Cr. (money you saved): $ 118.9 mil
Total Cr. (penalty): $ 59.6 mil
Total Cr. (driving up your competitors' costs): $28.18 mil

TOTAL MONEY YOU MADE: $ 206.7 mil

Case 2:

Total Cr. (money you saved): $ ____ mil
Total Cr. (penalty): $ ____ mil
Total Cr. (driving up your competitors' costs): $ ____ mil

TOTAL MONEY YOU MADE: $ ____ mil

Case 3:

Total Cr. (money you saved): $ ____ mil
Total Cr. (penalty): $ ____ mil
Total Cr. (driving up your competitors' costs): $ ____ mil

TOTAL MONEY YOU MADE: $ ____ mil

A.4 SPREADSHEET USED TO COMPUTE TASK PERFORMANCE

	XYZ	COM G	COM 3	COM 7		
1 Only (101 W)	281.39	289.26	171.78	84.75		
Bid	168.98					
Next Lower Bid		281.39	84.75	0		
Over		0	0	0		Total
Credit	112.41	0	0	0	$ Credit	112.41
Penalty					$ Penalty	0
					$ Made	112.41
2 Only (62 W)	64.89	256.6	143.79	63.22		
Bid		256.5				
Next Lower Bid		143.79	64.89	0		
Over		112.71	0	0		Total
Credit	0	28.1775	0	0	$ Credit	28.1775
Penalty	26.34				$ Penalty	-26.34
					$ Made	1.8375
3 Only (78 W)	90.81	97.11	171.78	179.71		
Bid	260.34					
Next Lower Bid		90.81	97.11	171.78		
Over		0	0	0		Total
Credit	-169.53	0	0	0	$ Credit	-169.53
Penalty				85.94	$ Penalty	85.94
					$ Made	-83.59
1, 2	357.62	327.69	204.71	110.07		
Bid	0	0	0	0		
Next Lower Bid		204.71	110.07	0		
Over		0	0	0		
Credit	0	0	0	0	$ Credit	0
1, 3	548.2	337.3	212.95	282.9		
Bid	429.32	0	0	0		
Next Lower Bid		282.9	0	212.95		
Over		0	0	0		
Credit	118.88	0	0	0	$ Credit	119
2, 3	357.62	327.69	204.71	274.67		
Bid	0	0	0	0		
Next Lower Bid		274.67	0	204.71		
Over		0	0	0		
Credit	0	0	0	0	$ Credit	0
1, 2, 3	578.69	377.65	247.53	294.93		
Bid	0	0	0	0		
Next Lower Bid		294.93	0	247.53		
Over		0	0	0		
Credit	0	0	0	0	$ Credit	0

PENALTY

	XYZ	COM G	COM 3	COM 7	
1 ONLY	0	0	0	0	
2 ONLY	26.34	0	0	0	
3 ONLY	0	0	0	85.94	
TOTAL	26.34	0	0	85.94	59.6

CREDIT

1, 2	0	3	0
1, 3	118.9	2	28.18
2, 3	0	1	0
1, 2, 3	0		

PERFORMANCE INDEX

one, one, one	two, one	three
0	206.7	0

B.1 PLANNED SEQUENCE

	Subj. 1	Subj. 2	Subj. 3	Subj. 4	Subj. 5	Subj. 6
Cell #1	C1224 **11**	2412C **21**	24C12 **31**	1224C **41**	12C24 **51**	C2412 **61**
Cell #2	C2412 **12**	C1224 **22**	2412C **32**	24C12 **42**	1224C **52**	12C24 **62**
Cell #3	12C24 **13**	C2412 **23**	C1224 **33**	2412C **43**	24C12 **53**	1224C **63**
Cell #4	1224C **14**	12C24 **24**	C2412 **34**	C1224 **44**	2412C **54**	24C12 **64**
Cell #5	24C12 **15**	1224C **25**	12C24 **35**	C2412 **45**	C1224 **55**	2412C **65**
Cell #6	2412C **16**	24C12 **26**	1224C **36**	12C24 **46**	C2412 **56**	C1214 **66**

Note: C = TestComp (Test A)
12 = Test12 (Test B)
24 = Test24 (Test C)

B.2 PREPARATION CHECKLIST

Subject #: _____
Date & Time: _____

____ Find the sequence of the assignments

____ Prepare the documents
____ Write down the subject number on pre- and post- experiment questionnaires

____ Prepare the tape recorder
____ Reset the tape recorder to 000

SUBJECT'S WORKSTATION
____ Auction (Train2)
____ NetMeeting (remove microphone and speaker check marks)

RESEARCHER'S 1ST WORKSTATION
____ NetMeeting (remove microphone and speaker check marks)
____ Prepare the appropriate Excel spreadsheet *(for Cells #3, 4, 5, 6)*

RESEARCHER'S 2ND WORKSTATION
____ Auction (Test xxx)
____ NetMeeting (remove microphone and speaker check marks)
____ Sound mixer
____ Prepare the appropriate Notepad *(for Cells #3, 4, 5, 6)*

RESEARCHER'S NOTEBOOK
____ Prepare 3 appropriate spreadsheets

B.3 PROCESS CHECKLIST

Subject #: _____
Date & Time: _____

☐ Initial Screening Process ($1)

____ Introduce the experiment (Introduction)
____ Ask the subject to read and sign the informed consent form (Consent Form)
____ Ask the subject to fill out the pre-experiment questionnaire (Pre-Questionnaire)
____ Check the subject's background
____ Check whether the subject is familiar with the task
____ Check whether the subject is familiar with Windows

☐ Training Process ($1)

____ Ask the subject to read the instructions (Auction Task, Screen Capture)
____ Explain the task in detail
____ Ask the subject to try the 1st training assignment (Cost Data Sheet)
____ Ask "Are you comfortable with everything so far?"

☐ Detailed Screening Process ($1)

____ Ask the subject to try the 2nd training assignment
____ Check whether the subject has some understanding of the task
____ Ask "Are you comfortable with everything so far?"

____ Explain the treatment procedure (GS, TFB, CWO) † (Procedures, Cost Data Sheets)
____ Explain the electronics communication process (NetMeeting, telephone)

____ Leave the room

☐ Experimental Process ($7)

____ Call the subject
____ Connect electronically to the subject

____ Select the 1st simulation test
____ Ask the subject to perform the 1st simulation test
____ Start the stop watch
____ Stop the stop watch
____ Note time taken
____ Calculate and note task performance

____ Provide TFB †
____ Provide CWO †
____ Save the 1st simulation test result

____ Select the 2nd simulation test
____ Ask the subject to perform the 2nd simulation test
____ Start the stop watch
____ Stop the stop watch
____ Note time taken
____ Calculate and note task performance

____ Provide TFB †
____ Provide CWO †
____ Save the 2nd simulation test result

____ Select the 3rd simulation test
____ Ask the subject to perform the 3rd simulation test
____ Start the stop watch
____ Stop the stop watch
____ Note time taken
____ Calculate and note task performance

____ Provide TFB †
____ Provide CWO †
____ Save the 3rd simulation test result

____ Save the task feedback result

____ Come back to the room
____ Start the audio tape
____ Ask the subject to fill out the post-experiment questionnaire (Post-Questionnaire)
____ Stop the audio tape
____ Compensate the subject
____ Ask the subject to sign the subject payment sheet (Payment Sheet)
____ Remind the subject about the confidentiality of this experiment

† *Applied to appropriate subjects*

C.1 INTRODUCTION SCRIPT

Thank you for participating in this experiment. My name is Aood. I am a Ph.D. student in the ISE Department at Virginia Tech. I am conducting research on knowledge work performance in a distributed work environment. You will be working on the Auction Task. This Auction Task is a simulation game for bidding telecommunications property. It was developed as a training tool for a telecommunications company's bidding personnel.

C.2 INFORMED CONSENT FORM

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Informed Consent for Participants of Investigative Projects

Title of Project: Investigation of factors that affect knowledge work performance in the distributed work environment.

Investigators: Kriengkrai Tankoonsombut
Dr. Patrick Koelling
Dr. Brian M. Kleiner

I. Purpose of This Research

The purpose of this research is to determine factors that may affect knowledge work performance when supervisors and workers are not physically collocated. Task performance such as decision quality, improvement of decision quality, and time to finish the task will be evaluated in this study. Approximately 36 participants will be involved in this study.

II. Procedures

An initial screening process (approximately 5 minutes) will be conducted to determine whether the subject is qualified to perform the given task. A 40-minute training session will be given after the initial screening process. After the training session, the subject will continue into the detailed screening process (approximately 30 minutes). The subject who passes the screening process (i.e., scores the minimum) will continue to work on solving a computerized task. The subject will be working in a separate location from and interact with the investigator through telephone and/or teleconferencing that supports video, audio, and text-based communications. During the experiment, the interactions between the subject and the investigator will be audio taped, and important performance data will be recorded. The subject will complete short pre- and post-experiment questionnaires. The task and the questionnaires are expected to take about an hour to complete. All together, the entire experiment is expected to take from one-and-a-half to two hours.

III. Risks

There are minimal risks (i.e., no greater than those encountered in daily life) associated with this study.

IV. Benefits of This Research

Although no direct benefits to you can be promised or guaranteed, this research may provide knowledge of how to design a better management system in a distributed work environment. Participating in this research will expose you to several concepts that may be new to you, including business auctions and electronic collaboration in a distributed work environment. The game used in the experiment may prove to be fun and challenging to you.

V. Extent of Anonymity and Confidentiality

All information related to you, individually, will be kept strictly confidential. The information you provide will have your identification removed, and only the subject number will identify you during analyses and written reports of the research.

The interactions between you and the investigator will be audio taped. The tapes will be kept by the investigator in a locked file cabinet in the Macroergonomics and Group Decision Systems Laboratory. Any recordings will be available to the investigator only and may be reviewed for later analysis. All recordings will be destroyed no later than one year after the completion of this study.

VI. Compensation

You will first go through a screening process. If you pass the screening process, then you will complete the full experiment. If you complete the full experiment, you will be compensated a total of $10. If you do not complete the full experiment, you will be compensated for the phase(s) of the experiment you complete (i.e., $1 for the initial screening, $1 for the training, and $1 for the detailed screening).

VII. Freedom to Withdraw

You are free to withdraw from this study at any time. If you choose to withdraw during the study, you will be compensated for the phase(s) of the experiment you complete (see VI).

VIII. Approval of Research

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

IX. Subject's Responsibilities

By signing this Informed Consent form, you voluntarily agree to participate in this study. <u>You also agree not to discuss any aspects of this research with others after the conclusion of the study</u>.

Contact Persons: If you have any questions about this research, you may contact:

Kriengkrai Tankoonsombut (Research Investigator)	(540) 231-2464	ktankoon@vt.edu
Dr. Patrick Koelling	(405) 744-5042	koelling@cpk.iden.okstate.edu
Dr. Brian M. Kleiner (Faculty Advisors)	(540) 231-4926	bkleiner@vt.edu
Mr. Tom Hurd (Chair, Institutional Review Board)	(540) 231-5281	

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

---------- ----------

(Signature) (Date)

C.3 PRE-EXPERIMENT QUESTIONNAIRE

(Subject #:_____)

I Please provide the following information about yourself:

Age: _____ Major: _____

Gender: _____ Level in school: ____ Freshman

QCA: _____ ____ Sophomore

____ Junior

____ Senior

____ Graduate - Masters

____ Graduate - Ph.D.

____ Others _____

II Your familiarity with the auction/bidding process:

____ None (e.g., I have never heard of it before.)

____ Very little (e.g., I have heard about it before.)

____ Little (e.g., I have some idea what it is.)

____ Fair (e.g., I know how it works.)

____ Familiar (e.g., I have seen the actual process before.)

____ Very familiar (e.g., I have participated in the actual process before.)

____ Extremely familiar (e.g., I have participated in the actual process many times.)

C.4 THE AUCTION TASK INSTRUCTIONS

(Please read the following overview of the Auction Task. You may not fully understand everything after you finish reading, but we will go over the Auction Task together afterward.)

Roles and Responsibilities
You will assume the role of XYZ's bidder. With this task, you will be asked to compete with simulated competitors in the bidding process. The quality of your decision will be reflected in the total amount of money spent in the bidding process and the number of the properties won. The first objective of this game is to win as many properties as you can at the minimum cost possible. The second objective of this game is to make other competitors lose as much money as possible.

Two Bidding Strategies
Bid to win (Competitor A and Competitor G): The companies participate with the hope of winning the auction at a price less than what the property is worth.

Bid to lose (Competitor 3 and Competitor 7): A strategy designed to increase competitors' cost of acquiring the property but not with the intention of the bidder's winning the property. This is a risky strategy because one could end up winning the property that was not intended to be won. How much are you willing to lose to increase your competitors' costs? In this experiment, the number is called the ***Competitive Factor***, which is set at 25% That means, Competitor 3 and Competitor 7 are willing to lose approximately $0.25 if they can make their competitors pay $1 extra. (Only in one case will the Competitive Factor be changed to 50% to simulate a more competitive environment.)

Withdrawing a Winning Bid
The winning company is given the opportunity at the end of each auction to withdraw from the auction. The party who withdraws his winning bid may be penalized. The penalty is calculated as the difference between the withdrawn bid and the bid made by the opponent who wins the restarted auction. For example: suppose that Competitor 3 bids $700 million against XYZ and then withdraws his bid. XYZ then wins the restarted auction for $500 million. In this case, Competitor 3 would be given a penalty of $700 million - $500 million or $200 million for withdrawing his bid. On the other hand, if XYZ had paid $750 million in the restarted auction, then Competitor 3 would owe no penalty.

Goals
You will represent XYZ. Again, your goals are to win as many properties as you can at the minimum cost possible and to make other competitors lose as much money as possible. In this

experiment, you want to maximize the amount of money you end up with at the end of the experiment. You can maximize the amount of your money if you:

- Win as many properties as you can at the minimum cost possible. If a property is worth $300 million to XYZ and you can win that property under that value (e.g., $200 million), then you will receive the credit of that difference (i.e., $100 million). However, if you win that property above that value (e.g., $350 million), then you lose $50 million.

- Try not to be penalized, but make your competitors pay as much penalty as possible. For example, if you are penalized $100 million, then you lose $100 million. If you make your competitors pay $200 million penalty, then you receive that $200 million credit.

- Try to drive up your competitors' costs. For every dollar that your competitors have to pay more for their properties, you will also receive 25% credit (the Competitive Factor). For example, if you can make your competitors pay an extra $100 million, you will receive a $25 million credit. (Only in one case in this experiment will the credit be changed to 50% to simulate a more competitive environment.) This is a risk involved because you could end up winning the property that was not intended to be won or paying some penalty.

About Properties and Their Values

In this experiment, you will be participating in five auction cases. The first two will be the training cases, and the other three will be the actual testing cases. In each case, you will be bidding for two or three telecommunications properties. The tables below summarize the overview information about the five auction cases. (There is no need to memorize the information.)

Training Cases:

Case	# of Properties	Bid to Win Competitors	Bid to Lose Competitors	Competitive Factor
1. Train2Prop	2	Competitor A	Competitor 3, Competitor 7	25%
2. Train3Prop	3		Competitor 3, Competitor 7	25%

Testing Cases (their order will be randomly assigned):

Case	# of Properties	Bid to Win Competitors	Bid to Lose Competitors	Competitive Factor
TestCompete (Test A)	3	Competitor G	Competitor 3, Competitor 7	50%
Test12 (Test B)	3	Competitor G	Competitor 3, Competitor 7	25%
Test24 (Test C)	3	Competitor G	Competitor 3, Competitor 7	25%

For the first training case, you will be bidding for two telecommunications properties. The values of these two properties are shown in the ***Cost Data Sheet*** (see the table below).

Train2Prop		(Win)	(Lose 25%)	(Lose 25%)
Property	XYZ	Competitor A	Competitor 3	Competitor 7
1 Only (101° W)	***281.39***	446.65	171.78	84.75
2 Only (62° W)	***64.89***	405.18	143.79	63.22
1, 2	***319.50***	495.44	204.71	110.07

There is no need to memorize the above table; just notice the following items:

1. Case name is Train2Prop. It is essential that you use the right Cost Data Sheet for the right case (see also the screen capture).
2. The 1st property (101°) is worth $281.39 million, and the 2nd property (62°) is worth $64.89 million for XYZ. If you can win both properties, they will be worth a total of $319.50 million for XYZ.
3. Competitor A uses Bid to Win strategy. Note that the 1st property (101°) is worth $446.65 million, and the 2nd property (62°) is worth $405.18 million for Competitor A. If Competitor A can win both properties, the properties will be worth a total of $495.44 million for him. That means, it doesn't add much more value to Competitor A to win both properties than for him to win only one property. As a result, under a normal situation, Competitor A may choose to win one property only (unless he can win both properties at very low costs).
4. Competitor 3 and Competitor 7 use Bid to Lose strategy, with the Competitive Factor of 25%. That means, they are willing to lose approximately $0.25 if they can make you pay $1 extra. Similarly, you will receive a 25% credit for every additional dollar that you make your competitors pay.

Bidding Waivers

In every round a bidder must do one of the following:

- Hold the winning bid from the previous round,
- Bid, or
- Use a waiver.

A bidder who fails to take one of these three actions in each round will be eliminated from the auction. Each bidder will begin the auction with a number of five waivers per property. If the auction is restarted, then bidders may be given additional waivers. The number of ***Waivers*** (see the screen capture) you have remaining is shown on the bidding screen.

Your Next Bid

The number has to be more than the ***Minimum Legal Bid***. Each time you want to submit your bid, just click the ***Submit*** button. You may minimally increase your bid (e.g., from $10 million

to $11 million in the next round), or you may drastically increase your bid (e.g., from $10 million to $50 million in the next round). Both strategies are appropriate in different situations, and you need to find your own best strategy.

When you use Submit, the number of waivers you have will remain the same because you are still actively participating in the auction. If you do not want to bid in that round, use ***Submit Zero***. Alternatively, if you do not want to bid in that round but want to sit out the round and observe others' responses, use ***Submit Proactive***. The two are slightly different in that when using Submit Proactive, you can ensure that the auction does not end if no one submits a bid in the round. Submit Zero is different in that the auction could end if no one submits a bid in the round. Both strategies are appropriate in different situations, and you need to find your own best strategy. Your available waivers may decrease when you click Submit Zero or Submit Proactive. The number will decrease by one if you did not hold the winning bid from the previous round; it will not decrease if you hold the winning bid from the previous round.

Ending an Auction

The auction ends when a round takes place where no bidder either bids or takes a waiver. At this time the winner of the auction is announced. The winner has the option to withdraw his winning bid. Make sure that you click the appropriate button (***Yes*** or ***No***) when you are prompted if you want to withdraw from a bid after winning a property! All competitors except for the one who withdrew his bid would be reinstated and given additional waivers. The minimum bid for the next round of the auction then drops back to the last price where there were three participants in the auction.

Value Analysis *(Cells #3, 4, 5, 6)*

You can click ***Value Analysis*** if you want to see the result of the auction at the end of each round. The same information is also shown on the screen in the ***Amount*** row.

Demonstration

____ Demonstrate Submit (highest, not highest bid)
____ Demonstrate Submit (minimum bid, jumped bid)
____ Demonstrate Submit Zero (waivers reduced, not reduced)
____ Demonstrate Submit Proactive (waivers reduced, not reduced)
____ Show property values
____ Show bid to win strategy (Competitor A)
____ Show bid to lose strategy (Competitor 3 and Competitor 7)
____ Show where the auction restarts
____ Show penalties
____ Demonstrate bid to lose strategy (XYZ)
____ Demonstrate how to withdraw a bid

____ Demonstrate value analysis *(Cells #3, 4, 5, 6)*

C.5 COST DATA SHEETS

Train2Prop		(Win)	(Lose 25%)	(Lose 25%)
Property	XYZ	Competitor A	Competitor 3	Competitor 7
1 Only (101 W)	281.39	446.65	171.78	84.75
2 Only (62 W)	64.89	405.18	143.79	63.22
1, 2	319.50	495.44	204.71	110.07

Train3Prop		(Lose 25%)	(Lose 25%)
Property	XYZ	Competitor 3	Competitor 7
1 Only (101 W)	292.47	181.91	84.24
2 Only (62 W)	73.46	153.58	62.73
3 Only (78 W)	99.68	181.91	242.39
1, 2	331.03	215.25	109.55
1, 3	341.05	223.59	282.24
2, 3	130.52	215.25	274.01
1, 2, 3	355.70	258.59	294.26

(Cells #2, 4, 6)
Goal: Make at least $70 million
Suggested strategy: Win Property 1 (101 W)

TestCompete (Test A)		(Win)	(Lose 50%)	(Lose 50%)
Property	XYZ	Competitor G	Competitor 3	Competitor 7
1 Only (101 W)	281.39	289.26	171.78	84.75
2 Only (62 W)	64.89	256.60	143.79	63.22
3 Only (78 W)	90.81	289.26	171.78	243.02
1, 2	319.50	327.69	204.71	110.07
1, 3	329.41	337.30	212.95	282.90
2, 3	121.30	327.69	204.71	274.67
1, 2, 3	343.90	377.65	247.53	294.93

(Cells #2, 4, 6)
Goal: Make at least $85 million
Suggested strategy: Win Property 1 (101 W)

Test12 (Test B)		(Win)	(Lose 25%)	(Lose 25%)
Property	XYZ	Competitor G	Competitor 3	Competitor 7
1 Only (101 W)	281.39	241.22	171.78	84.75
2 Only (62 W)	64.89	160.52	143.79	63.22
3 Only (78 W)	90.81	289.26	171.78	243.02
1, 2	449.10	327.69	204.71	110.07
1, 3	329.41	337.30	212.95	282.90
2, 3	121.30	327.69	204.71	274.67
1, 2, 3	532.95	377.65	247.53	294.93

(Cells #2, 4, 6)
Goal: Make at least $170 million
Suggested strategy: Win Property 1 (101 W) and
Win Property 2 (62 W)

Test24 (Test C)		(Win)	(Lose 25%)	(Lose 25%)
Property	XYZ	Competitor G	Competitor 3	Competitor 7
1 Only (101 W)	281.39	289.26	171.78	84.75
2 Only (62 W)	64.89	256.60	143.79	63.22
3 Only (78 W)	90.81	97.11	171.78	179.71
1, 2	357.62	327.69	204.71	110.07
1, 3	548.20	337.30	212.95	282.90
2, 3	357.62	327.69	204.71	274.67
1, 2, 3	578.69	377.65	247.53	294.93

(Cells #2, 4, 6)
Goal: Make at least $215 million
Suggested strategy: Win Property 1 (101 W) and
Win Property 3 (78 W)

C.6 PROCEDURES

Problems
You will be participating in three auction cases. Keep the following things in mind:

- You want to finish each case as fast and as accurately as possible.
- After you finish each case, I need a few minutes to collect necessary information and switch the case. Please use this time interval to relax yourself or plan/study the cost data for the next case.
- The cost data for each case are shown here (see Cost Data Sheets). Make sure that you use the right data set for the right case!

Goal Setting *(Cells #2, 4, 6)*
I will set financial goals for you before each simulation. At a minimum, you want to achieve these goals. If possible, you also want to surpass all these goals. In addition, I will provide suggestions of which property(s) you should try to win. Ultimately, you want to win properties at the minimum cost possible and make other competitors lose as much money as possible.

Task Feedback *(Cells #3, 4, 5, 6)*
During the auction, you can access the information of how you are doing by clicking the ***Value Analysis*** button. In addition, at the end of each auction case, I will give you a summary of how you have done so far. The summary will be in the form of:

> Total credit (money you saved): $ ___ million
> Total credit (penalty): $ ___ million
> Total credit (driving up your competitors' costs): $ ___ million
>
> TOTAL MONEY YOU MADE: $ ___ million

Comparison with Others *(Cells #5, 6)*
At the end of each simulation, I will give you the information about how other people have done in the same experiment. I will tell you the average score and the top score. In addition, I will tell you which property(s) the top performer won in that particular case.

Others
I have prepared pens, paper, a clock, and a calculator for you. Feel free to use any of these items as you like. If it helps, feel free to write on the Cost Data Sheet.

Electronics Communication Process
Demonstrate the following functions:
_____ How to start/stop receiving and sending video

_____ How to collaborate
_____ How to take control of the program
_____ How to un-collaborate

_____ How to answer the telephone

C.7 POST-EXPERIMENT QUESTIONNAIRE

(Subject #:_____)

	Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
1. I used task feedback (information about my performance) when bidding in the auction. *(Cells #3, 4, 5, 6)*	1	2	3	4	5	6	7
2. Task feedback helped me perform better. *(Cells #3, 4, 5, 6)*	1	2	3	4	5	6	7
3. I used the information about others' performance when bidding in the auction. *(Cells #5, 6)*	1	2	3	4	5	6	7
4. Information about other's performance helped me perform better. *(Cells #5, 6)*	1	2	3	4	5	6	7
5. I tried to achieve the goals. *(Cells #2,4, 6)*	1	2	3	4	5	6	7
6. Having goals helped me perform better. *(Cells #2,4, 6)*	1	2	3	4	5	6	7

7. I knew how to correct errors in strategy as the experiment progressed.
(Cells #1, 2, 3, 4, 5, 6)

8. I knew how to perform better as the experiment progressed.
(Cells #1, 2, 3, 4, 5, 6)

9. I thought the task was motivating.
(Cells #1, 2, 3, 4, 5, 6)

10. I was committed to the task.
(Cells #1, 2, 3, 4, 5, 6)

11. I thought the task was satisfying.
(Cells #1, 2, 3, 4, 5, 6)

D.1 RAWDATA

Treatments		*Identifications*		*Raw Test Scores*			*Standardized Test Scores*			*Time Used*			*Pre-Experiment (Demographic Information)*						*Post-Experiment (The Retrospective Report)*									
Feedback	Goal	Group	Subject	RawComp	Raw12	Raw24	TestComp	Test12	Test24	TimeComp	Time12	Time24	Age	Gender	QCA	Major	Level	Familiar	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
1	1	1	11	58.37	112.41	137.37	0.067	-0.479	-0.384	5.45	3.30	3.17	23	1	3.60	2	5	3	.	.	.	.	.	.	6	6	7	6	5
1	1	1	12	31.42	165.50	166.46	-0.622	0.529	0.437	6.20	9.40	7.70	19	2	2.98	2	2	3	.	.	.	.	.	.	5	6	6	7	7
1	1	1	13	67.06	155.68	155.50	0.290	0.343	0.128	8.60	11.00	10.40	29	2	4.00	2	6	2	.	.	.	.	.	.	7	7	6	4	5
1	1	1	14	-5.42	94.51	107.23	-1.565	-0.819	-1.234	7.20	5.08	3.17	24	1	3.50	1	5	1	.	.	.	.	.	.	6	5	7	6	6
1	1	1	15	90.98	124.32	136.97	0.902	-0.253	-0.395	7.45	9.20	6.00	30	1	3.60	1	6	2	.	.	.	.	.	.	5	6	7	6	5
1	1	1	16	109.30	-28.90	161.80	1.371	-3.164	0.305	4.00	9.50	7.75	25	2	3.74	2	6	6	.	.	.	.	.	.	6	4	5	6	6
1	2	2	21	76.69	49.32	163.18	0.536	-1.678	0.344	6.35	6.04	6.50	24	2	1.70	2	4	2	.	.	.	.	7	6	6	4	6	6	6
1	2	2	22	-15.20	257.80	152.95	-1.815	2.283	0.056	5.10	12.50	7.00	28	2	3.60	1	6	4	.	.	.	.	7	6	5	4	6	7	6
1	2	2	23	117.79	132.87	174.23	1.588	-0.091	0.656	7.00	6.00	5.90	26	2	3.20	2	5	4	.	.	.	.	6	6	5	7	3	6	3
1	2	2	24	2.63	119.95	202.11	-1.359	-0.336	1.443	5.95	7.80	6.30	27	1	3.90	1	6	3	.	.	.	.	6	3	6	6	5	7	5
1	2	2	25	-32.91	267.20	180.01	-2.269	2.461	0.819	3.50	7.40	4.95	21	2	4.00	2	5	3	.	.	.	.	6	3	4	4	6	6	6
1	2	2	26	-0.77	159.97	243.91	-1.446	0.424	2.622	6.90	10.80	10.47	24	1	3.48	1	5	4	.	.	.	.	5	5	5	6	6	6	7
2	1	3	31	76.98	102.20	206.70	0.544	-0.673	1.572	4.50	6.70	10.70	36	2	3.70	2	6	1	2	2	.	.	.	.	5	7	7	6	4
2	1	3	32	58.03	150.39	121.96	0.059	0.242	-0.819	6.60	6.35	3.90	37	1	3.27	1	6	3	7	7	.	.	.	.	6	7	7	7	7
2	1	3	33	15.94	151.95	131.73	-1.019	0.272	-0.543	9.00	8.20	6.10	26	1	2.45	2	4	5	7	7	.	.	.	.	7	7	7	7	7
2	1	3	34	40.02	143.61	104.18	-0.402	0.113	-1.320	6.00	4.60	4.17	38	2	3.80	2	6	3	4	5	.	.	.	.	7	7	7	6	6
2	1	3	35	77.52	181.52	155.12	0.557	0.834	0.117	5.10	6.90	4.30	34	1	3.66	2	6	3	7	6	.	.	.	.	6	6	7	6	7
2	1	3	36	38.01	146.39	154.16	-0.454	0.166	0.090	8.80	11.40	7.75	32	2	3.40	2	6	3	5	5	.	.	.	.	3	4	6	7	5
2	2	4	41	69.36	153.00	39.09	0.349	0.292	-3.157	7.40	7.45	7.80	20	1	3.75	1	2	4	6	6	.	.	6	6	6	6	7	6	7
2	2	4	42	60.21	61.93	167.90	0.114	-1.438	0.478	6.05	3.50	5.75	22	1	3.56	2	3	2	7	6	.	.	7	6	6	6	3	7	5
2	2	4	43	16.05	129.71	127.84	-1.016	-0.151	-0.653	8.05	8.05	7.30	22	1	2.60	2	4	5	5	3	.	.	6	4	5	6	6	6	6
2	2	4	44	53.61	155.03	129.23	-0.054	0.330	-0.613	4.30	5.95	3.80	28	2	3.70	2	6	1	3	5	.	.	5	5	5	6	4	5	6
2	2	4	45	65.53	111.39	125.50	0.251	-0.499	-0.719	10.30	7.80	8.90	26	2	3.35	2	5	6	5	5	.	.	7	6	7	7	7	7	7
2	2	4	46	74.65	130.06	146.17	0.484	-0.144	-0.136	8.97	7.50	8.90	23	2	3.80	2	5	3	3	1	.	.	4	6	4	6	7	6	5
3	1	5	51	76.43	143.99	131.12	0.530	0.121	-0.560	5.38	6.65	6.30	20	1	3.34	2	2	1	6	6	6	6	.	.	6	6	6	6	5
3	1	5	52	29.34	138.78	125.60	-0.676	0.022	-0.716	5.00	5.00	4.80	22	2	4.00	2	6	4	5	5	6	3	.	.	6	5	7	7	6
3	1	5	53	86.96	141.80	189.18	0.799	0.079	1.078	5.85	4.70	7.20	24	2	3.91	2	5	2	5	3	5	4	.	.	5	5	3	3	3
3	1	5	54	56.48	134.32	125.14	0.019	-0.063	-0.729	12.50	9.00	8.70	30	2	3.40	2	4	3	6	5	6	5	.	.	6	6	6	6	5
3	1	5	55	91.09	133.08	180.80	0.905	-0.087	0.841	9.29	5.75	6.97	25	2	3.60	1	5	4	7	6	7	6	.	.	7	6	6	7	7
3	1	5	56	50.72	141.92	124.11	-0.128	0.081	-0.758	13.24	9.47	7.48	23	2	3.35	1	5	4	6	7	7	7	.	.	6	7	7	7	6
3	2	6	61	22.66	255.00	183.44	-0.847	2.230	0.916	4.20	5.20	3.50	23	2	2.10	2	4	3	6	6	2	5	7	7	6	4	7	7	7
3	2	6	62	116.21	118.95	167.07	1.548	-0.355	0.454	6.20	4.50	4.20	21	2	3.00	2	4	3	6	5	4	4	6	5	6	5	5	5	5
3	2	6	63	132.28	145.68	122.91	1.959	0.153	-0.792	14.00	9.10	10.45	28	1	3.95	2	6	1	7	6	5	5	6	6	6	6	4	7	4
3	2	6	64	94.38	130.05	168.96	0.989	-0.144	0.507	5.10	5.10	6.45	26	2	3.98	2	6	3	6	6	2	2	7	6	5	5	5	5	5
3	2	6	65	31.55	121.30	160.95	-0.619	-0.311	0.281	6.55	6.53	6.00	22	1	3.60	2	4	3	5	4	3	2	6	5	2	3	6	6	6
3	2	6	66	72.60	122.48	164.58	0.432	-0.288	0.384	12.02	11.97	6.90	30	2	3.60	2	6	3	7	6	7	6	7	3	6	7	6	7	6

D.2 STATISTICAL RESULTS

ANALYSIS OF TASK PERFORMANCE

Analysis of Variance Procedure
(Table 4.5)

Dependent Variable: TIMTAKEN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	11.50724630	5.75362315	1.01	0.3678
Error	105	598.28702778	5.69797169		
Corrected Total	107	609.79427407			

R-Square	C.V.	Root MSE	TIMTAKEN Mean
0.018871	33.87121	2.3870425	7.0474074

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TIMLEVEL	2	11.50724630	5.75362315	1.01	0.3678

General Linear Models Procedure
(Table 4.6, Table 4.8, Post-Hoc Test)

Dependent Variable: TESTOTAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	20.21491389	4.04298278	2.53	0.0506
Error	30	48.01987567	1.60066252		
Corrected Total	35	68.23478956			

R-Square	C.V.	Root MSE	TESTOTAL Mean
0.296255	9999.99	1.2651729	0.0001111

Source	DF	Type I SS	Mean Square	F Value	Pr > F
FEEDBACK	2	8.41458006	4.20729003	2.63	0.0887
GOAL	1	2.20126678	2.20126678	1.38	0.2501
FEEDBACK*GOAL	2	9.59906706	4.79953353	3.00	0.0650

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
1.1.1 fb vs nfb	1	0.01173001	0.01173001	0.01	0.9323
1.1.2 tfb vs nfb	1	1.83762004	1.83762004	1.15	0.2925
1.1.3 cwo vs tfb	1	8.40285004	8.40285004	5.25	0.0291
Post-Hoc cwo vs nfb	1	2.38140000	2.38140000	1.49	0.2321

General Linear Models Procedure

Duncan's Multiple Range Test for variable: TESTOTAL

NOTE: This test controls the type I comparisonwise error rate, not the experimentwise error rate

Alpha= 0.05 df= 30 MSE= 1.600663

Number of Means 2 3
Critical Range 1.055 1.109

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	FEEDBACK
A	0.6046	12	3
A			
B A	-0.0254	12	1
B			
B	-0.5788	12	2

General Linear Models Procedure

Duncan's Multiple Range Test for variable: TESTOTAL

NOTE: This test controls the type I comparisonwise error rate, not the experimentwise error rate

Alpha= 0.05 df= 30 MSE= 1.600663

Number of Means 2
Critical Range .8613

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	GOAL
A	0.2474	18	2
A			
A	-0.2472	18	1

General Linear Models Procedure
(Table 4.9)

Dependent Variable: TESTOTAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	20.21491389	4.04298278	2.53	0.0506
Error	30	48.01987567	1.60066252		
Corrected Total	35	68.23478956			

R-Square	C.V.	Root MSE	TESTOTAL Mean
0.296255	9999.99	1.2651729	0.0001111

Source	DF	Type I SS	Mean Square	F Value	Pr > F
GROUP	5	20.21491389	4.04298278	2.53	0.0506

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GROUP	5	20.21491389	4.04298278	2.53	0.0506

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
1.3.1 both vs either	1	0.35724645	0.35724645	0.22	0.6400
1.3.2 bth/ethr vs nt	1	4.12898136	4.12898136	2.58	0.1187

General Linear Models Procedure

Duncan's Multiple Range Test for variable: TESTOTAL

NOTE: This test controls the type I comparisonwise error rate, not the experimentwise error rate

Alpha= 0.05 df= 30 MSE= 1.600663

Number of Means	2	3	4	5	6
Critical Range	1.492	1.568	1.617	1.652	1.679

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	GROUP
A	1.0828	6	6
A			
B A	0.7063	6	2
B A			
B A C	0.1263	6	5
B A C			
B A C	-0.1107	6	3
B C			
B C	-0.7572	6	1
C			
C	-1.0470	6	4

General Linear Models Procedure
(Table 4.7)

Dependent Variable: TESTOTAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	6.42549675	6.42549675	3.30	0.0992
Error	10	19.45882217	1.94588222		
Corrected Total	11	25.88431892			

R-Square	C.V.	Root MSE	TESTOTAL Mean
0.248239	-5488.323	1.3949488	-0.0254167

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SETG1	1	6.42549675	6.42549675	3.30	0.0992

General Linear Models Procedure
(Table 4.7)

Dependent Variable: TESTOTAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2.63016033	2.63016033	1.92	0.1962
Error	10	13.71473133	1.37147313		
Corrected Total	11	16.34489167			

R-Square	C.V.	Root MSE	TESTOTAL Mean
0.160916	-202.3206	1.1710991	-0.5788333

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SETG2	1	2.63016033	2.63016033	1.92	0.1962

General Linear Models Procedure
(Table 4.7)

Dependent Variable: TESTOTAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2.74467675	2.74467675	1.85	0.2038
Error	10	14.84632217	1.48463222		
Corrected Total	11	17.59099892			

R-Square	C.V.	Root MSE	TESTOTAL Mean
0.156027	201.5363	1.2184548	0.6045833

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SETG3	1	2.74467675	2.74467675	1.85	0.2038

General Linear Models Procedure
(Table 4.7)

Dependent Variable: TESTOTAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	2.50940700	1.25470350	0.59	0.5649
Error	15	31.71637950	2.11442530		
Corrected Total	17	34.22578650			

R-Square	C.V.	Root MSE	TESTOTAL Mean
0.073319	-588.3101	1.4541064	-0.2471667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SETF1	2	2.50940700	1.25470350	0.59	0.5649

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SETF1	2	2.50940700	1.25470350	0.59	0.5649

General Linear Models Procedure
(Table 4.7)

Dependent Variable: TESTOTAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	15.50424011	7.75212006	7.13	0.0067
Error	15	16.30349617	1.08689974		
Corrected Total	17	31.80773628			

R-Square	C.V.	Root MSE	TESTOTAL Mean
0.487436	421.4194	1.0425448	0.2473889

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SETF2	2	15.50424011	7.75212006	7.13	0.0067

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SETF2	2	15.50424011	7.75212006	7.13	0.0067

ANALYSIS OF FEEDBACK AND GOAL BENEFICIAL EFFECTS

General Linear Models Procedure
(Table 4.11)

Dependent Variable: Q7

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	3.55555556	0.71111111	0.57	0.7212
Error	30	37.33333333	1.24444444		
Corrected Total	35	40.88888889			

R-Square	C.V.	Root MSE	Q7 Mean
0.086957	20.07984	1.1155467	5.5555556

Source	DF	Type I SS	Mean Square	F Value	Pr > F
FEEDBACK	2	0.05555556	0.02777778	0.02	0.9779
GOAL	1	2.77777778	2.77777778	2.23	0.1456
FEEDBACK*GOAL	2	0.72222222	0.36111111	0.29	0.7502

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FEEDBACK	2	0.05555556	0.02777778	0.02	0.9779
GOAL	1	2.77777778	2.77777778	2.23	0.1456
FEEDBACK*GOAL	2	0.72222222	0.36111111	0.29	0.7502

General Linear Models Procedure
(Table 4.13)

Dependent Variable: Q7

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	3.55555556	0.71111111	0.57	0.7212
Error	30	37.33333333	1.24444444		
Corrected Total	35	40.88888889			

R-Square	C.V.	Root MSE	Q7 Mean
0.086957	20.07984	1.1155467	5.5555556

Source	DF	Type I SS	Mean Square	F Value	Pr > F
GROUP	5	3.55555556	0.71111111	0.57	0.7212

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GROUP	5	3.55555556	0.71111111	0.57	0.7212

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
2.3.1 both vs either	1	0.55555556	0.55555556	0.45	0.5091
2.3.2 bth/ethr vs nt	1	0.55555556	0.55555556	0.45	0.5091

General Linear Models Procedure
(Table 4.11)

Dependent Variable: Q8

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	8.47222222	1.69444444	1.45	0.2369
Error	30	35.16666667	1.17222222		
Corrected Total	35	43.63888889			

R-Square	C.V.	Root MSE	Q8 Mean
0.194144	19.01313	1.0826921	5.6944444

Source	DF	Type I SS	Mean Square	F Value	Pr > F
FEEDBACK	2	5.55555556	2.77777778	2.37	0.1108
GOAL	1	2.25000000	2.25000000	1.92	0.1761
FEEDBACK*GOAL	2	0.66666667	0.33333333	0.28	0.7545

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FEEDBACK	2	5.55555556	2.77777778	2.37	0.1108
GOAL	1	2.25000000	2.25000000	1.92	0.1761
FEEDBACK*GOAL	2	0.66666667	0.33333333	0.28	0.7545

General Linear Models Procedure
(Table 4.13)

Dependent Variable: Q8

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	8.47222222	1.69444444	1.45	0.2369
Error	30	35.16666667	1.17222222		
Corrected Total	35	43.63888889			

R-Square	C.V.	Root MSE	Q8 Mean
0.194144	19.01313	1.0826921	5.6944444

Source	DF	Type I SS	Mean Square	F Value	Pr > F
GROUP	5	8.47222222	1.69444444	1.45	0.2369

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GROUP	5	8.47222222	1.69444444	1.45	0.2369

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
2.3.1 both vs either	1	0.27222222	0.27222222	0.23	0.6334
2.3.2 bth/ethr vs nt	1	0.00555556	0.00555556	0.00	0.9456

General Linear Models Procedure
(Table 4.11)

Dependent Variable: Q9

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	9.58333333	1.91666667	1.33	0.2777
Error	30	43.16666667	1.43888889		
Corrected Total	35	52.75000000			

R-Square	C.V.	Root MSE	Q9 Mean
0.181675	20.27386	1.1995369	5.9166667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
FEEDBACK	2	2.16666667	1.08333333	0.75	0.4797
GOAL	1	6.25000000	6.25000000	4.34	0.0458
FEEDBACK*GOAL	2	1.16666667	0.58333333	0.41	0.6703

Duncan’s Multiple Range Test for variable: Q9

Alpha= 0.05 df= 30 MSE= 1.438889

Number of Means 2
Critical Range .8166

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	GOAL
A	6.3333	18	1
B	5.5000	18	2

General Linear Models Procedure
(Table 4.13)

Dependent Variable: Q9

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	9.58333333	1.91666667	1.33	0.2777
Error	30	43.16666667	1.43888889		
Corrected Total	35	52.75000000			

R-Square	C.V.	Root MSE	Q9 Mean
0.181675	20.27386	1.1995369	5.9166667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
GROUP	5	9.58333333	1.91666667	1.33	0.2777

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
2.3.1 both vs either	1	1.25000000	1.25000000	0.87	0.3587
2.3.2 bth/ethr vs nt	1	1.25000000	1.25000000	0.87	0.3587

General Linear Models Procedure
(Table 4.11)

Dependent Variable: Q10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1.66666667	0.33333333	0.37	0.8678
Error	30	27.33333333	0.91111111		
Corrected Total	35	29.00000000			

R-Square	C.V.	Root MSE	Q10 Mean
0.057471	15.47873	0.9545214	6.1666667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
FEEDBACK	2	0.50000000	0.25000000	0.27	0.7619
GOAL	1	0.11111111	0.11111111	0.12	0.7294
FEEDBACK*GOAL	2	1.05555556	0.52777778	0.58	0.5665

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FEEDBACK	2	0.50000000	0.25000000	0.27	0.7619
GOAL	1	0.11111111	0.11111111	0.12	0.7294
FEEDBACK*GOAL	2	1.05555556	0.52777778	0.58	0.5665

General Linear Models Procedure
(Table 4.13)

Dependent Variable: Q10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1.66666667	0.33333333	0.37	0.8678
Error	30	27.33333333	0.91111111		
Corrected Total	35	29.00000000			

R-Square	C.V.	Root MSE	Q10 Mean
0.057471	15.47873	0.9545214	6.1666667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
GROUP	5	1.66666667	0.33333333	0.37	0.8678

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GROUP	5	1.66666667	0.33333333	0.37	0.8678

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
2.3.1 both vs either	1	0.08888889	0.08888889	0.10	0.7569
2.3.2 bth/ethr vs nt	1	0.80000000	0.80000000	0.88	0.3562

General Linear Models Procedure
(Table 4.11)

Dependent Variable: Q11

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	2.33333333	0.46666667	0.35	0.8763
Error	30	39.66666667	1.32222222		
Corrected Total	35	42.00000000			

R-Square	C.V.	Root MSE	Q11 Mean
0.055556	20.29199	1.1498792	5.6666667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
FEEDBACK	2	2.16666667	1.08333333	0.82	0.4503
GOAL	1	0.00000000	0.00000000	0.00	1.0000
FEEDBACK*GOAL	2	0.16666667	0.08333333	0.06	0.9390

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FEEDBACK	2	2.16666667	1.08333333	0.82	0.4503
GOAL	1	0.00000000	0.00000000	0.00	1.0000
FEEDBACK*GOAL	2	0.16666667	0.08333333	0.06	0.9390

General Linear Models Procedure
(Table 4.13)

Dependent Variable: Q11

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	2.33333333	0.46666667	0.35	0.8763
Error	30	39.66666667	1.32222222		
Corrected Total	35	42.00000000			

R-Square	C.V.	Root MSE	Q11 Mean
0.055556	20.29199	1.1498792	5.6666667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
GROUP	5	2.33333333	0.46666667	0.35	0.8763

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GROUP	5	2.33333333	0.46666667	0.35	0.8763

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
2.3.1 both vs either	1	0.13888889	0.13888889	0.11	0.7481
2.3.2 bth/ethr vs nt	1	0.00000000	0.00000000	0.00	1.0000

Correlation Analysis
(Table 4.15, Table 4.16)

7 'VAR' Variables: TESTOTAL Q1 Q2 Q3 Q4 Q5 Q6

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

	TESTOTAL	Q1	Q2	Q3	Q4	Q5	Q6
TESTOTAL	1.00000	0.07698	-0.09643	-0.40960	0.03188	-0.01611	0.11607
	0.0	0.7207	0.6540	0.1861	0.9217	0.9494	0.6465
	36	24	24	12	12	18	18
Q1	0.07698	1.00000	0.78586	0.33113	0.60735	0.77205	-0.03036
	0.7207	0.0	0.0001	0.2931	0.0362	0.0033	0.9254
	24	24	24	12	12	12	12
Q2	-0.09643	0.78586	1.00000	0.22569	0.57348	0.75426	0.12961
	0.6540	0.0001	0.0	0.4806	0.0512	0.0046	0.6881
	24	24	24	12	12	12	12
Q3	-0.40960	0.33113	0.22569	1.00000	0.69384	-0.09407	-0.80454
	0.1861	0.2931	0.4806	0.0	0.0123	0.8593	0.0536
	12	12	12	12	12	6	6
Q4	0.03188	0.60735	0.57348	0.69384	1.00000	0.21822	-0.26245
	0.9217	0.0362	0.0512	0.0123	0.0	0.6779	0.6154
	12	12	12	12	12	6	6
Q5	-0.01611	0.77205	0.75426	-0.09407	0.21822	1.00000	0.13170
	0.9494	0.0033	0.0046	0.8593	0.6779	0.0	0.6024
	18	12	12	6	6	18	18
Q6	0.11607	-0.03036	0.12961	-0.80454	-0.26245	0.13170	1.00000
	0.6465	0.9254	0.6881	0.0536	0.6154	0.6024	0.0
	18	12	12	6	6	18	18

General Linear Models Procedure
(Table 4.17)

Dependent Variable: Q5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1.33333333	0.66666667	0.90	0.4291
Error	15	11.16666667	0.74444444		
Corrected Total	17	12.50000000			

R-Square	C.V.	Root MSE	Q5 Mean
0.106667	13.99154	0.8628119	6.1666667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
F56	2	1.33333333	0.66666667	0.90	0.4291

General Linear Models Procedure
(Table 4.17)

Dependent Variable: Q6

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1.44444444	0.72222222	0.46	0.6413
Error	15	23.66666667	1.57777778		
Corrected Total	17	25.11111111			

R-Square	C.V.	Root MSE	Q6 Mean
0.057522	24.05291	1.2560962	5.2222222

Source	DF	Type I SS	Mean Square	F Value	Pr > F
F56	2	1.44444444	0.72222222	0.46	0.6413

General Linear Models Procedure
(Table 4.17)

Dependent Variable: Q1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.04166667	0.04166667	0.02	0.8889
Error	22	45.91666667	2.08712121		
Corrected Total	23	45.95833333			

R-Square	C.V.	Root MSE	Q1 Mean
0.000907	26.06954	1.4446872	5.5416667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
G12	1	0.04166667	0.04166667	0.02	0.8889

General Linear Models Procedure
(Table 4.17)

Dependent Variable: Q2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.04166667	1.04166667	0.43	0.5199
Error	22	53.58333333	2.43560606		
Corrected Total	23	54.62500000			

R-Square	C.V.	Root MSE	Q2 Mean
0.019069	30.45157	1.5606428	5.1250000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
G12	1	1.04166667	1.04166667	0.43	0.5199

General Linear Models Procedure
(Table 4.17)

Dependent Variable: Q3

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	16.33333333	16.33333333	7.54	0.0206
Error	10	21.66666667	2.16666667		
Corrected Total	11	38.00000000			

R-Square	C.V.	Root MSE	Q3 Mean
0.429825	29.43920	1.4719601	5.0000000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
G34	1	16.33333333	16.33333333	7.54	0.0206

Duncan's Multiple Range Test for variable: Q3

NOTE: This test controls the type I comparisonwise error rate, not the experimentwise error rate

Alpha= 0.05 df= 10 MSE= 2.166667

Number of Means 2
Critical Range 1.894

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	G34
A	6.1667	6	5
B	3.8333	6	6

General Linear Models Procedure
(Table 4.17)

Dependent Variable: Q4

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	4.08333333	4.08333333	1.64	0.2287
Error	10	24.83333333	2.48333333		
Corrected Total	11	28.91666667			

R-Square	C.V.	Root MSE	Q4 Mean
0.141210	34.38239	1.5758596	4.5833333

Source	DF	Type I SS	Mean Square	F Value	Pr > F
G34	1	4.08333333	4.08333333	1.64	0.2287

Correlation Analysis
(Table 4.18)

5 'VAR' Variables: TESTOTAL AGE QCA LEVEL FAMILIAR

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 36

	TESTOTAL	AGE	QCA	LEVEL	FAMILIAR
TESTOTAL	1.00000 0.0	0.09201 0.5935	0.05035 0.7706	0.18730 0.2740	-0.18242 0.2869
AGE	0.09201 0.5935	1.00000 0.0	0.19679 0.2500	0.66756 0.0001	-0.16535 0.3352
QCA	0.05035 0.7706	0.19679 0.2500	1.00000 0.0	0.44383 0.0067	-0.15564 0.3647
LEVEL	0.18730 0.2740	0.66756 0.0001	0.44383 0.0067	1.00000 0.0	-0.01508 0.9304
FAMILIAR	-0.18242 0.2869	-0.16535 0.3352	-0.15564 0.3647	-0.01508 0.9304	1.00000 0.0

TTEST PROCEDURE
(Table 4.19)

Variable: TESTOTAL

MAJOR	N	Mean	Std Dev	Std Error	Minimum	Maximum
1	9	-0.40800000	1.75190004	0.58396668	-3.61800000	1.65900000
2	27	0.13614815	1.26617084	0.24367469	-1.82000000	2.29900000

Variances	T	DF	Prob>|T|
Unequal	-0.8599	10.9	0.4083
Equal	-1.0129	34.0	0.3183

For H0: Variances are equal, F' = 1.91 DF = (8,26) Prob>F' = 0.2015

TTEST PROCEDURE
(Table 4.19)

Variable: TESTOTAL

GENDER	N	Mean	Std Dev	Std Error	Minimum	Maximum
1	14	-0.53800000	1.49604828	0.39983572	-3.61800000	1.60000000
2	22	0.34254545	1.24413032	0.26524948	-1.60900000	2.29900000

Variances	T	DF	Prob>|T|
Unequal	-1.8352	24.1	0.0789
Equal	-1.9135	34.0	0.0641

For H0: Variances are equal, F' = 1.45 DF = (13,21) Prob>F' = 0.4378

VITA

Kriengkrai Tankoonsombut was born in Bangkok, Thailand. He received his Bachelor of Engineering in Electronics degree from King Mongkut's Institute of Technology, Ladkrabang, Bangkok, Thailand, in 1989. Upon graduation, he worked as a quality assurance engineer at Seagate Technology Company, Thailand.

Kriengkrai earned an MBA with an emphasis in Information Systems from California State University, Fresno in 1993. He received his Ph.D. in Industrial and Systems Engineering with an emphasis in Management Systems Engineering from Virginia Polytechnic Institute and State University in 1998. Throughout his graduate study, he worked as a graduate research assistant and graduate teaching assistant. He was also in charge of the Virginia Polytechnic Institute and State University Industrial and Systems Engineering Department's computer labs as a systems manager/administrator.

Kriengkrai is a member of Alpha Pi Mu (Industrial and Systems Engineering Honor Society) and a member of Phi Beta Delta (International Scholars Honor Society). His areas of interest are information technology/systems, technology management, engineering economics analyses, and work performance.