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Christa Abraham
Grand Valley State University

Lisa Evans
Grand Valley State University

Patrick Hoban
Grand Valley State University

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Efficacy of Implementing an Ergonomics Program in an
Industrial Setting Regarding Cumulative Trauma
Disorders to the Upper Extremity

By

Christa Abraham
Lisa Evans
Patrick Hoban

A THESIS

Submitted to
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in partial fulfillment of the requirements
for the degree of

MASTERS OF SCIENCE IN PHYSICAL THERAPY

1994

EFFICACY OF IMPLEMENTING AN ERGONOMICS PROGRAM IN AN
INDUSTRIAL SETTING REGARDING CUMULATIVE TRAUMA DISORDERS TO
THE UPPER EXTREMITY

ABSTRACT

The purpose of this study was to determine if implementation of an industrial ergonomics program would decrease the number of upper extremity cumulative trauma disorders, lost days of work, and insurance costs. Data was collected from company records and OSHA logs including type of injury, lost days of work, restricted days of work, and insurance costs. This data was then analyzed using regression analysis and descriptive statistics.

The results of this study supported the concept that ergonomic programs may decrease the number of lost days of work. In this study, a number of limitations and weak correlations were found between industrial ergonomics and a decrease in restricted work days, insurance costs, and the number of cumulative trauma disorders to the upper extremity. This study indicated that industrial ergonomics has the possibility to provide significant benefits to a company, yet future research is needed to support this concept.

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PREFACE

DEFINITION OF TERMS:

ERGONOMICS: The science concerned with how to fit a job to a person's anatomical, physiological, and psychological characteristics in a way that will enhance human efficiency and well-being.

MUSCULOSKELETAL INJURY: Injury pertaining to muscular and skeletal system.

UPPER EXTREMITY: Pertaining to the hand, wrist, forearm, elbow, arm and shoulder.

BIOMECHANICS: The application of mechanical forces to living organisms and the investigation of the effects of the interaction of force and the body or system. Includes forces that arise from within and outside the body system.

RHEUMATOID ARTHRITIS: A systemic disease, characterized by inflammation of the synovial joints, stiffness, swelling, cartilagenous hypertrophy and pain.

DIABETES MELLITUS: Disorder of carbohydrate metabolism, characterized by hyperglycemia and glucosuria and resulting from inadequate production or utilization of insulin.

CONGENITAL DEFECTS: Physical abnormalities that are present at birth.

OSHA LOGS: Records kept for Occupational Safety and Health Administration, a U.S. governmental regulatory agency concerned with health and safety of workers.

RESTRICTED DAYS: The number of days that the employee was placed on restricted duty, which usually entailed switching him or her to a position on the line that did not stress his or her injured body part.

LOST DAYS: The number of days that the employee was not able to work in any capacity.

INSURANCE COST: The amount of money that the insurance carrier had to pay out on an employee. This included medical, legal, and administrative costs. No in-house medical costs were included in this amount.

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CHAPTER ONE

INTRODUCTION

Throughout history certain issues have gained popularity in science and medicine. In the 1990's ergonomics is considered to be one of those areas. Ergonomics, from the greek words "ergo" (work) and "nomos" (law), is a systematic approach to problems concerning fit between individuals, tools, and the work environment. As an interdisciplinary science, ergonomics brings together engineering and medicine to analyze the interaction between people and products (Keller,1987).

As industrial production has grown to be a major aspect of American life the number of work related injuries has concurrently risen. The terms repetitive motion injuries and cumulative trauma disorders have arisen to encompass the wide variety of pathologies caused by repetitive tasks that often place excessive strain on muscles and nerves in the hand and wrist. The cumulative effect of the repetitive tasks, combined with the forces exerted, creates the problem. In the last ten years these types of injuries have gone from relative obscurity to account for half of all job related injuries in the United States. This has cost companies more than one billion dollars a year (Verespej,1991).

In an attempt to reduce these high costs many companies have turned to ergonomic training programs. Ergonomic initiatives take on many forms, such as engineering design and/or redesign, ergonomic training and comprehensive medical case management (Longmate, 1990). Ergonomics has been recognized by corporations and the Occupational Health and Safety Administration as the technique of choice for preventing musculoskeletal injuries in the work place (Keller, 1987). Many corporations have taken these steps, but few have ever gathered written documentation as to the program's degree of success. Not being able to document how successful ergonomics has been is a problem for these companies. This type of documentation becomes necessary to convince middle and upper management that the money they are investing into the ergonomic program is worthwhile (LaBar, 1991).

This study was conducted to determine the effectiveness of implementing an ergonomics program in an manufacturing setting of approximately 600-800 employees located in the Midwest. As ergonomics continues to gain popularity and awareness it seems necessary to evaluate the effectiveness of these initiatives in a variety of settings. The hypothesis of this study is that implementation of an ergonomics program over a period of time will decrease the number of upper-extremity repetitive motion injuries, lost days of work, and insurance costs per capita. The

hypothesis will be supported if there is a decrease in any of the variables listed above.

A retrospective study was performed by collecting and analyzing data from company records. This study consisted of a year by year comparison in regards to number of upper extremity repetitive motion injuries, insurance costs, and lost days of work. The data was analyzed using regression statistics to identify any possible trends which supported or rejected the hypothesis.

CHAPTER TWO

REVIEW OF LITERATURE

INTRODUCTION

Ergonomics in the workplace is a rising and important issue among many industrial companies. It is estimated that between 48% and 58% of all industrial injuries could be prevented by application of ergonomics engineering (Keller, 1987). The challenge of ergonomics is to adapt the workplace to the worker through the changing of tools, the environment, and body positioning. The scope of the effectiveness of an ergonomics program is wide in that it looks at ways to identify those aspects of a job that lead to injuries, to the use of more ergonomically-correct machines, to the redesign of a job to prevent injury and to the training of an employee to correct improper posturing and to improve efficiency of movement. Industrial ergonomics is the study of the relationship between the worker and the requirements of the work environment.

ERGONOMIC PRINCIPLES

There are several principles that are fundamental to the science of ergonomics, first is that the human body has limitations which should be considered in the design of any tool, work place, or product; second, that individuals

possess different limitations and good design requires understanding the range of characteristics for all potential user groups; and third, musculoskeletal injury is likely when human limitations are exceeded during a given activity. The risk of such injury can be reduced by proper design of workstations and training of employees (Gross, 1990).

Much of the basis of ergonomics is that it introduces the possibility of prevention of injuries, which would decrease both the suffering of the worker and the time and money spent on treating injuries after they have occurred. Of the injuries that are incurred in the industrial setting, one of the primary classifications is that of Cumulative Trauma Disorders (CTD) to the upper extremity. CTDs are caused by repeated strain to a joint, tendon, bone, or muscle and occur when the body cannot repair itself as fast as a given trauma is being incurred. As stated previously, this classification of injury currently comprises a large portion of the \$60 billion in Workers' Compensation costs, which have gone from relative obscurity to accounting for one half of all job-related illnesses in the U.S. The cost estimate of greater than one billion dollars a year was based on an average of thirty thousand dollars or more per injury and thirty thousand new injuries each year (Vesperej, 1991).

The upper extremity was chosen as the focus for this study because it represents a large part of CTD claims and

also contains many common types of CTDs. There is a basic etiology of CTD to the upper extremity that is based upon the fact that biological tissues are often subject to fatigue failure. A fatigue failure can be defined as one occurring with repetition of loads below that which would otherwise cause failure if the load was applied only once. All connective and structural tissue will fail if subjected to repeated loads that are too high for too long a period of time without an opportunity for repair to occur. It is thought that the accumulated microtrauma caused by such cyclic loads can cause an inflammatory response, which may be responsible for the chronic syndromes resulting in pain and restricted motion. There are also other factors involved in these overuse injuries such as abnormal anatomy, the physical fitness of the individual, changes related to age, and previous injury (Pope, 1987).

There are multiple forms of CTDs of the upper extremity, and of these, carpal tunnel syndrome (CTS) was found to be most often cited. Causes of this were reported by Kendall (1960) when he studied the interaction of the median nerve, the flexor tendons, and the flexor retinaculum, and Smith et al. (1977), who found from cadaver studies that the median nerve is vulnerable to compression in the carpal tunnel during contraction of the flexor tendons when the wrist is flexed. When inflammation occurs from overuse of the flexor tendons and/or excessive compression of the median nerve, the condition very often

becomes chronic quickly and disability occurs. Another aspect of this injury that increases its disability cost is that it occurs in both extremities twice more commonly than in the dominant hand alone (Wick, 1989). Reasons for this are most often related to the individual characteristics of the worker. Factors such as age, chronic disease (such as Rheumatoid Arthritis or Diabetes Mellitus) or congenital defects will effect both hands in the same way (Loslever, 1993).

Other common CTDs of the upper extremity include rotator cuff tendonitis, where the tendons under that acromion process become inflamed and swollen from repeated overhead lifting or external/internal rotation of the arm; thoracic outlet syndrome, where blood vessels between the head and neck become pinched in certain positions, causing decreased blood supply, sensation, and strength; lateral epicondylitis, where tendons at the elbow joint that help to hold the wrist in extension during gripping and twisting are overused and become inflamed; deQuervain tenosynovitis, where tendons to the thumb are subjected to trauma during a sharp angulation in wrist motion and again, become inflamed with fluid; and white finger, where the feeling in and control of fingers and hands is lost, which may be caused from working with certain power tools (Vesperej, 1991).

The neuromuscular effect of power tools has been considered previously by Carlsoo and Mayr (1974) who found that pneumatic hammer recoil produced a stretch reflex and

muscular contractions in the elbow and wrist flexors. They suggested that repetitive stretching of muscle attachments from these reflexes can cause pain and lead to morphological changes. Radwin et al. (1987) found hand tool operation can introduce disturbances in muscle control which can result in excessive grip exertions. These muscles which are exposed to hand tool vibration can react by exhibiting a tonic vibration reflex in the form of an increasing involuntary contraction. The increase can be on the same order as a two fold increase in load weight.

BIOMECHANICS

From a biomechanics standpoint, the probability of incurring a future musculoskeletal injury greatly increases when there is mismatching of either a worker's body type or strength to the environment and requirements of a workstation (Chaffin, 1992). This is seen in instances such as a tall employee working at knee level for fifty percent of his day or a relatively weak person working in a station that requires lifting relatively heavy loads. When there is a mismatching, the injury is most often manifested in the tendon or joint, as previously indicated.

Biomechanics is also used to help in the design and layout of work places to make them as ergonomically correct as possible. The effects of disadvantageous working conditions, the unnecessary physiological cost arising from body movements that may be avoided, and especially, the static load resulting from unfavorable postures of the body

are all pertinent factors that must be taken into account. Work place layout is of great importance when considering both the direction of repetitive manual movements and improper positioning of the body, since the amount of strain and the energy lost with these can be great.

Although the study of biomechanics is helpful in addressing the issue of work place accidents, injuries still occur, and the musculoskeletal stress that arises in workers does so in a pattern unique to each individual. Although occupational activities may be contributory, it is clear that lifestyle, behavior, and cognitive processes of the individual will also be of essential concern when considering a means of combating injuries and illness (Girgling et al., 1988). In accordance with this, Ferguson (1972) reported the not all sickness absence is due to real illness, but also from withdrawal behavior adopted to decrease stress at work.

FACTORS ASSOCIATED WITH INJURY

These studies show that work accidents are multifactorial and are generally more than a misfit between environmental demands and a worker's decreased ability to cope with them. The accident involvement may be mediated by subjective stress reactions such as job satisfaction and somatic complaints, which were significant predictors of absence from sickness in a study by Melamed et al. (1989). This study also reported: 1.) a linear relationship between ergonomic stress level and accident incidence; 2.) that

workers more sensitive to environmental stressor, as indicated by reported subjective annoyance, had increased accident rates; and 3.) that absence from sickness was significantly related to overall subjective stress experienced, as manifested by reported job dissatisfaction and somatic complaints. Together these show the role of aggregate work stress, coupled with sensitivity to environmental stressors, in increasing the risk of accidents.

RISK FACTORS

Risk factor identification is an important part of an ergonomics program. A model described in Fragala (1992) is presented:

- 1.) GENERAL OBSERVATION of job duties and risk factors present.
- 2.) EMPLOYEE DISCUSSIONS concerning what job steps are difficult, perceived risk factors, painful actions/motions in certain tasks, and difficult tools.
- 3.) ADMINISTER EMPLOYEE QUESTIONNAIRE to acquire additional information relevant to the program.
- 4.) REVIEW MEDICAL DATA including injury logs, OSHA logs, worker's compensation reports, and employee absenteeism.
- 5.) ASSESS FATIGUE CONSIDERATIONS to determine, for example, if there are differences in a worker's motions at the beginning and end of shift.

Key elements of risk factor analysis include the intensity of the risk factor and the number of individual factors present simultaneously. Data such as that of risk factors is gathered and analyzed best by an ergonomics team, headed normally by an ergonomics engineer or ergonomist. This person has multiple responsibilities, including: 1.) reviewing current medical incidents, 2.) developing a medical incidence number reporting system, 3.) assessing existing jobs to determine high risk work practices and job components, 4.) interacting in new equipment design projects from the conceptual through implementation stages, 5.) developing ergonomic guidelines for use in day to day use, and 6.) developing and conducting ergonomics training programs for workers, managers, and engineers (Keller, 1987).

ERGONOMICS TEAM AND PROGRAM

The ergonomist is best suited to work with a team of professionals from such areas as safety, medicine, management, engineering, line operations, and maintenance (Keller, 1987). The duties of the ergonomics team are to identify injury/illness, production, and qualitative statistical trends; to classify and evaluate different techniques a worker can use in performing a given job - particularly one of a highly repetitive nature; predict mechanical stresses produced when a person performs a manual task; determining how people learn to produce complex body movements; and predicting time until fatigue in a manual

task and how changes can affect the type and degree of fatigue (IBID). The goal of the team is to design a program to implement the strategies they have developed. To be efficient and successful, the program must reflect the corporate culture and take advantage of existing internal resources as much as possible. Careful cost benefit analysis of available solution alternatives and development of a detailed action plan for solution implementation and measurement of benefits is also important.

A well organized action plan is the foundation to a successful industrial ergonomics program. Typical objectives in organizing a program include the following steps, as described by Gross (1990): 1.) establish top management commitment and allocate capital resources, 2.) assemble ergonomic task force members, introduce the concept of the program, and explain their individual roles, 3.) develop and implement a multilevel training program for management, technical professionals, and direct labor employees. Provide training materials and quantitative assessment tools, 4.) construct a job task analysis of the working environment, the workstation layout, the physical demands of the task, and positioning of displays and controls, 5.) develop short, medium, and long term goals for the corporate ergonomics program, including timetables, 6.) establish an ergonomics information resource, 7.) develop a system for prioritizing ergonomic needs throughout the

company, 8.) continually evaluate and document the effectiveness of the program, measure improvements in productivity, product quality, and employee morale, as well as reductions in injuries, lost time, turnover, compensation costs, and OSHA-related ergonomics citations, and finally, 9.) constantly compare goals and achievements. A program such as this will take both time and commitment to excellence to be successful, but will pay off as injuries decrease and production increases.

In the recommendation formulation for the program, changes must be achievable within the constraints of the system under evaluation. The goals must be realistic, attainable, and measurable. It should be obvious that simple, easy recommendations are easier to implement in all cases, and a cost benefit analysis to show positive effects of the program's recommendations should be done at regular intervals.

When implementing the ergonomics program, Pope, 1987, reports that support of top management and education of all people affected are both of paramount importance. Experts will lend credibility to the program throughout its implementation and redesign. Training of proper postures and the use of new equipment to help workers can be supportive, along with the use of 35mm photography and video analysis to determine better positioning, more efficient placement of tools and product, and the number of times a maneuver is performed in a given time period. As the

program is being integrated and implemented, it is imperative to remember that the end-users are the key and it is important to listen to feedback from them throughout all phases. This also helps with morale since they are given more control over what is happening to them.

Initial ergonomic studies that should be done would include analysis of changes in injury numbers; illnesses and lost-time; morale and transfer numbers; and any increase in productivity or quality. Along with these studies, there should be a system of monitoring and evaluation based on a text of predetermined indicators. Indicators are preselected, measurable variables that relate to the structure, process, or outcome of the ergonomic program. Structure indicators measure resources, equipment, and number of people involved in the program. Process indicators involve functions carried out by service deliverers such as physicians and physical therapists. Outcome indicators are the results of activities and may include results such as injury numbers, number of job safety reviews conducted, and savings from decreased injuries (Fragala, 1992). Follow-up studies should be scheduled at regular intervals and based upon baseline data gained prior to implementation. This will show the efficacy of the program, offer information to disseminate to workers and managers, and be useful as a retrospective record to show changes that occurred at different times in the course of

the program. This should again include cost benefit analysis studies (Keller, 1987).

The importance of documentation of ergonomic results cannot be overstated. If it cannot be demonstrated that the program is successful, with time, effort, and expense not being wasted, most middle and upper management will not allow a program to continue. Many at this level need to see hard data that systematic ergonomic changes will result in decreased expenses and increased productivity (LaBar, 1991). A misleading factor that often scares many managers is that there is often an increased reporting of injuries at first, but this is typically off-set by decreased severity of the claims. This can be explained by the fact that the injuries are being assessed earlier, when they are at a stage where they can be treated with less expense. With 30% of the costs coming from 20% of the cases - usually the ones that are delayed until they become so severe that surgery is indicated or disability occurs - a focus should be to minimize the number of cases that reach that costly and critical stage by identifying the injuries early (LaBar, 1992).

SUCCESSFUL COMPANIES

A review of literature shows that there are a number of companies that have begun to take ergonomics seriously and have reported substantial program success. Honda Corporation of America is one of the most graphic examples, with claimed reductions of 50% in the number of ergonomics-

related injuries and illnesses in their first year, after only minor job specific changes. This was followed by a further 35% decrease in each of the next 2 years that the program was in place (LaBar, 1992). Other companies such as Ford Motor Company have approached ergonomics programs through extensive training and education, as well as manuals, log sheets, and data tracking forms that cover everyone from managers to line workers to engineers (Verespej, 1991). At the Johnson and Johnson Corporation, one of the philosophies within the company's governing credo is to produce a safe and healthy work environment for its employees. From this commitment, programs to address ergonomic problems have become a routine part of each business day (Longmate, et al, 1990). Although there can be a substantial reduction of injuries and increase in production, the attention to detail that is needed in the restructuring of corporate workplaces need not be excessively expensive. The Berkeley Study of Accommodation Costs revealed that 80% of the expense of changes to the workplace cost less than \$500, and when a change like this can prevent a \$30,000 CTD, the financial benefits are conclusive.

CONCLUSION

Throughout the literature, there were key themes of prevention of injuries through fitting the task and workplace to the person, that ergonomics is an ongoing process, and finally, that the key benefits of decreased

injuries and costs, and increased productivity should make the implementation of an ergonomics program important to companies seeking success.

CHAPTER THREE

METHODOLOGY

STUDY DESIGN

This study is a retrospective design in which data was collected from past company records. The data was drawn from computer files and written records using the classification of injury (cumulative trauma disorder) and the year the injury was reported as file headings. The information was stratified according to medical claims incurred, type of injury, lost work days, restricted work days, and insurance costs. The data was then compared through a year by year average, comparing every year to the next and analyzed by regression and descriptive statistics.

STUDY SITE AND SUBJECTS

The data was collected from an automotive manufacturing company located in the Midwest region of the United States. Approximately seven years ago, this company implemented many ergonomic changes into various work stations to decrease injuries. Approval was granted to collect and analyze company records for the years of 1987-1993. The data collected was used to analyze the effectiveness of the ergonomics program implemented.

The subject population consisted of production employees who have worked at this company. The subjects

were selected according to the year they reported their work-related injury (between 1987-1993) and if the injury type was classified as a cumulative trauma disorder to the upper extremity. An authorized employee collected the data by computer file review. The relevant information was copied for stratification and analyzation.

INSTRUMENTS

The data was obtained using the company computer program and their OSHA 200 logs for the years 1987-1993. (see Appendix B) The company insurance agency was also contacted and insurance records were obtained for medical costs per injury. Medical costs included only treatment received "out of house" due to the fact that no records were kept regarding cost of "in house" medical treatment. The "out of house" insurance information included the medical, legal and administrative fees necessary for each particular claim. The information from the OSHA logs were compared with the insurance records and data was collected.

PROCEDURE

The data was analyzed via the company OSHA 200 logs and insurance records for the subjects who met the collection criteria. The data obtained and analyzed from these employee files include: medical claims incurred, type of injury, lost work days, restricted work days, insurance costs and related injuries to job description. All industrial employees given a diagnosis of upper-extremity

repetitive motion injury for the years 1987-1993 were included in the study. The data was collected in January 1994, at the company, under the supervision of the Superintendent of Occupational Safety and Health. The industrial company and the subjects remain anonymous throughout this study to ensure confidentiality.

DATA ANALYSIS

The data collected was comparatively analyzed by descriptive statistics. Regression statistics were used to analyze the relationship between the independent and dependent variables. In this study the independent variable was time, whereas the dependent variables include the number of injuries, lost days of work, and insurance costs. R-squared values were calculated to determine the strength of the relationship between these variables. Charts and graphs were developed to represent the statistical findings.

CHAPTER FOUR

RESULTS

Lost Days of Work (As shown in graph 1.1 & 1.2)

Excluding the year 1988, there was a decreasing trend ($R^2=.317$) in the number of lost work days. The extremely high rate in 1988 may have been due to the fact that prior to the implementation of this ergonomic program this company had no "restricted work" policy. If an employee was injured to the extent that he could not complete his prior job he did not work.

Restricted Work Days (As shown in graph 2.1 & 2.2)

The data demonstrated an increasing trend ($R^2=.214$) in the number of restricted work days for the years 1987 through 1991. For the years 1992 and 1993 there is a sharp decline in these restricted days. These results may demonstrate the principle that implementation of a restricted work policy will increase the number of restricted days and in turn decreasing the number of lost work days. This seemed to show true as there was a large increase in the number of restricted work days in 1990 (the year this new policy was introduced), yet a sharp decrease in the number of lost days of work in that same year.

Number of Upper-Extremity Repetitive Motion Injuries
(As shown in graph 3.1 & 3.2)

There was an increasing trend ($R^2=.489$) in the number of upper-extremity repetitive motion injuries throughout the years 1987 through 1993. This may have been related to the increasing role of employee education regarding preventative health care. As employees were educated regarding the signs and symptoms of possible pathology and were made more aware of detecting these early signs there may have been an increase in reported injuries. These injuries, however, tended to be reported earlier decreasing the likelihood that the disorder will become severe. Although the rate may rise, questioning the efficacy of implementation of ergonomic measures, the severity hypothetically tends to decrease saving the company both medical costs and lost days of work.

Insurance Costs (As shown in graph 4.1 & 4.2)

The data gathered regarding insurance costs showed no obvious trend ($R^2=.002$), with a severe increase in costs for 1990. A possible explanation for this may be poor record keeping. This and further possible explanations will be discussed in detail in the following chapter.

The hypothesis of this study was that implementation of an ergonomic program over a period of time will decrease the number of upper-extremity repetitive motion injuries, lost

days of work, and insurance costs per capita. The data collected in this study only supports the premise that ergonomic implementation reduces the number of lost days of work.

LOST DAYS DATA ANALYSIS

YEAR LOST DAYS PER
10 EMPLOYEES

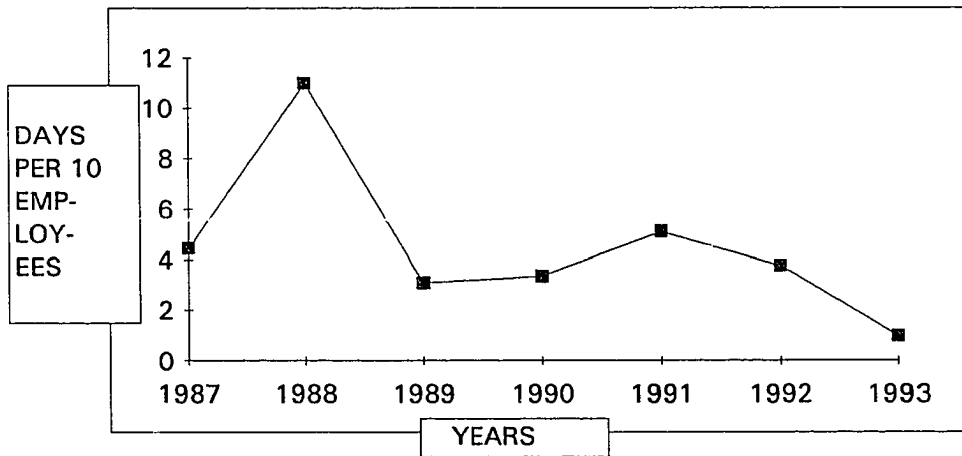
1987	4.448
1988	10.982
1989	3.074
1990	3.337
1991	5.114
1992	3.754
1993	0.982

Regression Statistics

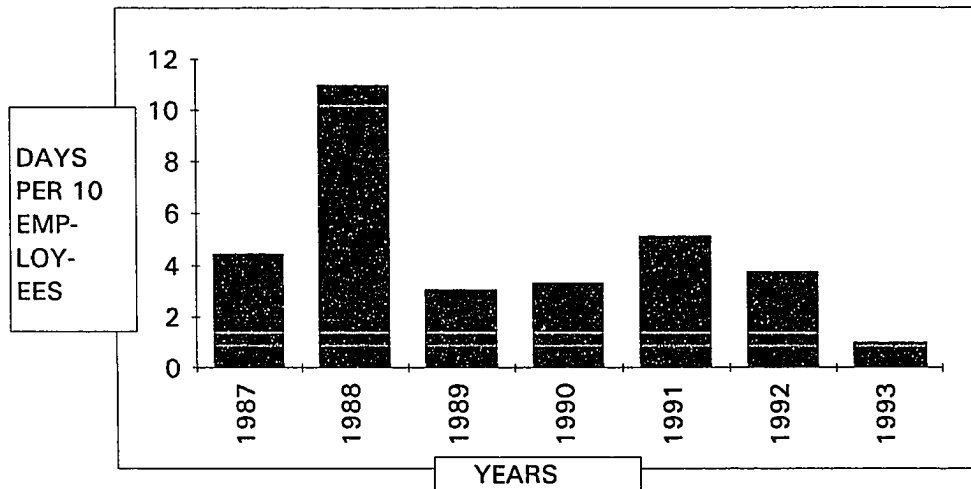
R Square 0.316618

Table 1.2: Regression Statistics

Table 1.1: Lost Days



Graph 1.1: Lost Days Per 10 Employees Per Year



Graph 1.2: Lost Days Per 10 Employees Per Year

RESTRICTED DAYS DATA ANALYSIS

RESTRICTED DAYS
PER 10 EMPLOYEES

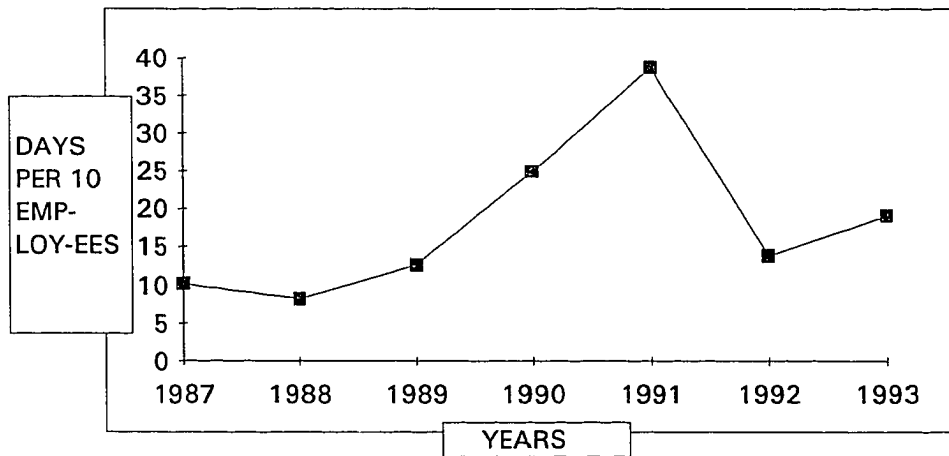
1987	10.177
1988	8.236
1989	12.642
1990	24.867
1991	38.737
1992	13.766
1993	19.063

Regression Statistics

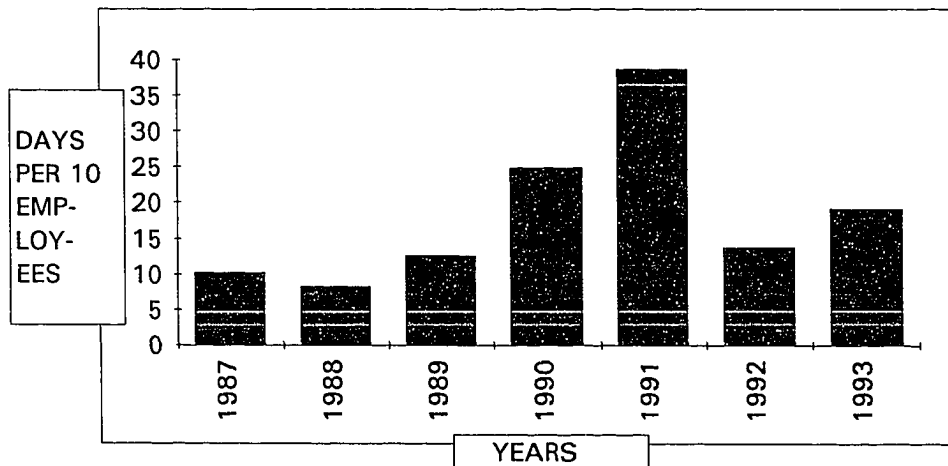
R Square 0.213506

Table 2.2: Regression Statistics

Table 2.1: Restricted Days



Graph 2.1: Restricted Days Per 10 Employees Per Year



Graph2.2: Restricted Days Per 10 Employees Per Year

INJURIES DATA ANALYSIS

YEAR INJURIES PER
10 EMPLOYEES

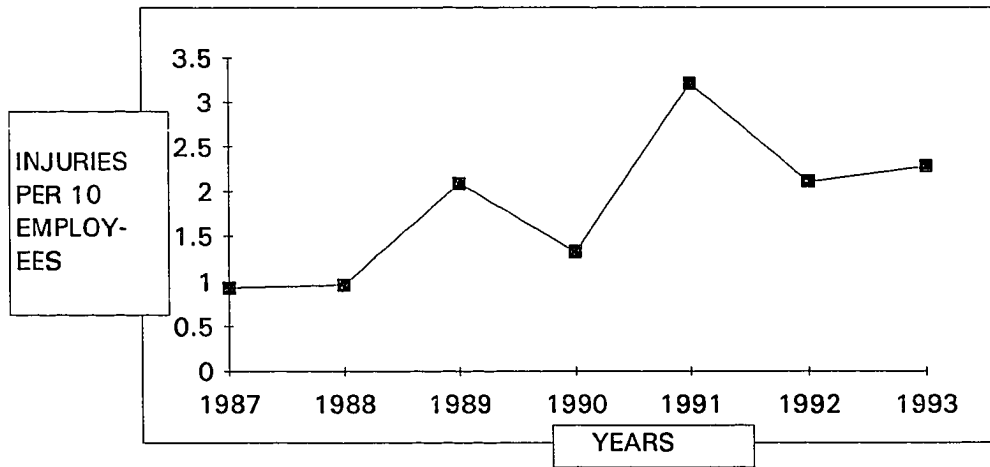
1987 0.925
1988 0.957
1989 2.089
1990 1.321
1991 3.214
1992 2.109
1993 2.279

Regression Statistics

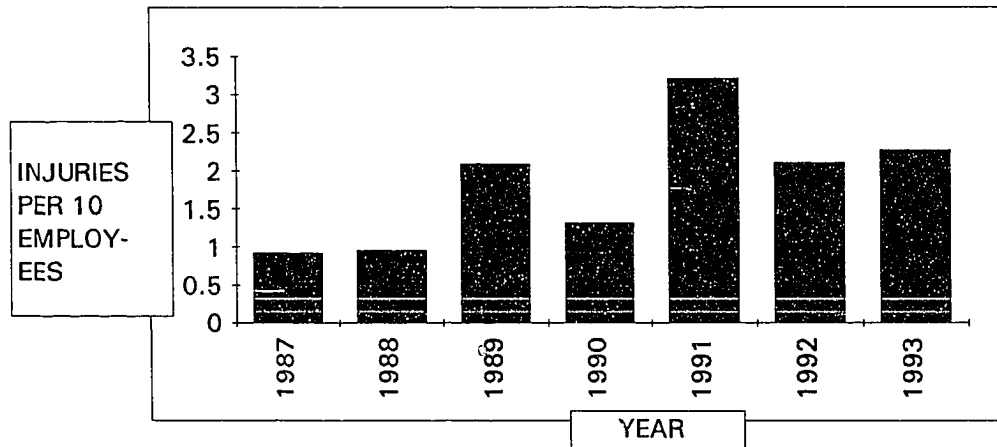
R Square 0.488664

TABLE 3.2: Regression Statistics

TABLE 3.1: Injuries



GRAPH 3.1: Injuries Per 10 Employees Per Year



GRAPH 3.2: Injuries Per 10 Employees Per Year

INSURANCE COSTS DATA ANALYSIS

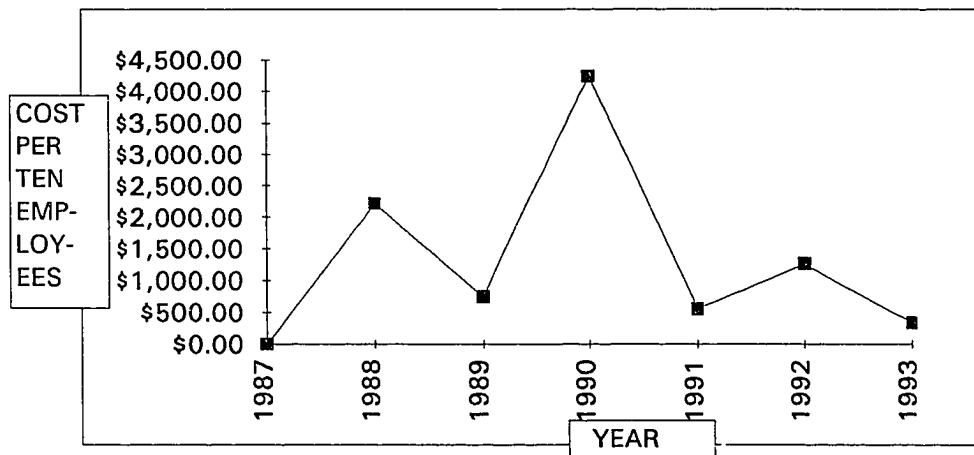
YEAR	COST PER 10 EMPLOYEES
1987	\$0.00
1988	\$2,213.80
1989	\$750.34
1990	\$4,235.81
1991	\$560.89
1992	\$1,263.17
1993	\$335.43

Table 4.1: Insurance cost

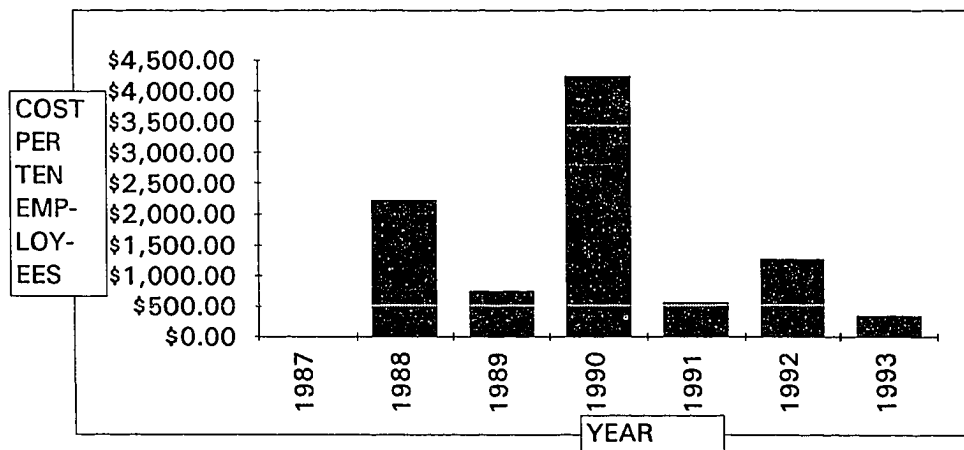
Regression Statistics

R Square 0.001715

Table 4.2: Regression statistics



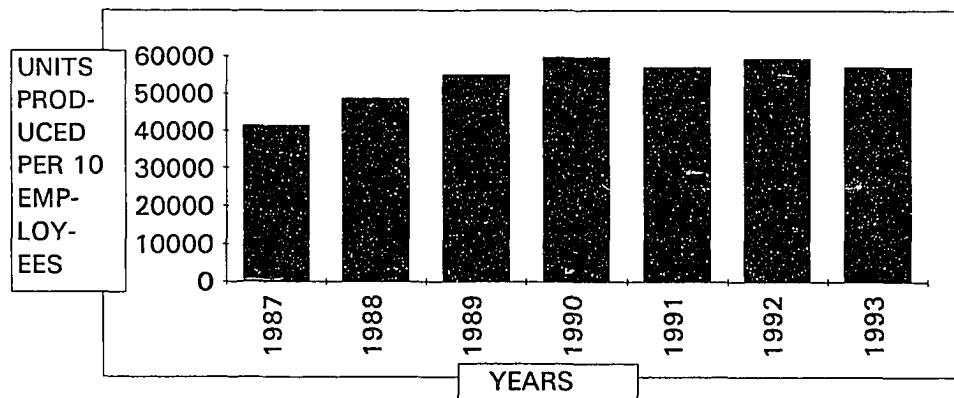
Graph 4.1: Cost Per 10 Employees Per Year



Graph 4.2: Cost Per 10 Employees Per Year

PRODUCTION (UNITS PER 10 EMPLOYEES)	
YEAR	PRODUCTION PER 10 EMPLOYEES
1987	41390
1988	48610
1989	54990
1990	59710
1991	57010
1992	59390
1993	57120

Table 5.1: Production



Graph 5.1: Production Per 10 Employees Per Year

CHAPTER FIVE

DISCUSSION AND IMPLICATIONS

The purpose of this study was to determine if implementation of an industrial ergonomics program would decrease the number of upper extremity repetitive motion injuries, lost days of work, and insurance costs. As ergonomic programs continue to develop in many settings, the need for studies such as this are important to provide the efficacy of these changes. Multiple studies have indicated that many industrial work routines are not properly adapted to the human body, which justifies the need for these ergonomic improvements. However, in our literature search through Medline, business journals and ergonomic books we could find no studies that analyze the effectiveness of an implemented ergonomic program over a period of time. Therefore, this study represents the beginning of further research to evaluate how effective these ergonomic changes are to an industrial company.

The findings of this study were variable and indicative of a variety of influential factors. The data for lost days, restricted days, insurance costs, and upper extremity repetitive motion injuries was analyzed for each year from 1987-1993. The results indicated a variety of relatively weak trends for each category and the implications will be discussed.

The trend for lost days reveals a high number of lost day occurrences during 1987 and 1988 and then a dramatic decrease over 1989 and 1990. The remaining three years showed a slight increase and then decrease in reportable lost days. These findings may indicate that many days were being lost to injuries. This company decided to invest in ergonomic changes to reduce the number of injuries thereby decreasing the number of lost work days.

In 1987 and 1988 the ergonomics program implemented associate education regarding signs and symptoms of possible pathology and basic training of ergonomic principles for injury prevention (see Appendix C). Prior to these programs the employees had limited knowledge regarding signs and symptoms of common repetitive injuries. Therefore, the high number of lost days in 1987 and 1988 may imply that injuries were reported in their late stages and required more time off for adequate injury management.

The considerable decrease in the number of reportable lost days indicates that employee education programs may have been successful in injury prevention and early reporting. The employees may have been able to recognize common clinical signs and symptoms related to repetitive motion injuries which allowed for early treatment and decreased the risk for a more severe injury.

Another reason for this high number of lost days in 1987 and 1988 may have been due to the fact that the company had not established a specific "restricted duty" program.

Prior to this policy an injured employee was more likely to be away from work (lost days) until the injury was resolved. This is clearly evident in the increased number of lost days for this company. In 1990 a specific "restricted duty" work program was implemented into the system. An employee was now able to work under these restricted conditions whereby decreasing the reported lost days for the company. The decreasing trend in the lost day findings may indicate the success of the "restricted duty" program. The lost work day results verify that the company was successful in decreasing the number of lost days over a period of seven years.

The findings for restricted work days indicate a gradual increasing level from 1988-1991. The level then slightly decreases and then increases from 1991-1993. The increasing level may strongly agree with the "restricted duty" program implementation as previously mentioned. The possible reason for the trends decrease and increase during 1991-1993 may be explained by the lower injuries reported during those years, which is directly related to the restricted day numbers.

It is noted that as the lost work day numbers decreased the restricted work days increased. This may imply the effectiveness of the "restricted duty" program. The company has the possibility to be more productive and cost efficient by providing this for injured employees.

The findings for insurance costs over the seven year period varied considerably. The explanation for these inconsistencies is unknown. Some factors that may have affected these findings include inadequate "in-house" medical records, uncontrollable injury severities during a particular year, and incomplete company insurance records. The insurance cost findings show no correlation with lost days, restricted days, or upper-extremity repetitive motion injuries.

The findings for upper-extremity repetitive motion injury occurrence shows a gradual increasing level for 1987-1989. For unknown reasons the level decreases in 1990 and then makes a dramatic increase in 1991. Again the level decreases in 1992 and increases in 1993.

The primary reason this company implemented these ergonomic changes was to decrease the number of injuries. These findings may imply that education and prevention programs accounted for the earlier and higher reporting of clinical signs and symptoms of injuries, which was reported in the OSHA 200 logs as an injury. The focus of this study was on upper-extremity injuries which may have been on a rise for unknown reasons, while other injuries may have been on a decline. Other unknown factors may exist that would explain the variable trends for upper-extremity repetitive motion injuries. Overall, there was not a decreasing trend in upper-extremity repetitive motion injuries over a seven year period.

LIMITATIONS

This company has incorporated annual ergonomic changes over a seven year period which have revealed a variety of results. There was no set structure or plan for these changes so many types of ergonomic programs were implemented depending on the area of need. Therefore, it was difficult to determine what specific changes have been the most beneficial to this company.

The total ergonomic program cost to the company was not possible to calculate. The resources for funding this program were provided by many sectors within the company. Each sector had their own budget but comprehensive records of specific cost changes were not available. It would have been very informative to compare cost outputs and cost benefits provided by these ergonomic changes.

The ergonomic changes implemented may have had an impact on employee job satisfaction. Employee interviews and surveys may have provided this study with some subjective information to explain the data results. There may have been a variety of social factors among the employees that could explain data findings.

Another limitation was poor record keeping by the company. In-house clinics, physical therapy, and exercise programs were aspects of their ergonomic changes but records were not available to evaluate the impact of these changes. This would have provided more accurate documentation regarding injury treatment costs to the company. Records

regarding specific work station changes were also not available for analysis and comparison. These records would have been beneficial for more specific ergonomic analysis.

During the seven year period this company's production fluctuated, which may have altered the findings. Although the company hired more employees as production increased, overtime and overwork may have existed to keep up with production. This may have had a direct impact on the data findings. Also, a seven year data analysis may have been too short of a time frame to see valid changes. Therefore, time may be a limiting factor.

The focus of this study was on upper-extremity repetitive motion injuries and did not account for other injuries which may have impacted the results. It is quite possible that analysis of all injury types or another specific injury would yield different findings. Therefore, the specific upper-extremity focus has been a limitation to this study.

SUGGESTIONS

This study suggests that future studies would be beneficial in providing more conclusive information about ergonomic implementation. It would be interesting to interview the employees regarding their impressions of job satisfaction after ergonomic implementation and relate this to the data findings. It would also be valuable to compare the data of pre to post ergonomic implementation to get specific results on where the program has been the most

beneficial within the company. These are suggestions that can provide even more evidence of the efficacy of industrial ergonomics.

SUMMARY

As ergonomics continues to gain approval and popularity in industrial settings then the need for valid ergonomic research will also rise. In order for a concept to be accepted it needs to be proven through valid and reliable research. The rising ergonomic trend indicates the high success of this concept, but the need still exists to prove its long-term effectiveness. As industrial companies approach long-term ergonomic use, studies will need to provide efficacy for the costly changes.

This company indicated that they were satisfied with the ergonomic changes that have been implemented over the seven year period. They felt they were accomplishing their ergonomic goals which was to decrease injuries. This study did not provide evidence of a decrease in upper-extremity injuries over a seven year period.

This study indicates that industrial ergonomics has the possibility to provide significant benefits to a company. Our study only provides statistical support that ergonomics will decrease the number of lost days of work. We found a number of limitations and weak correlations between industrial ergonomics and restricted work days, insurance costs, and upper-extremity repetitive motion injuries. Throughout our data collection, it became very evident that

a company must keep comprehensive and accurate records of changes and outcomes to adequately evaluate the effectiveness of these changes. These records will provide valuable information for further research and analysis of industrial ergonomic efficacy. Industrial ergonomics has proven to decrease lost work days for this industrial company.

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APPENDIX A

Safety Policies and Guidelines**PURPOSE:**

This company is very safety conscious. The obvious reason for good safety practices is to prevent injuries to associates. In addition, good safety practices:

- Prevent damage to products, machinery, and facilities
- Encourage effective operations
- Encourage higher productivity
- Reduce confusion
- Make the work environment more enjoyable and pleasant for all associates.

POLICY:

This company believes that through the practice of following three safety guidelines, accidents and injuries will be minimized.

1. FIVE PRINCIPLES OF SAFE WORK:

(In Japanese these are known as the five "S's"):

SEIRE (pronounced "say-ree"): This is the concept of sorting out those things that are no longer needed from those that are needed. Those items that are no longer needed are to be discarded in a proper manner, thus avoiding clutter.

SEITON (pronounced "say-tohn"): This is the concept of arranging those items or tools to be kept in a manner that makes them easily accessible. Being able to find items and tools easily makes the associate more productive, effective and satisfied.

SEISO (pronounced "say-so"): This is the concept of cleaning the work area. Sweeping up scraps of material wiping dust or oil off work surfaces, machines, and tools, etc.

SEIKETSU (pronounced "say-ket-su"): This is the concept of maintaining a clean work area as well as personal hygiene. A neat work area is one that is less likely to encourage accidents and injury.

SHITSUKE (pronounced "sheet-soo-kay"): This is the concept of maintaining the worker's morale and skills so that the four other principles of safe work can be accomplished.

2) CHECK FOR ABNORMALITIES:

- Be aware of the proper functioning of machines and the environment.
- Be alert and check for malfunctions or abnormalities in the operation of the machine.
- Correct or have corrected the abnormalities as soon as possible.

3) MAINTAIN STANDARD WORK PROCEDURES:

- The work procedures and processes have been developed with safety and effectiveness of operation in mind. To perform a work task differently than what has been designed could cause an unsafe condition. Therefore, all associates are requested not to change the work process from the way they were trained to do it.
- If associates have ideas for change in the work process, they should make suggestions to their team leaders, who will present suggestions to the supervisor for consideration.
- By following these three practices, many potential safety problems can be avoided before they happen. Small problems, if left unattended, will usually become big problems and accidents and injuries may occur.

PROCEDURE:

Attention to safety practices and the above policy is a continuing function to be performed by all associates.

RESPONSIBILITY:

- It is the responsibility of all associates to maintain good, safe work practices in accordance with this policy and other established safety procedures.
- Sub-leaders, team leaders, supervisors, superintendents, assistant managers and managers are especially responsible for following practices and ensuring that the safety practices are adhered to by all associates.

ILLNESSES

Form 10-100 (Rev. 10-1-60)		Form 10-100 (Rev. 10-1-60)	
Name of the Organization or Individual		Name of the Organization or Individual	
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36
37	38	39	40
41	42	43	44
45	46	47	48
49	50	51	52
53	54	55	56
57	58	59	60
61	62	63	64
65	66	67	68
69	70	71	72
73	74	75	76
77	78	79	80
81	82	83	84
85	86	87	88
89	90	91	92
93	94	95	96
97	98	99	100

APPENDIX C

Ergonomic Initiatives

<u>Program Title</u>	<u>Start Date</u>
Restricted Work	1990
In-House Clinics	1991
Job Analysis	1989
Administrative Policy	1990
Office Ergonomics	1993
Physical Therapy	1992
Heat Stress Management	1987
Weight Guidelines	1989
Safe Lifting Practices	1988
Back Care	1988
Associate Symptom Assessment	1990
Exercise Program	1990
Total Care Management	1992
Wellness Physicals	1990

APPENDIX D			
Collected Data			
DATE OF	RESTRICTED		
INJURY	LOST DAYS	DAYS	MEDICAL COST
1/15/87	15	45	\$0.00
1/29/87	17	17	\$0.00
3/5/87	0	0	\$0.00
3/5/87	0	0	\$0.00
3/12/87	11	21	\$0.00
3/19/87	4	32	\$0.00
3/27/87	0	1.5	\$0.00
3/27/87	0	1.5	\$0.00
3/30/87	0	9	\$0.00
4/9/87	0	6	\$0.00
7/23/87	0	0	\$0.00
8/6/87	0	1	\$0.00
8/13/87	0	0	\$0.00
8/15/87	10	29	\$0.00
8/15/87	10	29	\$0.00
9/3/87	0	15	\$0.00
9/8/87	0	12	\$0.00
9/8/87	0	12	\$0.00
9/10/87	0	8	\$0.00
9/10/87	0	8	\$0.00
9/29/87	34	0	\$0.00
10/19/87	0	0	\$0.00
10/19/87	0	0	\$0.00
10/29/87	0	19.5	\$0.00
10/29/87	0	19.5	\$0.00
11/18/87	24	0	\$0.00
2/4/88	0	0	\$150.00
2/17/88	0	8	\$0.00
3/7/88	0	0	\$0.00
3/9/88	13	0	\$0.00
3/21/88	0	0	\$75.00
3/24/88	0	0	\$534.50
3/24/88	0	0	\$534.50
4/11/88	13	2.5	\$946.00
4/11/88	13	2.5	\$946.00
4/14/88	85	43	\$30,174.00
4/18/88	0	15	\$0.00
5/19/88	10.5	12	\$431.00
5/19/88	10.5	12	\$431.00
5/23/88	9	0	\$535.00
5/23/88	9	0	\$535.00
6/16/88	0	0	\$0.00
6/16/88	0	0	\$0.00

6/16/88	0	0	\$0.00
6/16/88	0	0	\$0.00
6/23/88	0	3	\$0.00
8/4/88	0	14	\$745.00
8/25/88	0	83	\$459.00
10/10/88	18.5	17.5	\$18,540.00
10/10/88	18.5	17.5	\$18,540.00
10/13/88	0	6.5	\$65.00
10/13/88	0	6.5	\$65.00
10/13/88	0	6.5	\$65.00
10/13/88	0	6.5	\$65.00
10/20/88	15.66	10.33	\$852.00
10/20/88	15.66	10.33	\$852.00
10/20/88	15.66	10.33	\$852.00
10/24/88	0	0	\$0.00
10/31/88	63	27	\$0.00
11/8/88	0	13	\$0.00
11/8/88	63	0	\$3,997.50
11/8/88	63	0	\$3,997.50
11/14/88	0	0	\$0.00
12/19/88	0	0	\$3,501.00
1/16/89	0	0	\$0.00
1/16/89	0	0	\$0.00
1/26/89	20	0	\$0.00
1/26/89	20	0	\$0.00
1/30/89	0	0	\$0.00
2/3/89	0	0	\$250.00
2/6/89	10	5	\$4,307.00
2/8/89	0	0	\$0.00
2/8/89	0	0	\$0.00
2/10/89	0	0	\$486.00
2/18/89	0	0	\$0.00
2/22/89	0	0	\$0.00
2/22/89	0	0	\$0.00
2/22/89	0	0	\$0.00
2/24/89	0	0	\$2,005.00
2/27/89	0	0	\$0.00
3/3/89	0	0	\$0.00
3/3/89	0	0	\$0.00
3/10/89	0	0	\$0.00
3/10/89	0	0	\$0.00
3/17/89	0	0	\$0.00
3/17/89	0	0	\$0.00
3/17/89	0	0	\$0.00
3/22/89	0	0	\$0.00
3/27/89	0	7.5	\$22.50
3/27/89	0	7.5	\$22.50
3/29/89	0	0	\$0.00
3/29/89	0	0	\$0.00

3/29/89	0	0	\$0.00
4/7/89	0	0	\$0.00
4/7/89	0	0	\$0.00
4/7/89	0	0	\$0.00
4/17/89	0	0	\$0.00
4/26/89	0	0	\$0.00
5/17/89	0	0.5	\$0.00
5/17/89	0	0.5	\$0.00
5/19/89	5	25	\$2,854.00
5/19/89	0	0	\$0.00
5/24/89	0	0	\$0.00
5/24/89	0	0	\$0.00
5/24/89	0	0	\$0.00
5/24/89	0	1	\$232.00
5/26/89	0	2	\$0.00
5/31/89	0	0	\$0.00
5/31/89	0	0	\$0.00
5/31/89	0	58	\$0.00
6/2/89	0	140	\$0.00
6/6/89	0	0	\$0.00
6/16/89	0	129	\$0.00
6/16/89	0	1	\$0.00
6/23/89	0	0	\$0.00
6/26/89	0	0	\$0.00
6/26/89	6	17	\$604.00
6/26/89	0	45	\$132.00
6/30/89	0	0	\$0.00
7/12/89	0	0	\$0.00
7/12/89	0	0	\$0.00
7/12/89	0	0	\$0.00
7/14/89	0	0	\$0.00
7/17/89	0	0	\$0.00
7/17/89	13	2	\$2,131.00
7/17/89	2	5	\$2,131.00
7/17/89	18	3	\$2,131.00
7/27/89	0	0	\$0.00
7/27/89	0	0	\$0.00
7/27/89	0	0	\$0.00
8/2/89	0	0	\$0.00
8/7/89	0	0	\$0.00
8/7/89	0	0	\$0.00
8/10/89	0	0	\$0.00
8/16/89	0	6	\$0.00
8/17/89	0	0	\$0.00
8/17/89	0	0	\$0.00
8/17/89	0	0	\$0.00
8/17/89	0	0	\$0.00
8/17/89	0	0	\$0.00
8/22/89	0	0	\$0.00

8/22/89	0	0	\$0.00
8/25/89	0	0	\$0.00
8/25/89	0	0	\$0.00
8/25/89	0	0	\$0.00
8/28/89	0	0	\$0.00
8/30/89	0	0	\$0.00
8/31/89	0	0	\$0.00
9/5/89	17	20	\$2,895.00
9/5/89	17	20	\$2,895.00
9/6/89	0	66	\$0.00
9/12/89	0	0	\$0.00
9/20/89	0	0	\$0.00
9/22/89	0	0	\$0.00
9/26/89	0	0	\$0.00
10/4/89	0	47	\$0.00
10/6/89	0	17	\$0.00
10/12/89	0	39	\$0.00
10/12/89	0	0	\$0.00
10/13/89	0	0	\$0.00
10/19/89	0	0	\$0.00
10/23/89	0	0	\$0.00
10/25/89	0	0	\$0.00
10/26/89	0	33	\$12,049.00
11/1/89	0	0	\$0.00
11/1/89	0	0	\$0.00
11/2/89	0	0	\$0.00
11/2/89	0	0	\$0.00
11/2/89	0	0	\$0.00
11/6/89	0	2	\$0.00
11/6/89	0	2	\$0.00
11/15/89	25	10.5	\$4,067.50
11/15/89	25	10.5	\$4,067.50
11/16/89	0	0	\$0.00
11/16/89	0	0	\$0.00
11/16/89	0	0	\$0.00
11/28/89	0	0	\$0.00
12/1/89	0	0	\$0.00
12/4/89	0	0	\$0.00
12/6/89	0	10	\$0.00
12/15/89	0	0	\$0.00
12/15/89	0	0	\$0.00
12/20/89	0	0	\$163.00
12/22/89	0	0	\$0.00
12/22/89	0	0	\$0.00
1/11/90	0	0	\$0.00
1/16/90	0	0	\$0.00
1/16/90	0	18	\$0.00
1/18/90	0	0	\$915.00
1/22/90	0	0	\$160.00

1/22/90	0	0	\$0.00
1/24/90	0	0	\$0.00
2/9/90	0	0	\$0.00
2/9/90	0	0	\$0.00
2/15/90	0	0	\$0.00
2/20/90	0	3	\$0.00
3/6/90	0	0	\$0.00
3/9/90	4	288	\$85,283.00
3/12/90	0	27	\$0.00
3/12/90	0	133	\$14,748.00
3/16/90	0	5	\$0.00
3/20/90	0	65	\$64.00
3/30/90	0	0	\$0.00
3/30/90	0	0	\$0.00
4/5/90	0	0	\$0.00
4/5/90	0	0	\$0.00
4/11/90	0	0	\$0.00
4/13/90	6	49	\$0.00
4/17/90	0	0	\$0.00
4/17/90	0	0	\$0.00
4/17/90	0	0	\$0.00
4/30/90	35	48	\$34,970.50
4/30/90	35	48	\$34,970.50
5/2/90	0	50	\$694.00
5/4/90	0	0	\$0.00
5/4/90	0	0	\$0.00
5/4/90	0	0	\$0.00
5/4/90	0	11.5	\$0.00
5/4/90	0	11.5	\$0.00
5/16/90	0	0	\$0.00
5/16/90	0	0	\$0.00
5/16/90	0	0	\$0.00
5/29/90	0	11	\$160.00
5/31/90	0	117	\$2,670.00
5/31/90	20.5	98	\$0.00
5/31/90	20.5	98	\$0.00
6/20/90	0	15	\$0.00
7/5/90	0	1	\$84.00
7/16/90	0	43	\$0.00
7/16/90	0	33	\$38,752.50
7/16/90	0	33	\$38,752.50
7/17/90	0	0	\$0.00
7/18/90	0	49	\$586.00
7/23/90	12	0	\$2,679.00
8/1/90	0	0	\$0.00
8/1/90	0	0	\$0.00
8/9/90	0	0	\$0.00
8/24/90	0	69	\$0.00
9/5/90	0	0	\$9.00

9/17/90	0	10	\$0.00
9/17/90	0	16.5	\$0.00
9/17/90	0	16.5	\$0.00
9/25/90	33	77	\$4,921.00
10/3/90	0	55	\$0.00
10/10/90	0	5	\$0.00
10/10/90	0	10	\$29,028.00
10/11/90	0	0	\$0.00
10/11/90	0	0	\$0.00
10/11/90	0	0	\$0.00
10/11/90	0	0	\$0.00
10/11/90	0	0	\$0.00
10/12/90	0	0	\$0.00
10/16/90	0	100	\$9,844.00
10/17/90	0	0	\$80.00
10/17/90	0	0	\$80.00
10/17/90	37	50.5	\$3,781.50
10/17/90	37	50.5	\$3,781.50
10/23/90	0	0	\$0.00
10/23/90	0	0	\$0.00
10/23/90	0	6	\$0.00
10/30/90	0	0	\$0.00
10/30/90	0	0	\$0.00
10/30/90	0	0	\$0.00
10/30/90	0	0	\$100.00
10/31/90	0	0	\$0.00
11/7/90	0	6	\$0.00
11/7/90	0	0	\$640.00
11/9/90	0	0	\$0.00
11/9/90	0	0	\$396.00
11/20/90	0	0	\$0.00
11/20/90	0	0	\$0.00
11/20/90	0	0	\$0.00
11/20/90	0	0	\$0.00
11/20/90	0	0	\$0.00
11/20/90	0	0	\$0.00
11/27/90	0	0	\$0.00
11/27/90	0	0	\$0.00
11/27/90	0	61	\$0.00
12/12/90	0	0	\$0.00
12/17/90	0	0	\$0.00
12/17/90	0	0	\$0.00
1/7/91	0	0	\$0.00
1/7/91	0	20	\$0.00
1/15/91	0	0	\$0.00
1/15/91	0	0	\$0.00
1/16/91	0	9	\$0.00
1/24/91	0	0	\$0.00
1/24/91	0	0	\$0.00
1/24/91	0	0	\$0.00

1/25/91	0	75	\$20,084.00
1/25/91	0	0	\$0.00
1/25/91	0	0	\$0.00
1/28/91	0	0	\$0.00
1/28/91	0	0	\$0.00
1/30/91	0	0	\$0.00
1/30/91	0	63.3	\$0.00
1/30/91	0	63.3	\$0.00
1/30/91	0	63.3	\$0.00
1/31/91	0	11	\$0.00
1/31/91	0	11	\$0.00
2/8/91	0	0	\$0.00
2/8/91	0	6	\$172.50
2/8/91	0	6	\$172.50
2/8/91	0	0	\$0.00
2/8/91	0	0	\$0.00
2/8/91	0	62.5	\$12.00
2/8/91	0	62.5	\$12.00
2/8/91	49.5	101	\$0.00
2/8/91	49.5	24	\$0.00
2/13/91	0	16.5	\$0.00
2/13/91	0	16.5	\$0.00
2/18/91	0	0	\$0.00
2/19/91	0	0	\$0.00
3/4/91	0	12	\$0.00
3/4/91	0	57	\$893.00
3/4/91	0	0	\$0.00
3/7/91	40	64	\$4,171.00
3/7/91	0	0	\$357.00
3/7/91	0	0	\$0.00
3/14/91	0	0	\$0.00
3/14/91	0	0	\$0.00
3/19/91	0	38	\$0.00
3/19/91	0	24	\$0.00
3/26/91	0	0	\$0.00
3/26/91	0	6	\$0.00
3/26/91	0	6	\$0.00
3/27/91	0	0	\$37.00
3/27/91	0	0	\$0.00
3/27/91	6.5	35	\$4,955.50
3/27/91	6.5	94	\$4,955.50
4/2/91	0	0	\$0.00
4/2/91	0	0	\$0.00
4/5/91	0	63	\$0.00
4/5/91	0	63	\$0.00
4/5/91	0	95	\$1,147.00
4/5/91	0	0	\$0.00
4/5/91	0	0	\$0.00
4/5/91	0	0	\$0.00

4/5/91	0	13	\$0.00
4/5/91	0	14	\$0.00
4/5/91	0	0	\$0.00
4/11/91	0	0	\$0.00
4/26/91	0	0	\$0.00
4/26/91	0	63	\$653.00
4/26/91	0	0	\$0.00
4/26/91	0	0	\$126.00
5/1/91	0	0	\$0.00
5/1/91	0	0	\$0.00
5/1/91	0	0	\$0.00
5/9/91	0	0	\$0.00
5/9/91	0	6	\$0.00
5/9/91	0	116	\$0.00
5/9/91	0	26	\$0.00
5/13/91	0	48.5	\$125.00
5/13/91	0	48.5	\$125.00
5/13/91	0	0	\$0.00
5/13/91	0	0	\$0.00
5/13/91	0	0	\$0.00
5/17/91	0	8	\$0.00
5/22/91	0	0	\$21.50
5/22/91	0	0	\$21.50
5/22/91	0	36	\$426.50
5/22/91	0	36	\$426.50
5/22/91	0	0	\$0.00
5/30/91	0	70	\$0.00
6/4/91	3	35	\$0.00
6/4/91	3	35	\$0.00
6/4/91	0	0	\$0.00
6/4/91	18	74	\$0.00
6/4/91	18	83	\$0.00
6/4/91	0	0	\$0.00
6/4/91	0	0	\$0.00
6/4/91	0	0	\$0.00
6/10/91	0	75	\$9,703.00
6/10/91	0	0	\$2,033.50
6/10/91	0	0	\$2,033.50
6/10/91	0	34	\$0.00
6/10/91	0	10	\$0.00
6/10/91	0	0	\$0.00
6/10/91	0	142	\$0.00
6/10/91	0	0	\$0.00
6/10/91	0	0	\$0.00
6/10/91	0	7.5	\$0.00
6/10/91	0	7.5	\$0.00
6/14/91	0	0	\$138.50
6/14/91	0	0	\$138.50
6/14/91	0	0	\$0.00

6/14/91	0	0	\$0.00
6/18/91	0	0	\$0.00
6/18/91	0	0	\$0.00
6/18/91	0	0	\$0.00
6/18/91	0	28	\$1,379.00
6/21/91	0	1.5	\$139.50
6/21/91	0	1.5	\$139.50
6/21/91	0	1.5	\$139.50
6/21/91	0	1.5	\$139.50
6/21/91	0	5	\$0.00
6/21/91	0	5	\$0.00
6/21/91	0	14.33	\$0.00
6/21/91	0	14.33	\$0.00
6/21/91	0	14.33	\$0.00
6/21/91	0	28	\$0.00
6/21/91	0	78	\$0.00
6/21/91	0	2	\$0.00
6/21/91	0	2	\$0.00
6/21/91	0	0	\$0.00
6/24/91	0	10	\$0.00
6/24/91	0	32.5	\$0.00
6/24/91	0	32.5	\$0.00
6/24/91	0	32.5	\$0.00
6/24/91	0	32.5	\$0.00
6/24/91	0	3	\$0.00
6/24/91	0	3	\$0.00
6/24/91	0	0	\$0.00
6/24/91	0	0	\$0.00
7/2/91	0	5.5	\$0.00
7/2/91	0	5.5	\$0.00
7/2/91	0	22	\$0.00
7/2/91	0	19.5	\$0.00
7/2/91	0	19.5	\$0.00
7/2/91	0	0	\$0.00
7/2/91	0	25	\$0.00
7/11/91	0	5	\$0.00
7/11/91	0	0	\$0.00
7/11/91	0	3	\$0.00
7/11/91	0	3	\$0.00
7/11/91	0	0	\$0.00
7/11/91	0	0	\$0.00
7/11/91	0	0	\$0.00
7/11/91	0	0	\$0.00
7/19/91	0	0	\$0.00
7/19/91	0	0	\$0.00
7/19/91	0	0	\$0.00
7/24/91	0	25	\$0.00
7/24/91	0	0	\$0.00
7/24/91	0	0	\$0.00

10/10/91	0	57	\$292.00
10/11/91	0	0	\$0.00
10/17/91	0	0	\$0.00
10/17/91	0	4	\$0.00
10/17/91	0	4	\$0.00
10/17/91	0	17	\$0.00
10/17/91	4	0	\$0.00
10/23/91	0	0	\$0.00
10/23/91	0	0	\$0.00
10/23/91	0	0	\$0.00
10/23/91	0	0	\$0.00
10/23/91	0	0	\$0.00
10/23/91	0	0	\$0.00
10/23/91	0	0	\$0.00
10/24/91	7	0	\$0.00
10/30/91	0	0	\$0.00
11/8/91	0	0	\$0.00
11/8/91	0	0	\$0.00
11/10/91	0	0	\$0.00
11/12/91	0	0	\$0.00
11/12/91	0	0	\$0.00
11/12/91	0	0	\$1,797.00
11/21/91	0	0	\$0.00
11/21/91	0	0	\$0.00
11/21/91	0	0	\$0.00
11/21/91	0	12	\$0.00
11/21/91	44.5	0	\$0.00
11/21/91	44.5	0	\$0.00
11/21/91	30	0	\$0.00
11/21/91	0	0	\$0.00
11/21/91	19	0	\$0.00
11/21/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
11/27/91	0	0	\$0.00
12/3/91	0	0	\$0.00
12/12/91	0	0	\$0.00
12/12/91	0	0	\$0.00
12/12/91	0	0	\$0.00
12/12/91	6	0	\$0.00
12/12/91	0	0	\$0.00
12/16/91	0	0	\$0.00
1/8/92	0	0	\$0.00

1/8/92	0	0	\$0.00
1/8/92	0	0	\$0.00
1/17/92	0	12	\$0.00
1/17/92	0	0	\$1,028.00
1/17/92	0	0	\$0.00
1/22/92	0	0	\$1,175.00
1/22/92	0	0	\$1,175.00
1/22/92	0	0	\$0.00
1/22/92	0	12	\$0.00
1/22/92	0	18	\$0.00
1/22/92	0	0	\$0.00
1/22/92	0	0	\$0.00
1/30/92	0	0	\$0.00
1/30/92	0	13	\$0.00
1/30/92	0	0	\$0.00
1/30/92	0	0	\$0.00
1/30/92	0	0	\$0.00
1/30/92	0	0	\$4,740.00
2/3/92	0	0	\$0.00
2/4/92	0	0	\$0.00
2/10/92	0	0	\$0.00
2/10/92	0	0	\$343.00
2/10/92	0	2.5	\$0.00
2/10/92	0	2.5	\$0.00
2/10/92	0	0	\$5.00
2/12/92	0	0	\$0.00
2/12/92	0	0	\$0.00
2/13/92	0	0	\$0.00
2/13/92	0	1.5	\$0.00
2/13/92	0	1.5	\$0.00
2/27/92	0	0	\$37.00
3/3/92	0	0	\$0.00
3/3/92	0	130	\$15,614.00
3/13/92	0	0	\$204.00
3/17/92	0	0	\$0.00
3/17/92	0	0	\$0.00
3/17/92	0	0	\$0.00
3/18/92	0	0	\$0.00
3/23/92	0	0	\$0.00
3/25/92	0	0	\$0.00
3/25/92	0	0	\$193.33
3/25/92	0	0	\$193.33
3/25/92	0	0	\$193.33
3/25/92	30.5	0	\$5,423.50
3/25/92	30.5	0	\$5,423.50
3/30/92	63	37	\$14,633.00
3/30/92	0	39	\$1,482.00
3/30/92	11	26	\$0.00
3/30/92	0	0	\$0.00

3/30/92	0	0	\$0.00
4/1/92	0	0	\$0.00
4/3/92	0	0	\$947.00
4/7/92	0	40	\$248.00
4/7/92	0	0	\$0.00
4/7/92	0	43.5	\$18.50
4/7/92	0	43.5	\$18.50
4/7/92	0	0	\$0.00
4/7/92	0	0	\$0.00
4/7/92	0	7	\$37.00
4/14/92	0	0	\$0.00
4/15/92	0	0	\$0.00
4/15/92	0	22	\$0.00
4/15/92	0	0	\$0.00
4/15/92	0	0	\$0.00
4/15/92	0	0	\$0.00
4/15/92	0	0	\$0.00
4/15/92	0	0	\$0.00
4/28/92	0	28	\$22.00
4/28/92	0	0	\$0.00
4/28/92	0	0	\$0.00
4/28/92	0	3	\$0.00
4/28/92	0	0	\$0.00
5/6/92	0	0	\$0.00
5/6/92	0	0	\$279.00
5/6/92	0	0	\$279.00
5/6/92	0	0	\$0.00
5/13/92	0	0	\$0.00
5/26/92	0	0	\$0.00
6/11/92	0	0	\$0.00
6/11/92	0	0	\$0.00
6/11/92	0	0	\$0.00
6/16/92	0	0	\$0.00
6/16/92	0	0	\$0.00
6/16/92	0	0	\$0.00
6/16/92	0	0	\$243.00
6/24/92	0	3.5	\$0.00
6/24/92	0	3.5	\$0.00
6/24/92	0	3.5	\$0.00
6/24/92	0	3.5	\$0.00
6/30/92	0	3.8	\$0.00
6/30/92	0	3.8	\$0.00
6/30/92	0	3.8	\$0.00
6/30/92	0	3.8	\$0.00
6/30/92	0	3.8	\$0.00
7/10/92	0	0	\$50.00
7/10/92	0	33	\$0.00
7/14/92	0	11	\$0.00
7/14/92	0	0	\$0.00
7/14/92	0	0	\$0.00

7/14/92	0	0	\$0.00
7/14/92	0	0	\$0.00
7/14/92	0	0	\$0.00
7/14/92	0	0	\$0.00
7/14/92	0	0	\$0.00
7/14/92	0	0	\$168.00
7/14/92	0	0	\$168.00
7/22/92	0	0	\$0.00
7/22/92	0	5	\$254.00
7/29/92	0	0	\$0.00
7/29/92	0	0	\$0.00
8/5/92	0	0	\$0.00
8/5/92	0	0	\$0.00
8/5/92	0	63	\$0.00
8/11/92	0	0	\$0.00
8/11/92	0	0	\$0.00
8/11/92	0	0	\$0.00
8/11/92	180	40	\$38,967.00
8/11/92	0	0	\$0.00
8/11/92	0	0	\$0.00
8/11/92	0	0	\$0.00
8/11/92	0	0	\$0.00
8/11/92	0	0	\$0.00
8/11/92	0	0	\$0.00
8/26/92	0	0	\$0.00
8/26/92	0	6	\$0.00
8/26/92	0	0	\$0.00
8/26/92	0	0	\$0.00
8/26/92	0	0	\$0.00
9/1/92	0	0	\$447.00
9/10/92	0	54	\$47.00
9/14/92	0	10	\$0.00
9/14/92	0	10	\$0.00
9/17/92	0	0	\$0.00
9/22/92	0	0	\$0.00
9/22/92	0	0	\$0.00
9/22/92	0	9	\$0.00
9/22/92	0	97	\$0.00
9/22/92	0	32	\$0.00
9/22/92	0	32	\$0.00
9/30/92	0	19	\$0.00
10/2/92	0	0	\$0.00
10/2/92	0	9.5	\$0.00
10/2/92	0	9.5	\$0.00
10/6/92	0	13	\$0.00
10/13/92	0	0	\$0.00
10/13/92	0	0	\$0.00
10/28/92	0	0	\$0.00
10/28/92	0	0	\$0.00
10/28/92	0	28.33	\$371.00

10/28/92	0	28.33	\$371.00
10/28/92	0	28.33	\$371.00
11/3/92	0	0	\$0.00
11/3/92	0	12.5	\$366.50
11/3/92	0	12.5	\$366.50
11/3/92	0	0	\$0.00
11/3/92	0	26	\$0.00
11/10/92	0	0	\$0.00
11/10/92	0	0	\$10,010.00
11/10/92	0	0	\$0.00
11/10/92	0	0	\$0.00
11/10/92	0	0	\$0.00
11/17/92	0	24	\$0.00
11/17/92	0	0	\$0.00
11/24/92	0	0	\$0.00
12/1/92	0	17	\$0.00
12/1/92	0	0	\$0.00
12/1/92	0	0	\$0.00
12/3/92	0	0	\$0.00
12/3/92	0	0	\$0.00
12/3/92	0	0	\$0.00
12/7/92	0	0	\$0.00
12/17/92	0	0	\$0.00
12/17/92	0	0	\$0.00
12/17/92	0	0	\$0.00
12/17/92	0	0	\$0.00
12/17/92	0	0	\$34.00
12/17/92	0	0	\$34.00
12/21/92	0	16	\$0.00
1/4/93	0	0	\$0.00
1/5/93	0	0	\$0.00
1/5/93	0	0	\$0.00
1/5/93	0	0	\$0.00
1/6/93	0	0	\$0.00
1/7/93	0	0	\$0.00
1/12/93	0	40	\$0.00
1/18/93	0	0	\$0.00
1/18/93	0	25	\$0.00
1/18/93	0	0	\$0.00
1/26/93	0	0	\$0.00
1/28/93	0	14	\$0.00
2/2/93	0	16	\$0.00
2/2/93	0	87	\$0.00
2/2/93	0	38	\$549.00
2/9/93	0	26	\$0.00
2/9/93	0	26	\$0.00
2/9/93	0	0	\$0.00
2/9/93	0	0	\$0.00
2/9/93	0	0	\$0.00

2/9/93	28	55	\$7,347.00
2/17/93	0	0	\$0.00
2/17/93	0	0	\$0.00
2/17/93	0	46	\$0.00
2/17/93	0	0	\$0.00
2/17/93	0	15	\$0.00
2/17/93	0	31	\$1,006.00
2/23/93	0	0	\$0.00
2/23/93	0	37.5	\$77.50
2/23/93	0	37.5	\$77.50
2/23/93	0	0	\$0.00
3/2/93	0	40	\$0.00
3/2/93	0	19	\$0.00
3/2/93	0	13	\$0.00
3/2/93	0	0	\$0.00
3/4/93	0	0	\$0.00
3/4/93	0	0	\$0.00
3/4/93	0	0	\$0.00
3/10/93	0	0	\$0.00
3/10/93	0	0	\$0.00
3/10/93	0	5.5	\$0.00
3/10/93	0	5.5	\$0.00
3/10/93	0	20.5	\$1,009.50
3/10/93	0	20.5	\$1,009.50
3/10/93	0	0	\$57.00
3/15/93	0	0	\$0.00
3/15/93	0	0	\$0.00
3/18/93	0	43	\$0.00
3/19/93	0	6	\$0.00
3/24/93	0	8	\$0.00
3/26/93	0	5	\$0.00
3/26/93	0	5	\$0.00
4/1/93	0	0	\$0.00
4/1/93	0	0	\$0.00
4/1/93	0	0	\$0.00
4/1/93	0	0	\$0.00
4/1/93	0	9	\$21.00
4/6/93	0	0	\$0.00
4/6/93	0	3	\$0.00
4/6/93	0	3	\$0.00
4/14/93	0	26	\$0.00
4/21/93	0	21	\$0.00
4/21/93	0	0	\$0.00
4/26/93	0	0	\$0.00
4/26/93	0	11.5	\$0.00
4/26/93	0	11.5	\$0.00
4/26/93	0	0	\$273.00
5/4/93	0	6.5	\$0.00
5/4/93	0	6.5	\$0.00

5/4/93	0	12	\$0.00
5/4/93	0	33	\$214.00
5/5/93	0	5	\$89.00
5/5/93	2	8	\$30.00
5/7/93	7	9	\$2,380.00
5/11/93	0	7	\$0.00
5/12/93	0	7	\$0.00
5/14/93	0	0	\$0.00
5/17/93	0	3	\$39.00
5/24/93	0	12	\$0.00
5/24/93	0	0	\$0.00
6/1/93	0	10	\$0.00
6/1/93	0	0	\$0.00
6/1/93	0	0	\$0.00
6/8/93	0	0	\$0.00
6/8/93	0	0	\$0.00
6/8/93	0	0	\$36.00
6/8/93	0	0	\$0.00
6/8/93	0	0	\$0.00
6/8/93	0	10	\$0.00
6/8/93	0	10	\$0.00
6/8/93	0	4.5	\$98.00
6/8/93	0	4.5	\$98.00
6/8/93	0	45	\$0.00
6/15/93	0	0	\$142.00
6/15/93	0	0	\$142.00
6/15/93	0	0	\$0.00
6/15/93	0	9	\$0.00
6/18/93	16	1	\$0.00
6/23/93	0	41	\$0.00
6/23/93	0	0	\$0.00
6/23/93	0	0	\$0.00
7/6/93	0	0	\$0.00
7/12/93	0	15.5	\$0.00
7/12/93	0	15.5	\$0.00
7/12/93	0	0	\$0.00
7/12/93	0	0	\$0.00
7/12/93	0	0	\$1,058.00
7/20/93	0	0	\$0.00
7/23/93	0	0	\$0.00
7/23/93	0	0	\$0.00
7/23/93	0	0	\$0.00
7/23/93	0	0	\$0.00
7/23/93	0	0	\$0.00
7/23/93	0	0	\$0.00
7/28/93	0	9	\$0.00
7/28/93	0	0	\$0.00
7/28/93	0	0	\$0.00
7/28/93	0	0	\$0.00

7/29/93	13	14	\$2,343.00
7/30/93	0	0	\$0.00
7/30/93	0	13	\$0.00
8/3/93	0	49	\$0.00
8/3/93	0	0	\$42.00
8/10/93	0	0	\$0.00
8/19/93	0	2	\$0.00
8/19/93	0	4	\$0.00
8/19/93	0	4	\$0.00
8/19/93	0	0	\$0.00
8/19/93	0	0	\$0.00
8/19/93	0	0	\$0.00
8/19/93	0	0	\$0.00
8/19/93	0	0	\$0.00
8/19/93	0	0	\$0.00
8/19/93	0	0	\$0.00
8/23/93	0	0	\$384.00
8/23/93	0	10	\$0.00
8/23/93	0	2	\$0.00
8/31/93	0	5	\$0.00
8/31/93	0	5	\$0.00
8/31/93	0	0	\$0.00
8/31/93	0	0	\$0.00
9/10/93	2.5	23	\$1,074.50
9/10/93	2.5	23	\$1,074.50
9/15/93	0	0	\$0.00
9/24/93	0	6	\$0.00
9/24/93	0	6	\$0.00
9/24/93	0	0	\$0.00
9/24/93	0	7.5	\$0.00
9/24/93	0	7.5	\$0.00
9/24/93	0	0	\$0.00
9/24/93	0	0	\$0.00
9/24/93	0	1.66	\$0.00
9/24/93	0	1.66	\$0.00
9/24/93	0	1.66	\$0.00
9/27/93	4	0	\$196.00
9/29/93	0	0	\$0.00
9/29/93	0	0	\$0.00
9/29/93	0	9	\$245.00
10/4/93	0	0	\$0.00
10/4/93	0	0	\$0.00
10/4/93	0	11	\$0.00
10/4/93	0	11	\$0.00
10/4/93	0	10.5	\$4,009.00
10/4/93	0	10.5	\$4,009.00
10/4/93	0	0	\$0.00
10/4/93	0	0	\$0.00
10/4/93	0	3.75	\$0.00
10/4/93	0	3.75	\$0.00

10/4/93	0	3.75	\$0.00
10/4/93	0	3.75	\$0.00
10/12/93	0	0	\$0.00
10/15/93	0	0	\$0.00
10/15/93	0	0	\$0.00
10/17/93	0	0	\$0.00
10/17/93	0	0	\$0.00
10/18/93	12	0	\$0.00
10/18/93	0	0	\$0.00
10/26/93	0	0	\$40.00
10/26/93	0	0	\$40.00
10/26/93	0	0	\$0.00
10/26/93	0	0	\$0.00
11/3/93	0	0	\$0.00
11/4/93	0	29	\$0.00
11/4/93	0	0	\$0.00
11/4/93	0	0	\$0.00
11/4/93	0	0	\$0.00
11/4/93	0	0	\$0.00
11/10/93	0	0	\$60.00
11/10/93	0	0	\$60.00
11/16/93	0	246	\$0.00
11/16/93	0	0	\$0.00
11/16/93	0	0	\$0.00
11/16/93	0	5	\$0.00
11/17/93	0	0	\$389.00
11/17/93	0	10	\$0.00
11/22/93	0	0	\$0.00
11/23/93	0	17	\$0.00
11/23/93	0	5	\$0.00
11/23/93	0	0	\$0.00
12/7/93	0	42	\$0.00
12/7/93	0	23	\$0.00
12/7/93	0	0	\$0.00
12/14/93	0	5	\$0.00