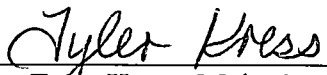


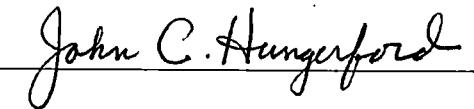
To the Graduate Council:

I am submitting herewith a thesis written by Jennifer Lynne McMullen entitled "A Retrospective Study on the Effect of Implementing an Ergonomics Program in an Industrial Setting." I have examined a final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Industrial Engineering.

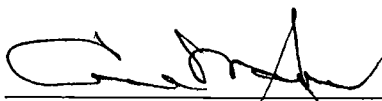

Tyler Kress, Major Professor

We have read this thesis
and recommend its acceptance:





Accepted for the Council:


Interim Vice Provost and
Dean of The Graduate School

A Retrospective Study on the Effect of Implementing an
Ergonomics Program in an Industrial Setting

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Jennifer Lynne McMullen

May 2001

Dedication

This thesis is dedicated to my husband

Mr. John G. McMullen

and to my father

Mr. Ron L. Lipford

for their faith, love, and support.

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I would like to extend my gratitude to the Department of Industrial Engineering, and Dr. James Bontadelli for allowing me the opportunity to participate in the Industrial Engineering Program. I would like to extend a special thanks to Dr. Tyler Kress who served as my major professor on this project.

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Abstract

In this retrospective study, the safety record of an industrial equipment manufacturing facility is analyzed between two years (1999 and 2000) to determine the positive effect of an ergonomics program implementation.

Ergonomics-related musculoskeletal disorders are the most prevalent type of illness reported in industry today. In 1998, MSDs affected nearly 1 million employees nationwide and cost an estimated \$45-\$55 billion per year in workers' compensation. Due to these alarming statistics, many companies are moving toward implementing controls and programs in the work place to reduce worker exposure to ergonomics hazards. The facility in this study implemented an ergonomics program in January of 2000 and as a result, noticed a significant reduction in ergonomics incidents that year as compared to the previous year.

Using the equations established by OSHA, the incident, frequency, and severity rates are compared from one year (pre- ergonomics program implementation) to the next (post-ergonomics program) in order to determine significant difference between the means utilizing paired comparison statistical t-tests. Also, safety incidents directly attributable to ergonomics hazards and workers' compensation costs are compared between the two years for a significant difference determination. Based on the results of these metrics, the effect of the ergonomics program can be validated.

Statistical t-tests were completed on 13 data sets from each year. Of these, the OSHA incident rate, OSHA ergo-related incident rate, workers' compensation costs, total number of ergo-related incidents, total number of OSHA recordable incidents, and total

number of illnesses were considered to have a significant difference between 1999 and 2000 (2000<1999 data). The hours worked and number of employees per month for each year also demonstrated a significant difference (2000>1999). The Wilcoxon Signed-Rank test was also performed on nonparametric data such as total number of strains, sprains, and tendonitis cases per year. From this study however, the only data demonstrating a significant difference between years was the total number of sprain illnesses.

Therefore, using these overall positive results it can be assumed that the ergonomics program did contribute significantly to the reduction of ergonomics and safety related illnesses in the manufacturing facility used in this study.

Preface

For several years past to present, the author of this study became heavily involved with the field of ergonomics in various manufacturing environments. She enjoys working with production employees, listening to their ideas, and being able to train and educate them on ways to improve their job from a physical standpoint. From this experience, she became more and more interested in studying the true effect of implementing ergonomics processes into a factory in order to promote this culture throughout other companies/industries as well. Ergonomics is not only good for the employees, but also good economics for any company. This retrospective study will demonstrate the positive effects that may be accomplished by implementing an ergonomics program in a manufacturing environment. It also recommends guidelines for setting up the program for any company that may be just starting to develop core business processes, such as the one featured in this study.

Chapter one presents the introduction and problem statement, which truly demonstrates a global perspective on the frequency and severity of work-related musculoskeletal disorders throughout the nation. The overall purpose and objective of the study is also presented, along with the hypothesis. An overview of background information from the manufacturing facility used in this study is also provided.

Chapter two presents a detailed literature review on the three most common MSDs present at the manufacturing facility in this study and the risk factors associated with each. Chapter three focuses on the methods utilized in this study in order to verify the

hypothesis. The OSHA equations used throughout industry to measure safety performance are presented, along with the other metrics that will be utilized in this study.

Chapter four analyzes the findings and results achieved from the facility in 1999 and 2000. Statistical t-tests are performed on all metrics to determine significant differences between the means of each year. A comparison is also made between the results of the facility and the results experienced by other facilities with the same industrial classification code. Also, workers' compensation costs are examined in detail. In conclusion to the chapter, a discussion is presented to summarize all findings from the analysis.

Chapter five discusses the validity of the data used in this research, a summary and conclusion, and possible agendas for future research.

Chapter six presents a recommended outline of steps to implement an ergonomics program. Each element of the program is then reviewed in detail.

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Chapter 1

Introduction and Objectives

1. Introduction

Musculoskeletal disorders are the most prevalent type of work-related illness facing the United States today. In 1998, work-related MSDs (that is sprains, strains, tears, CTS, and tendonitis) alone affected nearly 1 million employees around the nation (Bureau of Labor Statistics, 2000). MSDs not only affect the employee's ability to perform their otherwise normal job functions, but also affect their personal livelihood. At-home activities previously enjoyed by the employee such as gardening, sporting activities, sewing, or playing a musical instrument, may no longer be possible due to these debilitating conditions. Normal day-to-day activity may also become quite cumbersome. Picking up a child, buttoning clothes, or simply combing one's hair, for example can now present themselves as challenging tasks. One of the scariest aspects of MSDs is that even after resorting to surgeries that are available, the condition may persist, especially if any activity that caused the illness is continued.

Women are at higher risk of developing MSDs, especially carpal tunnel syndrome. In 1998, 70% of the carpal tunnel cases were females. Also, 57% of tendonitis cases were females (Bureau of Labor Statistics, 2000). More and more women are entering the work place as parts assemblers, office workers, cashiers, and nurses for example, all of which can involve tasks such as lifting, awkward postures, and repetitive motions.

approximately \$15 to \$20 billion per year, with total annual costs (direct and indirect) as high as \$45 to \$54 billion (Jeffress, 2000). A few of the indirect costs associated with MSDs are: lost work days due to surgery or extreme work restrictions, loss of productivity (overtime) due to restricted work activity or increased muscle fatigue, training replacement workers for jobs previously held by employees with an MSD, and the redesign and evaluation of the work station that caused the MSD. It has been estimated that for every \$1 spent on an MSD related workers' compensation claim, an additional estimated \$4 is spent for that claim in indirect costs (Jeffress, 2000).

Between 1995 and 1999, roughly 22% of all sprains, strains, and tear cases resulted in 3-5 days lost from work, with the median number of days away from work being 6 days. However, 16% of all MSD cases resulted in 31 days lost or more, due to sprains, strains, or tears (Bureau of Labor Statistics, 1999). This illustrates one of the main problems with MSD management in industry today: what affects one employee in a certain manner may not affect another employee in the same manner, and what one employee may be able to withstand after an MSD surgery, another may not ever be able to accomplish. For carpal tunnel cases between 1995 and 1999, 43% of all cases resulted in 31 days lost or more, with the median number of days away from work being 24 days. For cases involving tendonitis between the above dates, 19% of all cases resulted in 31 days lost or more as well, with the median number of days away from work at 10 days (Bureau of Labor Statistics, 1999). Given the above statistics, the problem with work-related MSDs is quite clear. Figures 1.1-1.3 illustrate the relationship associated with lost workdays and MSD cases.

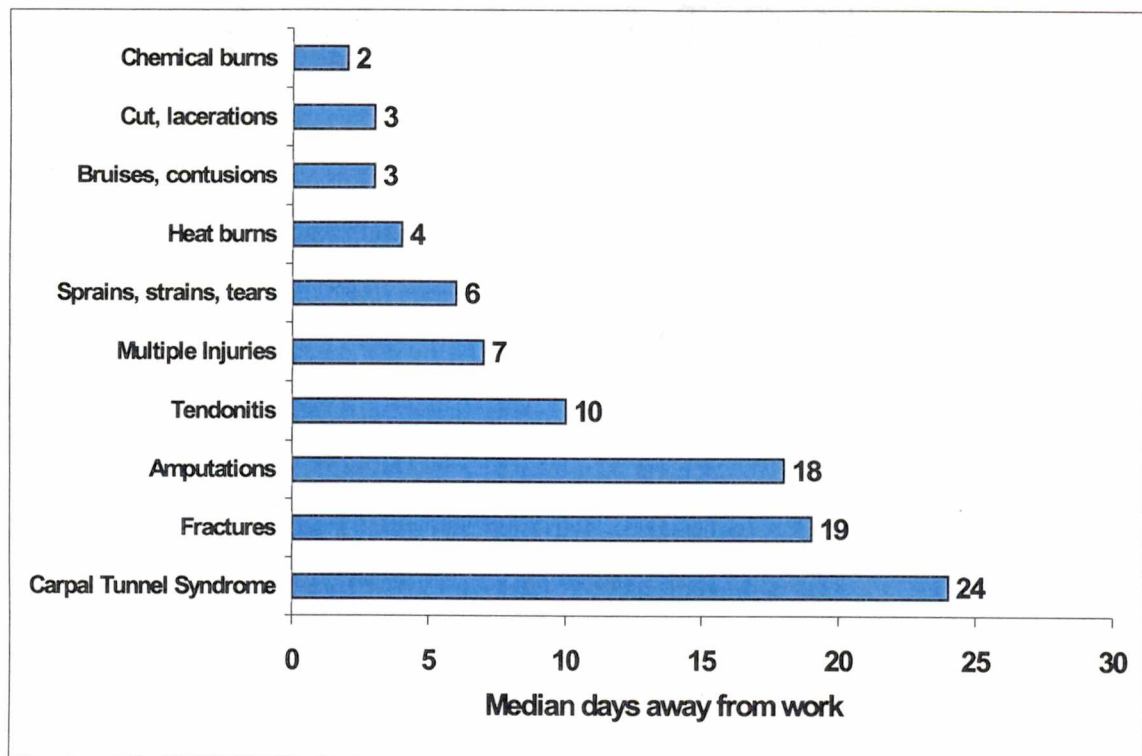


Figure 1.1: Median days away from work due to nonfatal occupational injury or illness by nature, 1998

From Bureau of Labor Statistics, U.S. Department of Labor, Survey of Occupational Injuries and Illnesses, 2000.

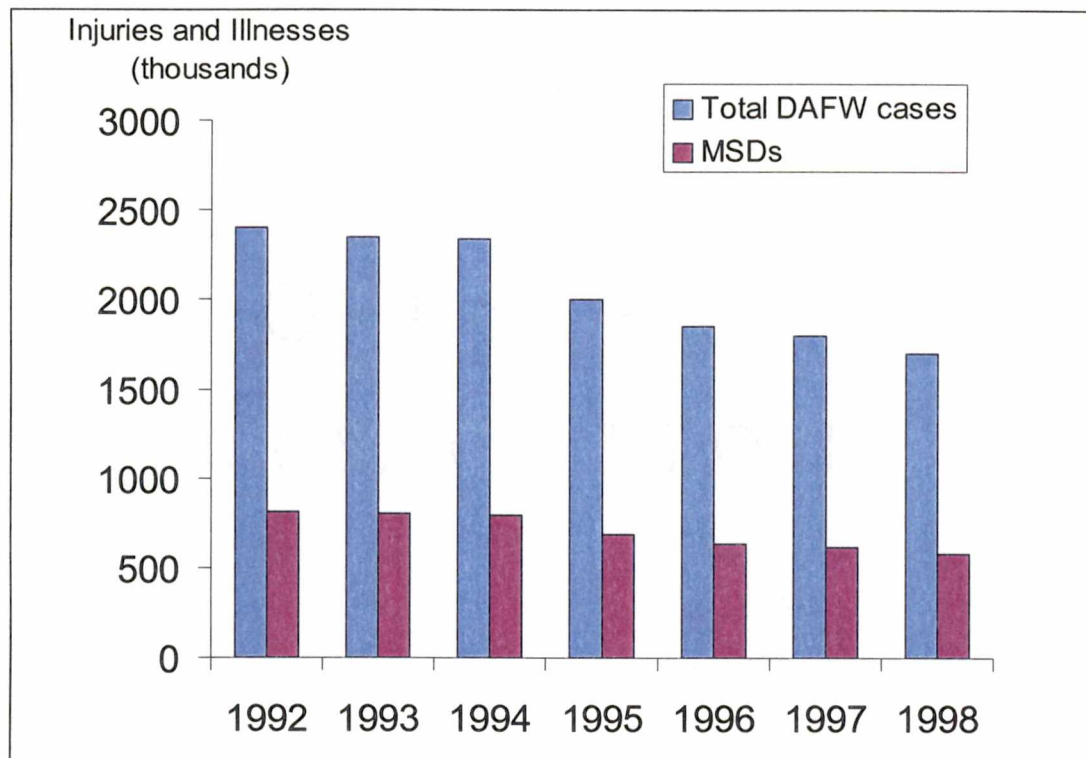


Figure 1.2: Comparison of total injury and illness cases involving days away from work to MSD cases involving days away from work
From Bureau of Labor Statistics, U.S. Department of Labor, Survey of Occupational Injuries and Illnesses, 2000.

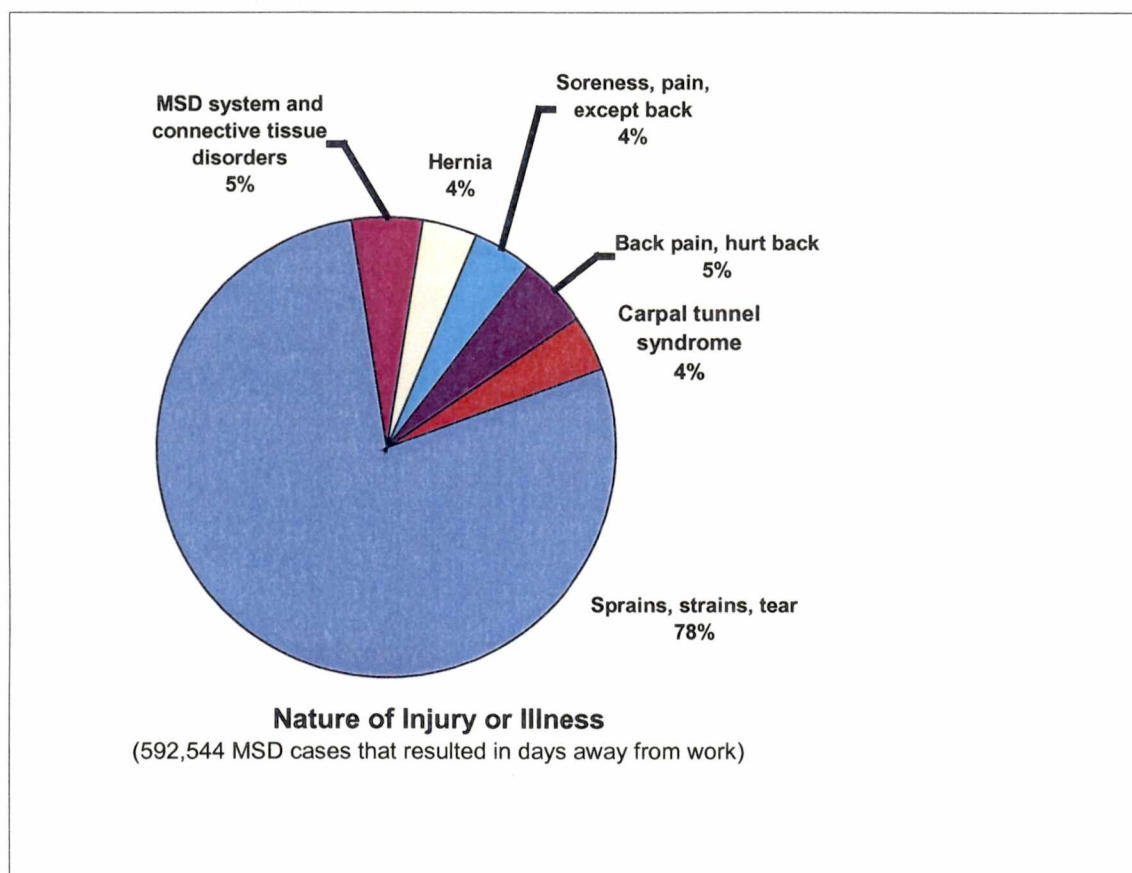


Figure 1.3: Musculoskeletal disorders with days away from work by nature of injury or illness, 1998
From Bureau of Labor Statistics, U.S. Department of Labor, Survey of Occupational Injuries and Illnesses, 2000.

In 1996-1997 the average total incurred costs per claim for strains and sprains was \$8,760, for carpal tunnel syndrome costs were \$13,263, and for tendonitis costs were \$9,112. The median cost per claim for all types of injuries and illnesses was \$10,000 (NCCI, 1996-1997). Therefore, costs associated with MSDs are generally above average from all other injury and illness types in industry. But, these are just averages. A \$150,000 or \$250,000 workers' compensation claim is not all that unusual in industry today. Some companies report workers' compensation claims within the range of \$2,000-\$3,000 per employee and over half of that is attributed to MSDs. The construction industry ranks the highest in terms of average cost per claim at nearly \$14,000 and a close second is the manufacturing industry at an average of \$10,000 per claim (NCCI, 1996-1997).

These are noteworthy costs to the employer. For example, if a manufacturer pays \$500,000 in workers' compensation premium and makes a 5% profit off of the sales of their product, they must sell an additional \$10,000,000 in goods to pay for their workers' compensation costs (Lovested, 1998).

Also, OSHA is continuing to cite companies for obvious ergonomic-related hazards in the workplace. These citations usually result in fines that the company must pay and cannot legally deduct from their business/corporate income taxes as a cost of doing business.

In order to control cost, some companies turn to training programs, such as lifting basics, or hand tool ergonomics. Another method might be the implementation of a job rotation schedule in the factory. If properly organized, job rotation schedules can reduce

exposure to workers in highly repetitive jobs, by rotating them to non-repetitive jobs every couple of hours or as needed. These are certainly viable methods, but fail to address the root of the actual problem: the ergonomic hazards related to the job need to be designed out of the job to prevent any worker from being exposed to a potential MSD. This can only be accomplished by the company's commitment to establishing an ergonomics program. In general, the ergonomics program will encompass: methods in which the company intends to identify MSD hazards in the work place, how they will attempt to control these hazards, and how they will continually refine and support the control method used for the hazard until the hazard has been ultimately eliminated from the job. The ergonomics process is a continuous improvement process, in that it must be refined and yet further refined until the desired results are achieved (the ultimate goal should be "zero" MSDs in the work place).

OSHA refers to many companies that have had success with implementation of ergonomics programs. They reference Sysco Food Services of Houston has reduced MSD injuries by 25% and workers' compensation costs by more than 45% after only 1 year of implementing the program. Another example, Ultra Tool and Plastics of New York implemented an ergonomics program that cut back injuries by 70% and reduced lost workdays by 80% (Dear, 1995).

The need for establishing an effective ergonomics program is clear. With nearly 1 million MSD cases per year in American industry and annual workers' compensation cost of \$45 to \$54 billion, companies simply cannot afford to ignore the problem.

3. Purpose and Objective

The purpose of this retrospective study is to demonstrate the positive effects of an ergonomics program implementation based on the comparison of illness rates and workers' compensation costs from a manufacturing facility both before and after the implementation. This study will present the ergonomics-related problems as they were before and after the ergonomics program was implemented. Statistical analysis will be performed on this data to determine significant difference between the means. Also, workers' compensation claims paid for MSDs both pre- and post- ergonomics program will be analyzed. The objective of this study is to demonstrate the overall positive result an ergonomics program can produce in terms of cost, illness reduction, product quality improvements, and increased employee job satisfaction.

4. Background

The manufacturing facility used in this study is located in East Tennessee and employees over 500 workers, operating on three full shifts, 24 hours per day, 5 days per week. The average number of employees fluctuates from month to month, with a minimum of 272 employees to a maximum of 605 employees since 1999. The average number of hours worked per month also fluctuates from month to month with a minimum of 44,715 hours to a maximum of 110,523 hours (Table 1.1). This plant began manufacturing product in January of 1998 and is still in full operation. The employees consist of approximately 422 males and 96 females.

Table 1.1: Average number of hours worked and average number of employees by month at manufacturing facility, 1999-2000

1999

Month	Avg. Number Hours	Avg. Number Employees
January	58832	272
February	60700	280
March	62824	290
April	66136	296
May	69928	348
June	90640	398
July	86500	398
August	79995	398
September	84531	477
October	86000	491
November	88445	501
December	44715	363

2000

Month	Avg. Number Hours	Avg. Number Employees
January	105409	480
February	92470	512
March	94972	521
April	105583	579
May	105373	592
June	98655	554
July	110523	605
August	106012	592
September	101810	574
October	97007	550
November	90836	518
December	89288	518

This facility manufactures skid steer loading equipment, SIC code 3531, "Manufacturing of Industrial and Commercial Machinery, Construction Machinery and Equipment" (NAICS, 1997). The major processes used at this facility are as follows: CNC laser machines, CNC plasma cutting machines, press brake or forming machines, folding machines, punch press machines, manual MIG welders, robotic MIG welders, grinding and sanding, shot blasting machines, and general assembly line work. Basic sub-processes to these jobs involve: operating overhead hoist systems, maneuvering material handling carts, lifting, carrying, and lowering objects, using hand tools of various types, manipulating parts into and out of fixtures, dies, and jigs, and standing for most of the shift. The average cycle time per skid steer machine is approximately 15 minutes.

The ergonomics program was implemented in January of 2000. Prior to that, ergonomics was a reactive initiative, in that after an employee sustained an MSD, controls were put into place to eliminate the ergonomic-related hazards of the job. Unfortunately, production engineers generally considered ergonomics as an after-thought in the first years of operation, as production demands were placed as highest priority in order to begin shipping product and generating profit. This can be well understood, but cost money in the long run.

In January of 2000, senior management made the commitment to develop and support an ergonomics program to address issues regarding increases in MSDs throughout the factory. This commitment led to the formation of an ergonomics team that outlined the program and began identifying ergonomic-related hazards in the factory. All employees

in this factory actively participate in the ergonomics program and many have been recipients of ergonomic improvements within their jobs. These improvements are not limited to production workers, but include office personnel as well.

5. Nomenclature

MSDs	Musculoskeletal disorders
CTS	Carpal tunnel syndrome
OSHA	Occupational Safety and Health Administration
SIC	Standard Industrial Classification
CNC	Computer numerical controlled
Repetitive	Motion that is repeated in time greater than 50% of one cycle, or a work cycle time of 30 seconds or less (Putz-Anderson, 1988).

Chapter 2

Literature Review

1. Introduction

Though occupational hazards were realized to have an effect on the development of musculoskeletal disorders in the beginning of the 18th century, the impact of occupational hazards on MSDs was not considered in scientific study until the 1970's. Since then, more than six thousand scientific articles relating to ergonomics in the workplace have been published. However, the extent to which occupational hazards effect the development of MSDs is still a major debate today (Bernard, 1997).

This review will provide information on MSDs, in particular the most prevalent types reported at the manufacturing facility of this study (specifically those dealing with backs, wrists, and elbows), and the work-related risk factors that have been associated with them.

2. Risk Factor Overview

The general categories for risk factors associated with the development of MSDs are: biomechanical, psychosocial, morphological, and genetic. The biomechanical factors are considered "predictable factors" (in that some of them may be measured in terms of exposure level and possibly controlled by engineering means) and are as follows: repetitive movement, forceful exertion, exposure to vibration, sustained awkward postures, or exposure to cold temperatures. Psychosocial factors can also be predicted to

some degree by use of employee surveys or interviews (Kumar, 2001). Examples of morphological and genetic factors are age (Guo et al. 1995), gender (Hales et al. 1994), smoking preference (Finkelstein 1995), physical activity level (Nirschl 1993), strength (Chaffin 1973), and medical predisposition such as diabetes, pregnancy, and heart disease. The overall relationship between these factors and how they interact together as risk variables for the development of an MSD is not fully understood and quite complex. An interaction theory presented by Kumar (2001) is presented in Figure 2.1. This figure demonstrates the possible interactions between risk variables and how they may produce the final outcome of an illness. Each of the factors reviewed above will be discussed in detail as they pertain to the most common disorders seen at the manufacturing facility in this study, given the studies that are currently available.

3. Back Illnesses

Low back disorders are generally the most common ergonomics-related illnesses in industry today. In 1998, nearly 56% of all occupational illnesses consisting of strains, sprains, and tears were related to the back (Figure 2.2). Lifetime prevalence of low back pain in industrialized countries has been estimated at 70% of the population in general (Andersson, 1981). Approximately 90% of back disorder cases are said to spontaneously recover and resume regular activity within a month, however (Bigos, 1994).

An employee may or may not first experience back pain in the workplace, but may assume the two are related and that workplace hazards are the cause. The employee may have developed the condition out of course of employment and the condition may be

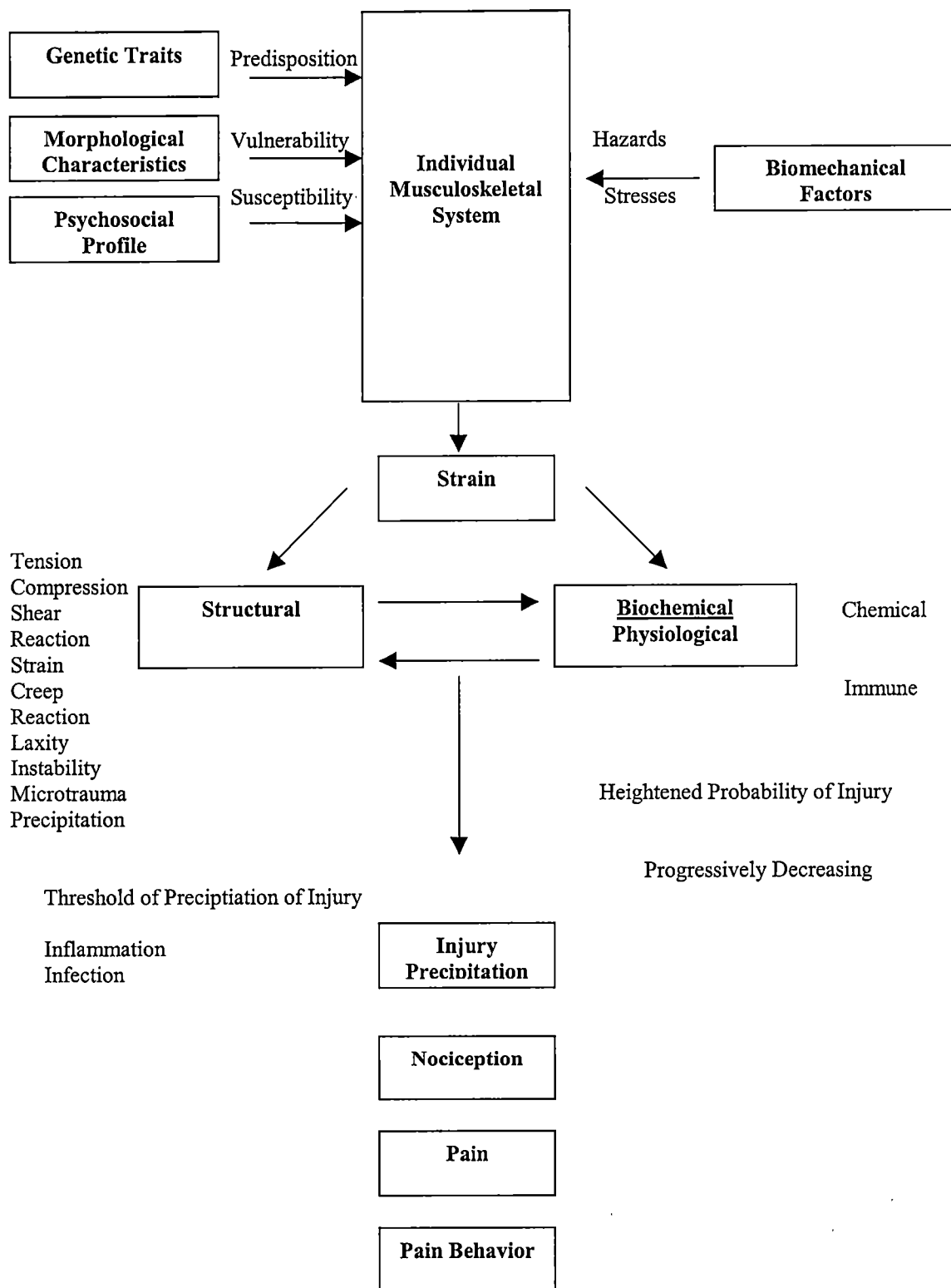


Figure 2.1: Multivariate Interaction Theory of Musculoskeletal Injury Precipitation From Kumar, 2001.

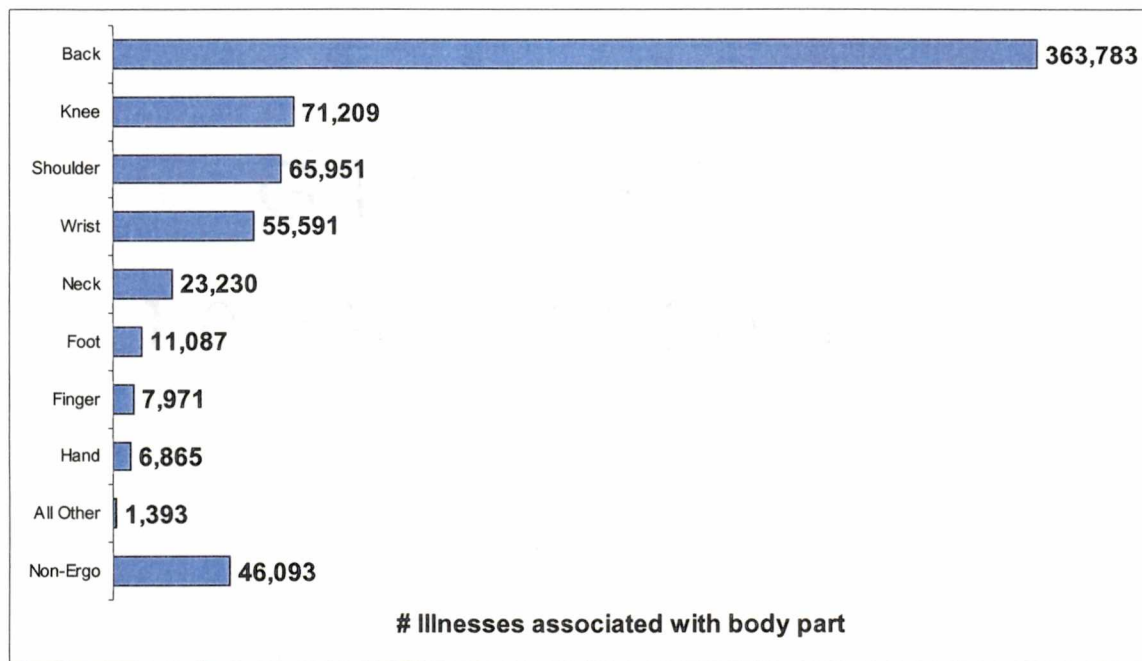


Figure 2.2: Part of body affected by strains, sprains, tears, or tendonitis, 1998
From Bureau of Labor Statistics, U.S. Department of Labor, Occupational Injuries and Illnesses Data, 2000.

directly related to the physical demands of his/her job, or the employee's regular job duties may have merely aggravated a pre-existing condition. If the condition is pre-existing, it may have arose out of previous employment with another company (whether the job duties were similar or not) or they could be due to non-workplace factors as mentioned above. Therefore the relationship between workplace hazards and the development of back disorders may be apparent in some cases, but not in others (Bernard, 1997).

In general, there are three severity categories of low back disorders: low back pain, impairment, and disability. Low back pain refers to either chronic or acute pain throughout the lower back region. This is considered the least severe form of a low back disorder. Impairment generally refers to the inability to perform normal physical activities, and disability relates to restricted duty prescribed by a physician or requires time away from work.

Disability is deemed the most severe form of a back disorder. In general, chronic disability generates the largest portion of costs for low back injuries (Hazard, 1994). The most common medical diagnosis for a back disorder, however is "non-specific symptoms" and in most cases a specific cause of the back disorder cannot be determined objectively.

A review of literature suggests that there are three major work-related risk factors that can be attributed to the development of a low back disorder: lifting improperly or frequent lifting, repetitive twisting movements (awkward postures), and whole body

vibration exposure (Kumar, 1999). Table 2.1 reviews the causal relationships between work-related risk factors and the development of back disorders.

There are also many factors that may cause low back pain and disorders aside from workplace hazards. Examples are age, gender, physical fitness level, and cigarette smoking (Hales, 1996). The age range at highest risk for the development of a low back disorder is between 35-55 and lost workdays typically increase with age. By the age of 35, most people have experienced some form of back pain (Chaffin, 1979). Men also tend to experience lower back disorders more often than women. For men, the age group at highest risk is approximately 40 and for women, between 50-60 (Marras, 2000).

It has also been shown that psychosocial factors can be a significant contributor (Garg and Moore, 1992).

Table 2.2 summarizes the number of studies that have been done on the relationship of each morphological, genetic, or personal factor and the strength of association with the development of low back disorders.

4. Wrist Strains (Tendonitis and Tenosynovitis)

In 1998, disorders of the wrist totaled around 8.6% of all sprains, strains, tears, and tendonitis cases (Bureau of Labor Statistics, 2000). In a study conducted by Ranney et al. (1995), it was found that out of 146 female workers in five different industries (garment and automotive trim sewing, electronic assembly, metal parts assembly, supermarket cashiery, and packaging), 22 employees (or roughly 15%) were diagnosed as having wrist tendonitis or tenosynovitis. Also, the highest prevalence per industry found in this

Table 2.1: Evidence for causal relationship between physical work factors and musculoskeletal disorders (Bernard, 1997).

Risk factor	Strong Evidence	Evidence
Lifting	X	
Awkward posture		X
Whole body vibration	X	

Table 2.2: Personal risk factor associated with low back pain (Marras, 1995).

Personal risk factors	Total no. of studies	Percentage of studies finding relationship
Age	31	35
Gender	24	8
Previous History	8	87
Intelligence/education	10	40
Number of year experience/seniority	7	14
Marital status	4	25
Household income/unemployment	6	66
Exercise/recreational activity	10	30
Smoking	9	44

study was with metal fabricators (at 25%). In 1989, the direct costs associated with upper extremity-related MSDs was \$563 million (Hales, 1996).

Wrist tendonitis generally involves compression of the median nerve, which runs through the carpal tunnel area of the wrist. The tendons cross the radiocarpal joint and become inflamed due to response from the impinged nerve. The most common form of wrist tendonitis is De Quervain's tendonitis, which is due to the entrapment of the tendons of the extensor pollicis brevis and abductor pollicis longus (Greico et al., 1998). Pain is usually felt on the radial aspect of the wrist.

Some of the epidemiological studies that have been accomplished are listed in Table 2.3. This table shows the risk ratios in various types of industry as they pertain to the development of disorders of the wrist. The industries at highest risk, based on the studies presented, are the manufacturing industry in general and the meat processing industry specifically. The studies also revealed relationships between wrist disorder development and work seniority, number of objects handled (precision tasks), repetitiveness, wrist posture, and contact force.

Repetition, force, and awkward postures are considered to have a strong influence on the development of wrist illnesses based on the epidemiological studies listed. All studies that reviewed repetition, force, and posture as risk factors had positive RR estimates (with the majority of the studies showing statistical significance). However, in a study done by Armstrong et al. (1987) repetition was combined with contact force, and a higher PR was obtained than when repetition and force were examined separately and individual PRs were added together. This suggests that perhaps a combination of risk

Table 2.3: Selected studies of wrist tendonitis (Grieco et al., 1998).

Study design	RR, OR, or PRR	Authors
Sausage makers**	24*	Kurppa et al. (1991)
Meatcutters**	14*	Kurppa et al. (1991)
Meat-packers**	38*	Kurppa et al. (1991)
Industrial-high force and repetition***	17*	Armstrong et al. (1987)
Industrial-high force and low repetition***	5.5	Armstrong et al. (1987)
Industrial-high repetition and low force***	3.3	Armstrong et al. (1987)
Assembly line packers***	7.1*	Luopajarvii et al. (1979)
Manufacturing workers***	5.4*	McCormack et al. (1990)
Assembly line packers***	3.9*	McCormack et al. (1990)
Scissors makers***	1.4	Kuorinka and Koskinen (1979)
Automotive workers***	2.5*	Bystrom et al. (1995)

*p<.05

**Cohort

***Cross-sectional

RR (Relative Risks), OR (Odds Ratio), PRR (Prevalence Rate Ratios)

factors show a stronger relationship on the development of wrist disorders, than when each factor exists alone (Bernard, 1997).

Other non-work risk factors that show a significant influence on the development of wrist disorders are: gender and age (Bystrom et al., 1995). It has been shown that men are more prone to De Quervain's tendonitis than women but women are more susceptible to wrist tendonitis in general (Armstrong, 1987). McCormack's study (1990) suggests that age is not a significant factor, but years on the job was inversely related (incident rates were higher if employee spent less than 3 years on the job).

5. Elbow strains and tendonitis/epicondylitis

Epicondylitis is a considerably rare disorder, in that it affects only 1 to 5% of the general population. Approximately one out of 100 people per year are affected based on Allander's study involving a Swedish based population, and the group with most prevalence are women aged 42 to 46 years old (1974). Actually, there are fewer studies addressing elbow MSDs than any other MSD (Bernard, 1997). The study accomplished by Ranney (1995) showed that of 146 female employees in various industries, 15% were diagnosed with lateral epicondylitis and roughly 6.8% were diagnosed with medial epicondylitis. The industry with the greatest number of lateral epicondylitis incidents was the sewing industry.

The muscles and tendons that allow for flexion and extension of the wrist, as well as grasping with the hand, begin at the inner and outer areas of the elbow. Repeated grasping, gripping or twisting of objects can irritate these muscles and tendons. The

inflammation response that occurs in the elbow is usually diagnosed as epicondylitis.

Inflammation along the inner area of the elbow is referred to as medial epicondylitis and inflammation along the outer area of the elbow is referred to as lateral epicondylitis (Cicecotti, 1998).

Table 2.4 demonstrates the relationships between various industry, risk factors, and elbow disorder incident rates based on several epidemiological studies. From this data it can be shown that work-related risk factors do have an impact on the development of elbow disorders. It has also been shown that the meat processing industry, in particular has a significantly high incident rate (6.7) of elbow disorders (Kurppa et al., 1991). Although other studies based on particular industries have not shown significant incident rates for elbow disorders, it is probable that repetitive, forceful movements can cause contraction of the muscle-tendon units that are attached in the elbow (Grieco et al., 1998). The study completed by Bernard (1997) summarized over 20 epidemiological studies related to physical risk factors and elbow MSDs. Their findings were as follows: there is insufficient evidence to uphold an association between repetitive work or awkward postures and epicondylitis, there is evidence for an association between forceful exertions and epicondylitis, and there is strong evidence to support an association between a combination of risk factors and epicondylitis. Table 2.4 also supports these conclusions.

Table 2.4: Epidemiologic studies addressing risk factors for elbow tendonitis (Hales, 1996).

Investigator (year)	Risk Factor	OR/RR
Roto (1984)	High force and posture	7
Dimbert (1987)	Blue-versus white collar jobs	0.7
Kopf (1988)	Repetition, Force	2.7
Ohlsson (1989)	Repetition	1.9
McCormack (1990)	Repetition	1.5
Burt (1990)	Repetition	2.8*
Kurppa (1991)	High Force	6
Viikkari-Juntura (1991)	High force	1
Moore (1994)	Repetition, force	5.5*
Baron (1991)	Repetition	2.3
Chiang (1993)	Low force/low repetition	1
Chiang (1993)	High force or high repetition	1.7
Chiang (1993)	High force/high repetition	5.3*
Anderson (1993)	Repetition	1.7
Hoekstra (1994)	Posture	4*
Olafsdottir (1995)	Repetitive movements	2.1

*p<.05

RR (Relative Risks), OR (Odds Ratio)

Chapter 3

Methodology

1. Introduction

In order to establish common records involving safety incidents throughout general industry, OSHA established recording and reporting requirements in the form of the "200 log." This is a form which prompts for all information about the incident, including how it occurred and whether it should be classified as an "injury" or an "illness." Illnesses are generally considered to be ergonomics-related. The classification of the injury or illness is established on the form as well. Medical-only incidents, for example minor abrasions or lacerations, are considered as "first-aid." Incidents that are more serious are coded as "recordable incidents." Examples of "recordable incidents" are incidents that involve stitches, physical therapy appointments, prescription medications, or positive x-rays. The term "recordable incident" is further divided into "lost-workday cases" which are cases that involve restrictive duties imposed on the employee by the physician, or "lost-time cases" which are cases that involve days away from work, prescribed by the physician.

The four classifications are recorded on the log and companies use the data to determine "case incident rates", "case frequency rates", and "case severity rates." These rates are calculated based on total number of hours and an average of 100 employees per month using equations 3.1, 3.2, and 3.3.

$$I = \frac{N \times 200000}{h}$$

(eq. 3.1)

where

I= case incident rate per 100 employees

N= number of incidents per month

h= number of hours worked per month

$$F = \frac{N \times 200000}{h}$$

(eq. 3.2)

where

F= case frequency rate per 100 employees

N= number of incidents per month

H= number of hours worked per month

$$S = \frac{N \times 200000}{h}$$

(eq. 3.3)

where

S= case severity rate per 100 employees

N= number of days away from work or restricted work activity

h= number of hours worked per month

By using this consistent method, companies are able to benchmark others in similar types of industry (by SIC code for example) to compare performance of their safety record on a global scale. The safety performance of the manufacturing facility in this study was compared to the overall safety performance of industries with the same SIC code.

2. Design

This study was a retrospective study, in that the data used had already been collected from the manufacturing facility from two previous years (1999 and 2000). The data is initially collected by the employee's direct supervisor and maintained by the Human Resources Department at the facility.

In this study, the researcher used the rates described above to compare the safety performance record of the manufacturing facility from one year (1999) to another year (2000). The intervention variable from one year to the next was the implementation of the ergonomics program.

The manufacturing facility also uses an "Accident Investigation Form" to record all safety incidents involving employees. Using this form, along with the OSHA 200 log, data may be analyzed further. In this study the ergonomics-related illnesses were examined also by the type of illness and the body part affected. Another point of interest was investigating the number of ergonomics-related illness that were considered "recordable incidents" as defined above and how these contributed to the total number of recordable incidents by month. This will determine how the intervention variable produced either a positive or negative effect on the data from one year to the next. A

comparison was also made between the Bureau of Labor statistics data and the data gathered from the manufacturing facility in order to check data alignment for correlation purposes.

3. Population

The population used in this study consisted of all employees working at the manufacturing facility that experienced either a first aid injury or illness or an OSHA recordable injury or illness. This included departments such as office personnel, maintenance, assembly technicians, fabrication technicians, paint technicians, and shipping personnel. There were a total of 92 injuries and illnesses at the manufacturing facility for the two years studied. However, this is not indicative of the actual number of individuals sustaining injury, as some employees may be exposed to more than one injury or illness throughout their course of employment.

4. Management of Data

The Human Resources Department at the facility maintains the data that was used for this study. The OSHA 200 logs, as well as the Accident Investigation Forms are kept in binders for each year in a locked file. The researcher entered the information into the computer, with no names or identifying numbers, such as Social Security numbers or employee identification numbers for confidentiality purposes.

5. Data Collection and Analysis

The data sets were entered into a spreadsheet in order to determine overall trends at the facility and also to assist with processing statistical tests utilizing the JMP statistical software package (Version 3.2.1).

To determine significant difference between the two years used in this study, a paired comparison one-tailed t-test was used. This test uses a comparison of differences between one year to the next against a suspected mean value of zero. The t-test then generates a level of significance greater or less than the selected alpha (in this study the researcher used an alpha value of 0.05). The null hypothesis of this test was that there were no differences between the mean of each year's results and the alternate hypothesis was that there was a difference. The one-tailed t-test lends further information about which data set is significantly greater than the next data set (in this case, year 2000 data was less than year 1999 data). If the p-value is less than the alpha value, the difference between the years is considered to be significant. However, one of the conditions of the parametric t-test is that the data are distributed normally. To test for normality, the Shapiro-Wilkes test was utilized. The null hypothesis of this test is that the data are not distributed normally. Therefore, if a data set is analyzed and determined to have a p-value greater than the selected alpha value (0.05 in this study), then it can be assumed that the data are distributed normally. On the other hand, if the p-value is less than the alpha value, there is not enough evidence to reject the null hypothesis, and therefore normality may not be assumed. When this occurs, a nonparametric test may need to be utilized in order to get a better estimate of statistical significance.

In this study, several of the data sets (OSHA frequency and severity rates and total number of sprain injuries) did not meet the normality assumption criteria, thus the Wilcoxon Signed-Rank test was utilized. This non-parametric test also checks for significant difference between the means, but does not require the data to be distributed normally.

Chapter 4

Results

1. Injury and Illness Trends of Manufacturing Facility in 1999

In 1999, the ergonomics program did not exist in the manufacturing facility, as stated in chapter one. As shown in Table 4.1, the top three types of injury in the facility were strains, tendonitis, and burns. Ergonomics-related illnesses are generally considered to be strains, sprains, tears, tendonitis, and carpal tunnel syndrome. Therefore in 1999, 59% of all injuries and illnesses were ergonomics-related. The top two injury types at the facility in 1999 were also strains and tendonitis. Based on this data, it should be assumed that most of the hazards associated with this plant are ergonomics-related and can therefore be somewhat controlled by proactive measures. This is due to the fact that incidents involving ergonomics hazards are not merely accidents, they are generally developed over a period of time.

The top three body parts injured in 1999 were backs, fingers, and wrists as shown in Table 4.2. The body parts typically associated with ergonomics-related illnesses are backs, wrists, shoulders, elbows, arms, hands, necks, and fingers.

Hence, the top three body parts injured in 1999 were typically correlated with ergonomic hazards as well. This is further evidence that ergonomic hazards were the most prevalent seen at the manufacturing facility in 1999.

Table 4.1: Most common injury and illness types commonly seen at the manufacturing facility

1999

Type of Injury	Percent of Total (%)
Strains	27
Tendonitis	17
Burns	13
Sprains	11
Lacerations	11
Contusions	9
Fractures	8
Carpal Tunnel Syndrome	4

Table 4.2: Most common body parts injured at the manufacturing facility

1999

Body Part Injured	Percent of Total (%)
Abdomen	3
Ankle	1
Arm	5
Back	19
Elbow	8
Eye	12
Face	3
Finger	13
Foot	3
Hand	4
Head	1
Knee	1
Leg	3
Neck	4
Shoulder	6
Wrist	14

To further understand the most common ergonomics-related illnesses seen at the facility in 1999, Figure 4.1 demonstrates the body part affected per illness type. In the situation of a strain illness, the top three body parts affected (in order of highest occurrence) were backs, shoulders, and necks. These could correlate to ergonomic hazards dealing with lifting and overhead work. In the case of sprains, the most prevalent body parts affected were backs and wrists. This could be associated with ergonomic hazards such as awkward postures accompanied with contact force and once again, lifting. Tendonitis generally affected wrists. Once more, this may be related to the ergonomic hazard of awkward postures accompanied with contact force and repetition.

2. Injury and Illness Trends of Manufacturing Facility in 2000

In the year 2000, an ergonomics program was implemented at the manufacturing facility. This program will be further outlined in chapter six. As shown in Table 4.3, the top three types of injury in the facility were strains, lacerations, and contusions. The only ergonomics-related illness of the top three listed was strains, which made up approximately 34% of all incidents in 2000. Therefore, when compared with 1999, ergonomics-related illnesses were reduced by 25% in 2000.

The top three body parts injured in 2000 were (in order of highest occurrence): fingers, wrists, and backs (Table 4.4). However, the top three MSD related body parts injured were: wrists, backs, and elbows. Figure 4.2 further demonstrates the nature of the MSD by body part affected for 2000.

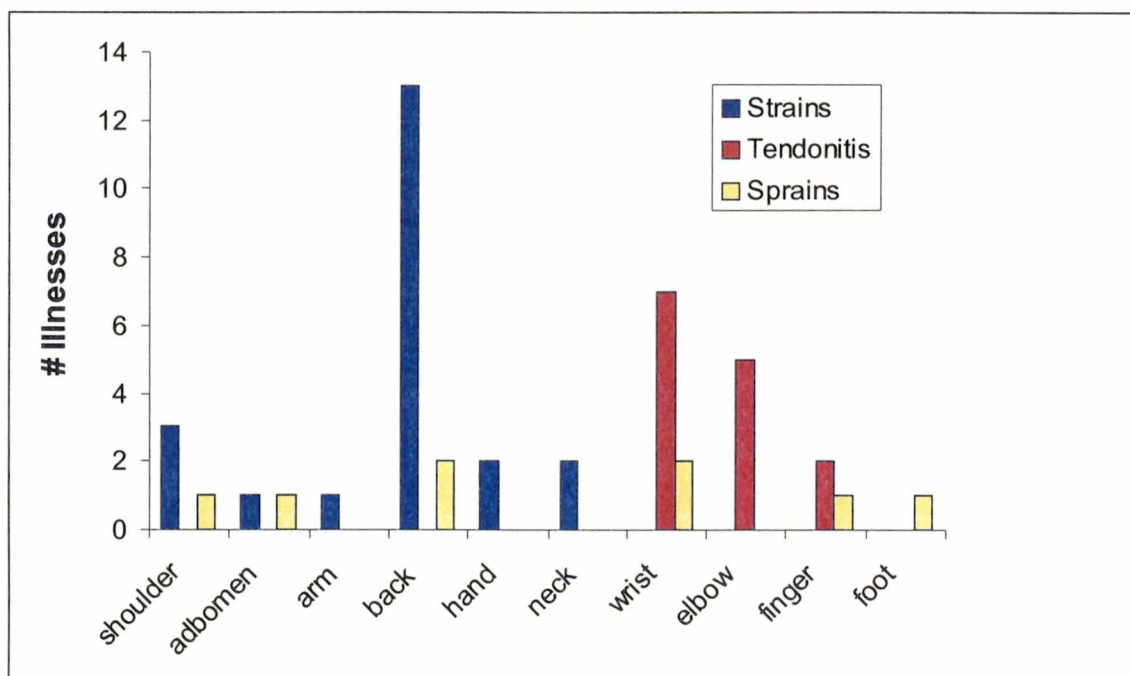


Figure 4.1: Body part affected by illness type at manufacturing facility, 1999

Table 4.3: Injury and illness types commonly seen at the manufacturing facility

2000

Type of Injury	Percent of Total (%)
Strains	34
Lacerations	21
Contusions	16
Burns	14
Tendonitis	7
Fractures	4
Sprains	3
Carpal Tunnel Syndrome	1

Table 4.4: Most common body parts injured at the manufacturing facility

2000

Body Part Injured	Percent of Total (%)
Abdomen	9
Arm	7
Back	9
Elbow	9
Eye	9
Face	4
Finger	14
Foot	3
Hand	9
Head	4
Knee	3
Neck	1
Shoulder	6
Wrist	13

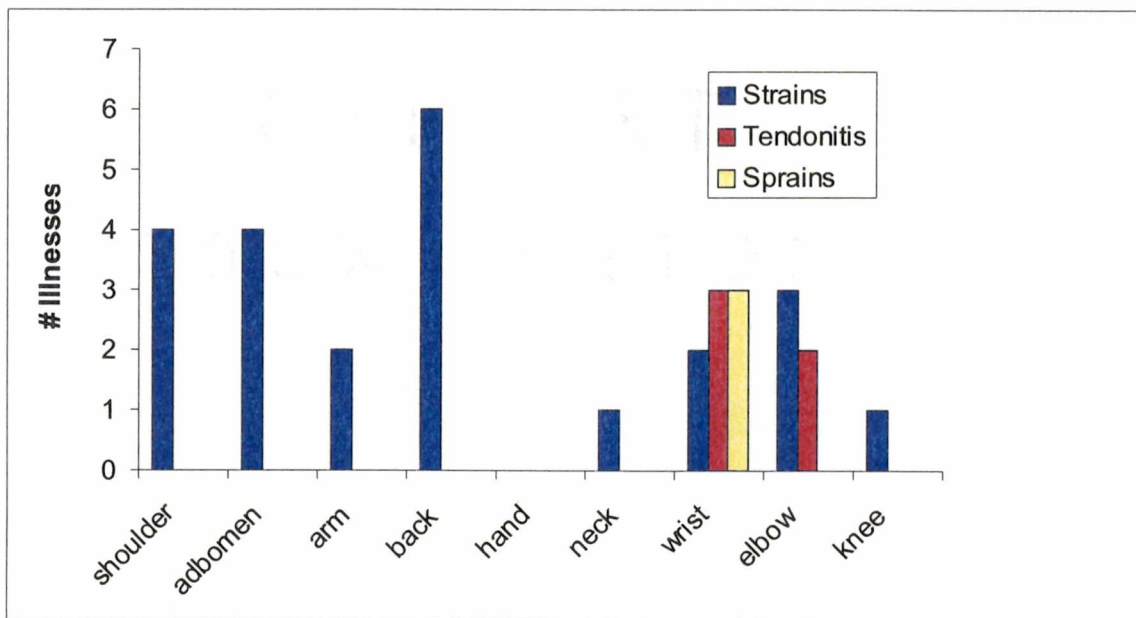


Figure 4.2: Body part affected by illness type at manufacturing facility, 2000

By comparing year 1999 to year 2000, it is easy to realize the reductions made with back, wrists, hands, and neck disorders. Figure 4.3 shows the relationship of 1999 to 2000 in terms of number of MSDs.

3. Comparison of 1999 to 2000 by Nature of Illness

Backs were the most prevalent body part injured in both 1999 and 2000 at the manufacturing facility in this study. In 1999, backs totaled approximately 52% of all sprains, strains, and tears, and in 2000 this number was reduced to approximately 27%. The highest workers' compensation claim for a back in 1999 was around \$80,000 (direct costs) and this claim is still open. This is quite typical of an ergonomics-related back claim in industry. Using the \$1 to \$4 ratio of direct to indirect costs mentioned in chapter one, this claim has cost the company an estimated \$320,000 and is still climbing. Therefore, reducing the number of back illnesses in an industrial facility by 13% is quite significant in terms of monetary value to the company.

The manufacturing facility had a total of 9 wrist disorders reported in 1999 (approximately 20% of ergo-related disorders) and a total of 8 in 2000 (or 25%). The majority of the disorders in 1999 were wrist tendonitis/De Quervain's syndrome and in 2000, wrist strains. Typically, wrist strains are classified as "first aid" incidents as they generally require a wrist brace or sling and over the counter medication. Wrist tendonitis and/or De Quervain's syndrome is usually classified as a "recordable" incident because they typically require physical therapy prescriptions or cortisone injections. The manufacturing facility in this study

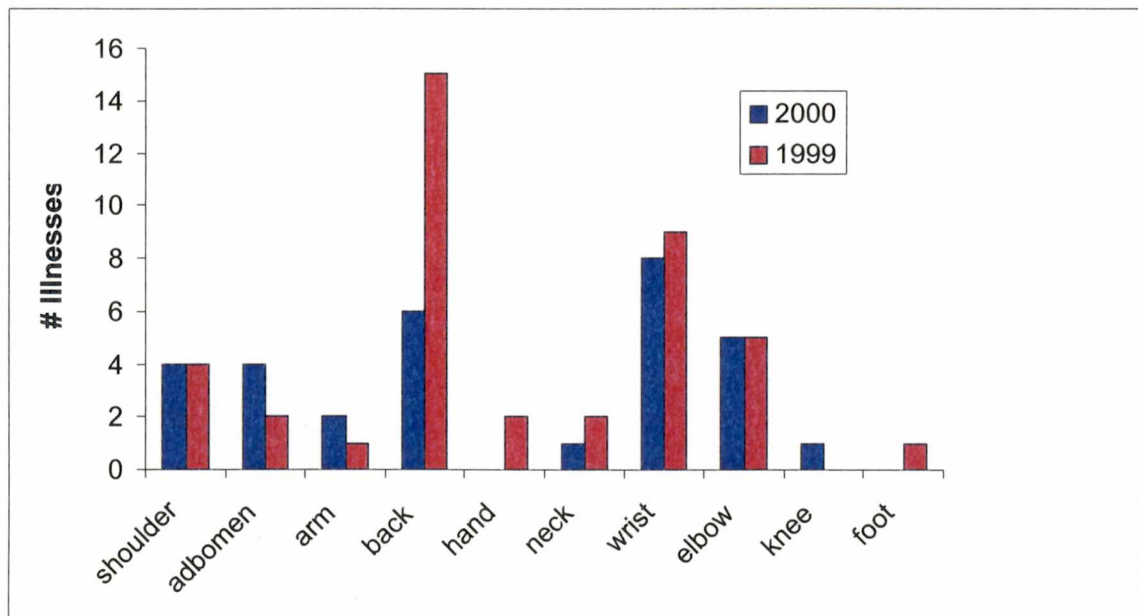


Figure 4.3: Comparison of year 2000 to 1999 MSD illnesses by body part reported at manufacturing facility

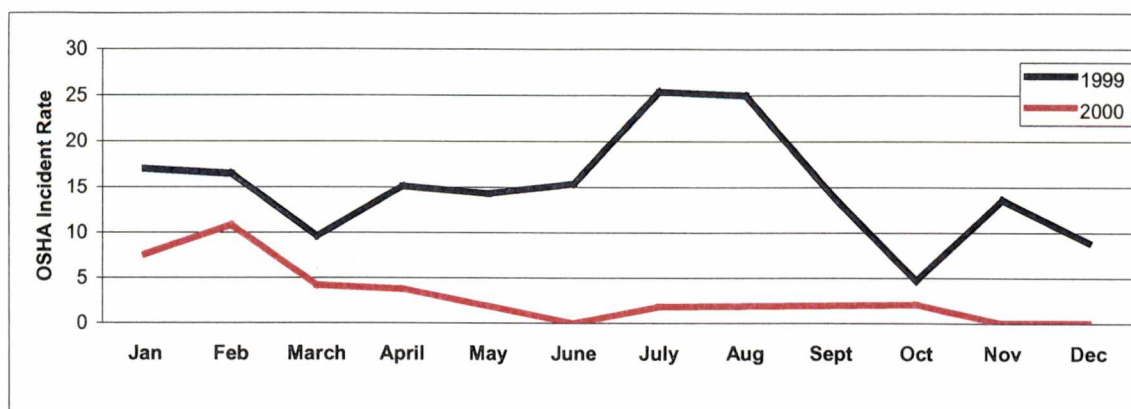
reduced the number of wrist tendonitis/De Quervain's syndrome incidents by 57% in 2000.

As for elbow MSDs, the manufacturing facility in this study had a total of 6 disorders in 1999 and 5 disorders reported in 2000.

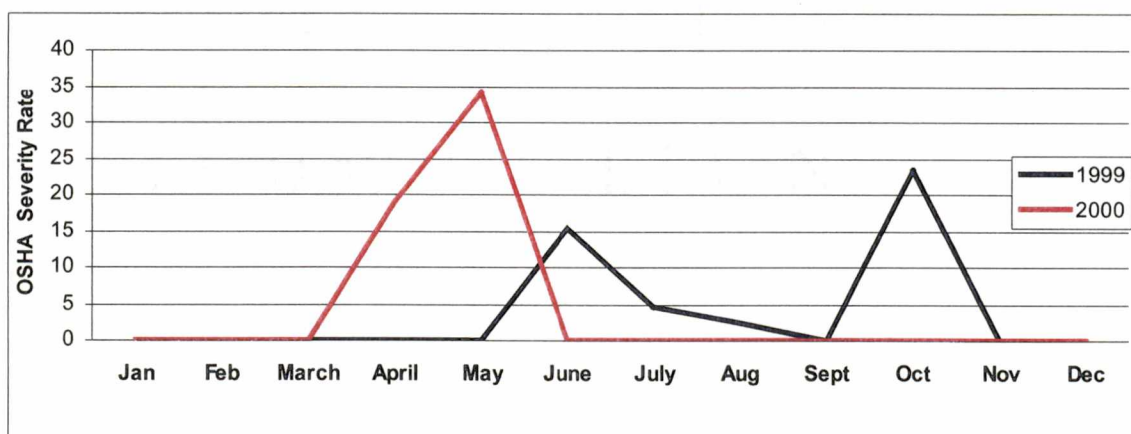
4. Analysis of Illnesses and Injury Trends at Manufacturing Facility

In 1999, the manufacturing facility in this study had a total of 80 illnesses and injuries. In 2000, this number was reduced by 14%. Of the total illnesses and injuries in 1999, 49 were ergonomics-related illnesses and in 2000 these were reduced to 37 cases. As stated in previous chapters, the ergonomics program did not exist in 1999 but was fully implemented in 2000 and was the only initiative undertaken by the company to address safety and ergonomics-related issues. Also in the year 2000, the number of hours worked per month and the average number of employees per month was greater, presenting even more of a challenge in terms of keeping safety incidents to an absolute minimum. Therefore, it is reasonable to assume any changes made within the realm of safety or ergonomics between 1999 and 2000 were somewhat if not completely related to the implementation of the ergonomics program.

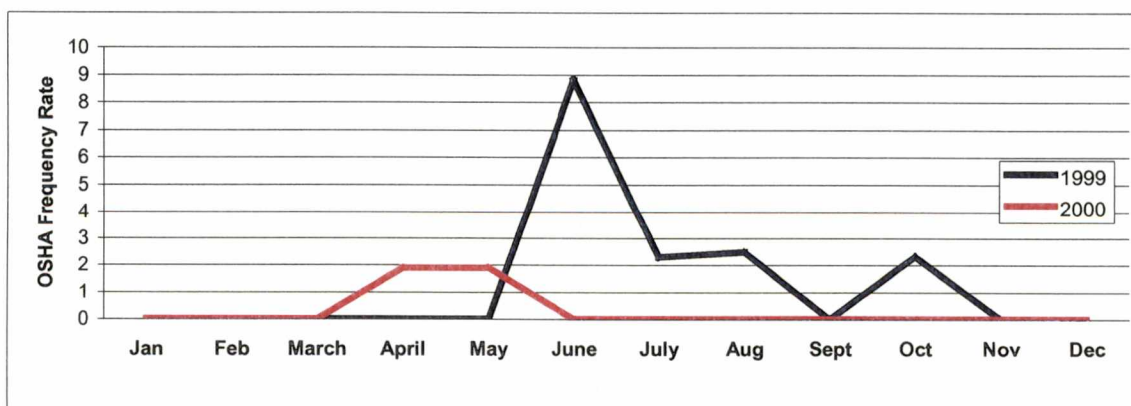
As shown in Figure 4.4, the OSHA recordable incident, severity, and frequency rates (calculated using equations 3.1, 3.2, and 3.3) at the manufacturing facility were quite different in 2000 than in 1999. The incident and frequency rates were dramatically



(a)



(b)



(c)

Figure 4.4: OSHA recordable incident (a), severity (b), and frequency (c) rates at manufacturing facility

decreased and the severity rate decreased by 4%. The total reduction in the OSHA recordable incident rates from 1999 to 2000 was 72%.

A statistical t-test was performed on this data using a null hypothesis of no difference between the means versus and alternate hypothesis of "year 2000 results were less than year 1999 results" (one-tailed test). The results of all analysis are presented in Table 4.5. As shown in the table, most data from 1999 and 2000 were statistically significant (67%) and tested positive under the normality assumption ($p > .05$). From these results, it can be assumed that the implementation of the ergonomics program had a very strong influence on the reduction of recordable illnesses and injuries in 2000. Statistical t-tests were also completed using the number of employees per month and number of hours worked per month data. The differences between year 1999 and year 2000 for this data also proved to be significant (2000 > 1999).

The number of ergonomics-related recordable incidents were also tested for statistical difference between the means for the years 1999 and 2000. As shown in Table 4.6, this analysis also proved a statistically significant difference between 1999 and 2000 (2000 mean data < 1999 data) and also the distributions met the normality assumption criteria. Figure 4.5 illustrates the decline in the number of ergonomics-related OSHA recordable incidents from 1999 to 2000.

In order to test the difference between individual ergonomics-related disorders, strains, sprains, and tendonitis were also considered separately. The results are also presented in Table 4.6. As shown in the table, tendonitis cases were the only disorder that showed a statistically significant reduction from 1999 to 2000 and the distribution

Table 4.5: Statistical difference between means tests for manufacturing facility safety results

Test Group	Significance (one-tailed) Year 2000 < Year 1999	p-value (normality)
OSHA Recordable Incident Rates, 1999 & 2000	.00015*	.9692
OSHA Frequency Rates, 1999 & 2000	.078***	.0021
OSHA Severity Rates, 1999 & 2000	.500***	.0251
Total Number of OSHA Recordable Incidents, 1999 & 2000	0.0003*	.6729
Total Number of Hours Worked by Month, 1999 & 2000	0.00**	.7332
Total Number of Employees by Month, 1999 & 2000	0.00**	.3655

*p>.05

** Year 2000>Year 1999

***Non-Parametric Wilcoxon Signed-Rank Test

Table 4.6: Statistical difference between means test for manufacturing facility ergonomics-related safety results

Test Group	Significance (one-tailed) Year 2000 < Year 1999	p-value (normality)
Total Number of Ergonomics-Related OSHA Recordable Incidents, 1999 & 2000	.00085*	.5153
Ergonomics-Related OSHA Recordable Incident Rates, 1999 & 2000	.0002*	.9578
Total Number of Strains, 1999 & 2000	.3074*	.4087
Total Number of Sprains, 1999 & 2000	.031**	.0012
Total Number of Tendonitis Cases, 1999 & 2000	.0475*	.1695
Total Number of Illnesses, 1999 & 2000	.0374*	.7812

*p>.05

**Non-Parametric Wilcoxon Signed-Rank Test

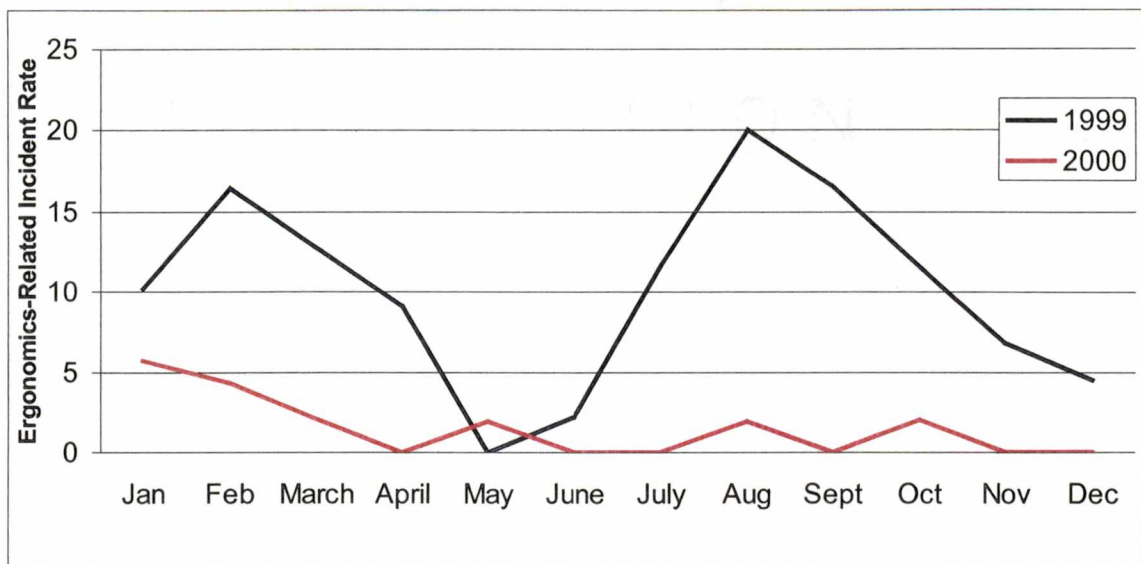


Figure 4.5: Ergonomics-related OSHA incident rates at manufacturing facility

was considered normal. Sprain cases did not meet the normality assumption, but were determined to be statistically significant using the nonparametric Wilcoxon Signed-Rank test. Strains did not pass the normality assumption and the t-test showed no difference between the means from 1999 to 2000.

Given the statistical analysis performed, it can be assumed that the ergonomics program implementation had a very strong effect on reducing the safety and ergonomics-related incidents from 1999 to 2000. Out of the 12 data analysis performed, 75% showed statistical difference between the means and also met the assumption of normality.

5. Comparison of Manufacturing Facility Results to Industry by SIC Code

The Bureau of Labor Statistics estimates that the total nonfatal injury and illness incident rate for the top-level SIC code (353) corresponding with the manufacturing facility in this study (construction and related machinery) is 14.1 per 100 employees in 1998 (which is the most current data available). The manufacturing facility in this study had a cumulative incident rate of 15.8 in 1999 and of 4.5 in the year 2000. Therefore, the manufacturing facility was well below the industry average in the year 2000 and 12% above the average in 1999. In terms of OSHA frequency rates, the BLS average was 3.7. The manufacturing facility in this study had an OSHA frequency rate of 1.65 in 1999 and 0.35 in 2000.

6. Workers' Compensation Costs

The workers' compensation costs for this facility were compared from the year 1999 to the year 2000 using a one-tailed t-test to once again determine statistical significance

between the means. The results are presented in Table 4.7. The data from the year 2000 proved to be significantly less than in 1999, and the distribution also passed the normality assumption. The distribution of this data is also illustrated in Figure 4.6. The average estimated cost per claim in this facility for back disorders in 1999 was \$75,000 and in 2000, \$26,000.

According to the BLS, the average cost per back claim in 1998 was \$19,746. When the cost of medical inflation is considered (prior to 1998) the manufacturing facility appears to be just at the industry average for back compensation costs in the year 2000. Figures 4.7 and 4.8 illustrate the average cost per claim by nature of injury and by body part for 1997-1998 from the Bureau of Labor Statistics. Figure 4.9 presents the cost per claim at the manufacturing facility by nature of injury in 1999 and 2000. As compared with the BLS information, this manufacturing facility is not quite aligned with the industry averages. The ergonomics-related illnesses are the greatest cost to the company, totaling nearly 72% of the total compensation paid in 1999 and 50% of the total paid in 2000. These are only the direct costs associated with MSDs. This data demonstrates the absolute necessity to control ergonomics-related hazards in the workplace whenever possible.

Table 4.7: Statistical difference between means test for workers' compensation costs at manufacturing facility

Test Group	Significance (one-tailed) Year 2000 < Year 1999	p-value (normality)
Workers' Compensation Costs, 1999 & 2000	.044*	.6011

*p>.05

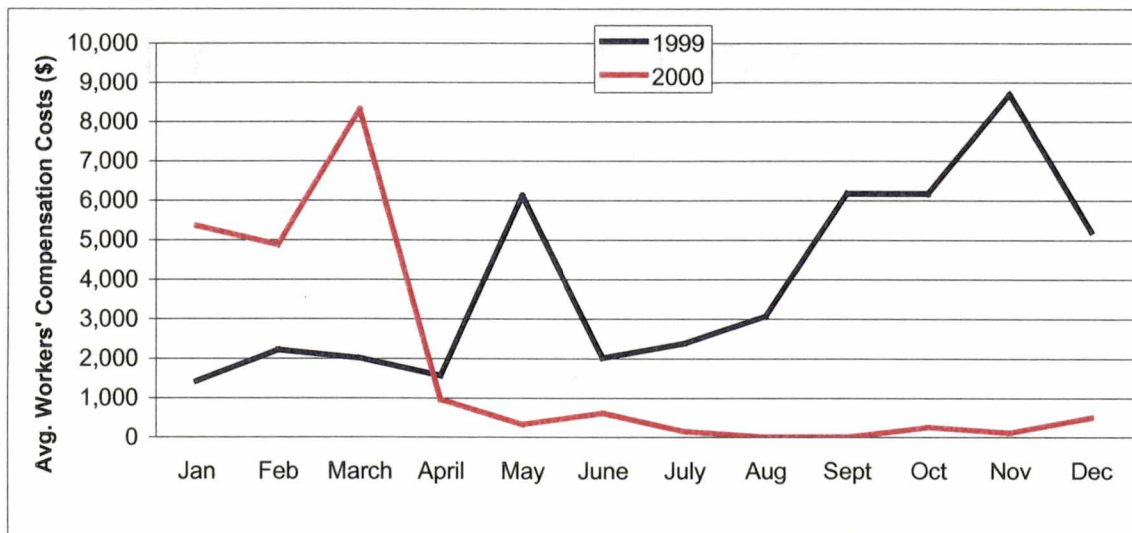


Figure 4.6: Average workers' compensation claim costs at manufacturing facility

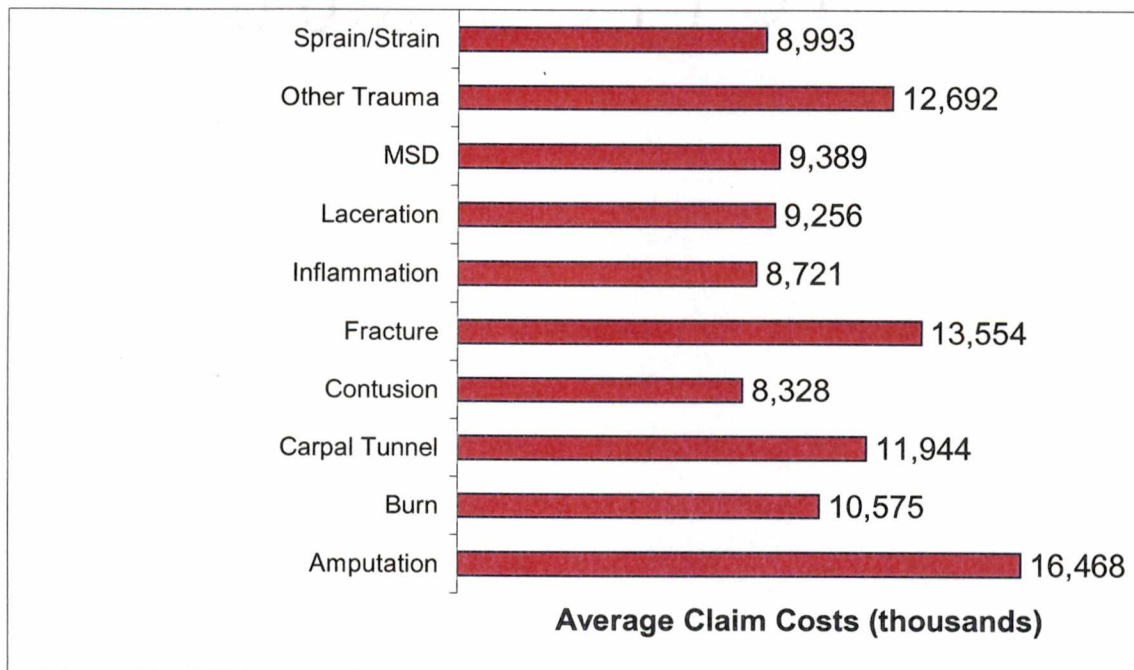


Figure 4.7: Average total incurred costs per claim by nature of injury, 1997-1998
From Bureau of Labor Statistics, 1999.

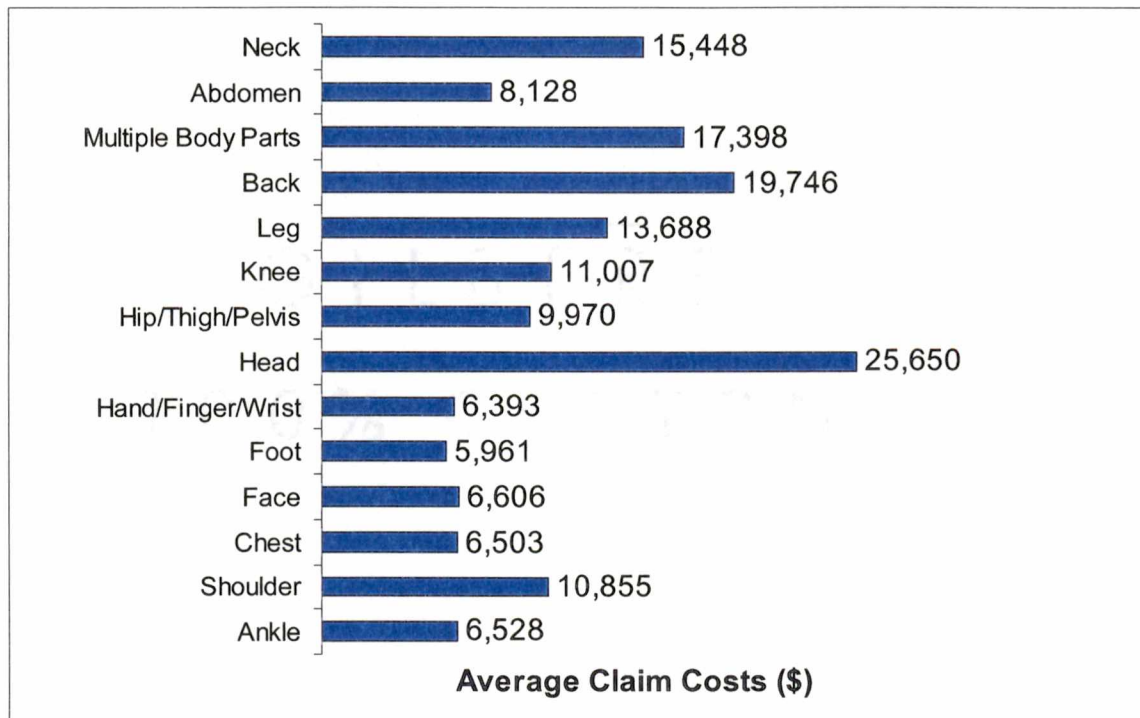


Figure 4.8: Average total incurred costs per claim by body part injured, 1997-1998
From Bureau of Labor Statistics, 1999.

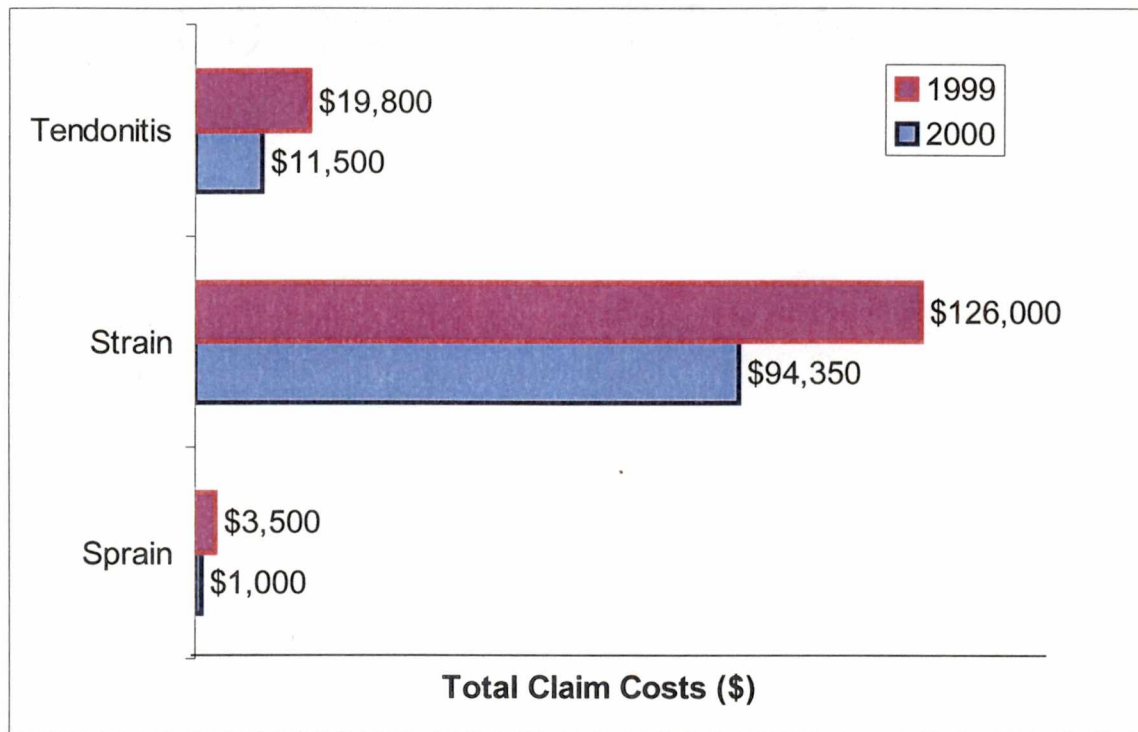


Figure 4.9: Total claim costs by nature of illness at manufacturing facility, 1999 & 2000

7. Discussion

The results of this retrospective study from the manufacturing facility are quite clear: an impressive reduction in safety and ergonomic-related incidents were achieved from the year 1999 to the year 2000. Given the background of this facility, as stated in chapter one, data prior to 1999 was unavailable but would have been beneficial to use in this study in order to examine additional data points. From the t-tests performed on all data, the reduction proved to be significant in every category except the OSHA frequency rates and severity rates and total number of strains. The OSHA severity rate is calculated using equation 3.3, which requires the number of days away from work as the independent variable. Therefore, the severity rate is certainly important, but does not contribute to the actual number of safety incidents. The severity rate is a measure of how well a company performs with returning individuals to work if a lost time injury or illness has occurred. For instance, if two different companies had the same employee undergo carpal tunnel surgery, one company may have the individual back to work in 14 days and the other in 2 days. This is largely based upon the company's willingness to allow for light duty work restrictions. Certainly it is in the company's best interest to provide this type of work, given the indirect costs associated with days away from work as discussed previously, as well as the re-conditioning of the employee into the work environment. Therefore, it can be assumed that the facility in this study did no better in 2000 than in 1999 with returning employees to work after sustaining lost time injuries.

OSHA frequency rates represent the number of lost time incidents over a period of time, using equation 3.2. In this study, the difference between 1999 and 2000 were not

considered significant, so it can also be assumed the company did not improve from 1999 to 2000 with the number of lost time case occurrences.

The number of strains actually increased from 1999 to 2000, therefore significance was not shown, but the overall number of MSD related incidents decreased significantly.

The number of employees per month and number of hours worked per month also showed significance, which further emphasizes the incredible improvement this facility realized in the year 2000. With more employees working and more hours worked per month, it would be assumed that the likelihood of injuries would be greater, but not in this case. The only intervention variable between 1999 and 2000 was the deployment of the ergonomics program and the results achieved by this implementing this program are astounding.

Chapter 5

Conclusions

1. Validity of Data

The hypothesis tested in this retrospective study was that the implementation of an ergonomics program reduces injuries and illnesses as well as worker's compensation costs in a manufacturing facility. Given the general positive results obtained from 12 separate statistical t-test analysis on data collected at the facility, and the fact that the implementation of an ergonomics program was the only intervention variable observed at the facility from 1999 to 2000, the hypothesis is very favorable. However, there are certain possible variables that could have affected the results in 1999, which should be discussed further.

In 1999, the plant was still in a "start-up" mode, that is still forming necessary core processes to run the business, finalizing design difficulties, hiring new manufacturing employees, and resolving process flow issues within the factory. Possible issues that could have affected the number of injuries and illnesses at the facility were: inappropriate methods, improper tools, lack of training, hiring personnel not accustomed to heavy industrial manufacturing work or environment, and overtime work hours. Unfortunately, these are issues not uncommon to a newly started manufacturing facility and are quite difficult to control, due to production demands and time constraints. Overtime requirements limit the employees' ability to utilize recovery time for their bodies, and

therefore may put them at higher risk for strain-type injuries. However, the key ingredient that was missing in 1999 was lack of ergonomics or safety initiative. If this initiative would have been present, tools such as job rotation, stretching (warm-up exercise) classes, and training could have been utilized and would have certainly made a difference.

Still yet, in the year 2000, the same problems the facility faced in 1999 were not completely resolved. Production demands increased each month and more and more employees were hired. This company is located in a very rural area of Tennessee and therefore finding skilled laborers, such as welders, becomes somewhat of a task. Many additional employees were hired with no manufacturing background thus the challenge of keeping safety incidents to a minimum still had a definite presence. Although overtime hours were minimized somewhat, two new work shifts were added to the schedule, which lacked engineering personnel for support functions. Hence, the year 2000 still faced some of the familiar challenges of 1999, along with several new challenges.

The manufacturing facility in this study was only able to produce two years (24 months or data points) of data for this study. It would have certainly been beneficial to have several years of data prior to the ergonomics program implementation in order to demonstrate the overall effect the program had on the reduction of illnesses. However, even using two years of data, a significant difference between the means was demonstrated in most cases.

2. Summary

When the safety and ergonomics program was implemented in January of 2000, a new culture began to form at this facility. Employees became involved with making improvements to their jobs and also participated in teams to resolve safety and ergonomics issues within their respective departments. The employees realized that management had made a commitment to improve their health and safety in the workplace and embraced that effort. A sense of pride was developed throughout the factory in maintaining an excellent safety record and that is exactly what was achieved as a result. This kind of *culture* is what drives an organization to produce positive change and ultimately reduce costs through a more consistent, healthier work force.

3. Future Research Possibilities

For future research, it would be of interest to utilize factories that have been in existence for long periods of time, and analyze the data from one period to the next to determine the effect of an ergonomics program implementation. Also, it would be of interest to look at different types of industry and compare how much reduction in illnesses was experienced according to industry type. Another idea for study would be to look at specific jobs within a facility and compare illness rates from one period to the another, using an ergonomics improvement project as the intervention variable. This would also inform the ergonomics team if the improvement project truly had a positive effect on the employees or not. Once again, in order to accomplish studies of these magnitudes, a factory would need to have many years of data collected.

Chapter 6

Recommendations

1. Overview

Given the results from 1999, senior management at the manufacturing facility decided to support an ergonomics program implementation to potentially reduce safety incidents and workers' compensation costs in 2000. This effort began in January of 2000. A full-time safety and ergonomics coordinator was employed as well as a staff of two ergonomics technicians.

Based on the results of this retrospective study, it would appear that implementing an ergonomics program is a good business decision for any company, especially one in a "start-up" capacity. Ultimately, the results desired by senior management were achieved by supporting the implementation. Therefore, based upon this study the recommendation for manufacturing facilities in general is to implement an ergonomics program as outlined below (adapted from the manufacturing facility in this study), in order to reduce safety and ergonomics-related incidents and thus better control costs. The benefits obtained from the program and the potential for huge cost reduction through reduced workers' compensation costs far outweigh the costs associated with devoting resources into the program implementation.

2. Develop a Written Program

The first step to any ergonomics program should be to put the program in written form in order to sell the program to management. This documentation will serve as a general guide for senior management to better understand the direction the program is headed and further define roles, responsibilities, and resources required. The program should also establish results-based realistic goals. Basically, every ergonomics program should address eight major issues. These are: management commitment and support, employee involvement, problem identification, job studies and evaluation, methods of controlling ergonomic hazards, training and education of the work force, medical management, and program administration. Each of these elements should be detailed in written form and presented to management for review and approval. Appendix A provides an example of a written ergonomics program adapted from the manufacturing facility in this study.

3. Establishing Management Commitment and Support

One of the most important aspects of an ergonomics program is first obtaining management commitment and then sustaining that commitment. Management must play an active part in the ergonomics program to the extent that every employee understands that results are expected, not merely desired. Any new program in industry has a top-down effect. That is, the commitment and support are provided at the highest level and the strength of that commitment is passed down through the hierarchy of employees. Senior management ultimately provides the foundation of the program. If the foundation

is faulty (lacks commitment and involvement), the other necessary building blocks of the program are sure to fail.

One way to keep management actively involved is to update them monthly or perhaps quarterly on the metrics of the program, such as results versus consumed resources. One very powerful tool is to compare the safety record of previous months (before the ergonomics program had been implemented) to the months following the implementation. Also, being able to show a reduction in MSD cases and thus workers' compensation costs is a very effective measure. However, one of the most successful ways to win over management are testimonials from the employees themselves, who are benefiting from the program. It is very powerful to hear an employee speak of pains they were used to experiencing as a "just a part of the job" and then speak of how ergonomics intervention took away the discomfort they were experiencing not only on the job, but at home as well. Pictures of how the job was done before and how the job has changed due to ergonomic fixes are also good methods of communication to management. Projects that are particularly appealing are those that produce a large effect on an employee's well being, but were completed using very little money. Fortunately, many ergonomics projects are based on common sense and require very little capital to achieve. With metrics such as these in place and well communicated to management, the ergonomics program is sure to succeed.

4. Training and Education

The next essential component of an ergonomics program is the training of all employees in the organization whom the program may effect. This includes, but is not limited to:

production supervisors and managers, production employees, video display terminal operators, manufacturing engineers, product design engineers, senior management, and the ergonomics program administrators and managers. Each of these groups would obviously require varying degrees of training. For instance, production supervisors, managers, and production employees should be trained on basic ergonomics principles such as the risk factors associated with the development of various MSDs, the signs and symptoms associated with MSDs, and the procedure to use in order to report MSDs. Production employees should be trained further on maintaining natural postures whenever possible and which postures are more conducive to developing an MSD. They should also be trained on simple fixes they may be able to incorporate into their jobs to reduce fatigue, such as taking micro-breaks for stretching exercises or shifting their weight from one foot to the other if standing for long periods.

Manufacturing and product design engineers should be more focused on the ergonomic-controls area of training but be trained on risk factors as well. Product design engineers need to be included in the ergonomics program because they have the ability to fix the potential ergonomic hazard before it is introduced onto the production floor. If they are able to identify areas within the product assembly that may be difficult to reach or produce awkward postures for employees, they may have the opportunity to design

that area differently, thus reducing or eliminating the hazard completely. Figure 5.1 is an illustration of the powerful effect design engineers may have in terms of cost reduction by including ergonomics at the initial concept phase of the product.

Video display terminal operators should be trained specific to their jobs. In other words, training that involves how to set up a computer workstation appropriately to reduce the specific risk factors they are exposed to. Another good training session for VDT operators is an upper-body stretching or exercise course.

Senior management should receive a general overview of risk factors, types of MSDs (minimize the types reviewed based on what is typically seen at the facility), and costs associated with each MSD.

Each group should also be advised of their roles and responsibilities in the ergonomics program. Examples of roles and responsibilities are how to respond to employees that have ergonomics requests or complaints, procedures for accessing a health care provider for an employee that has reported a suspected MSD, and how to support the organization's ergonomic program efforts.

Obviously, the members of the ergonomics team should receive the most extensive training. This would include MSD problem solving methods such as how to perform a job task analysis, evaluate the results, and use ergonomic design principles to solve the problem in order to minimize exposure to the risk factor in question. Members of this team should (whenever feasible) attend ergonomics conferences, off-site training sessions, and college courses to improve their skill level and keep up to date on advances within this field. Interacting with other ergonomics professionals is also very

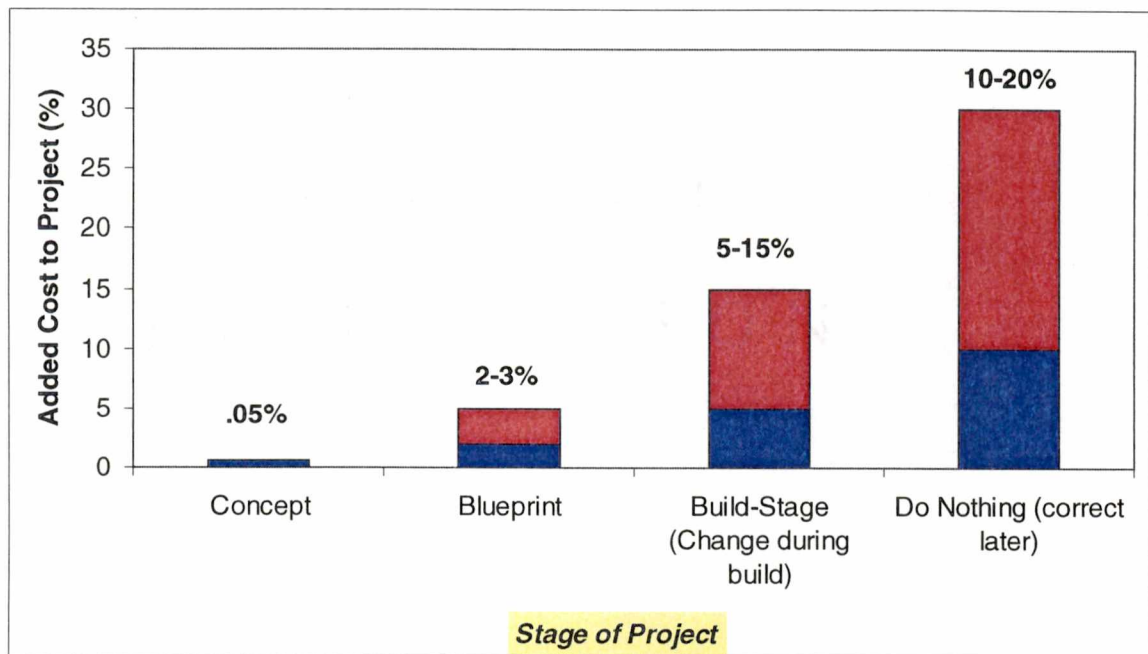


Figure 6.1: Costs associated with excluding ergonomics in a new product design
From Alexander and Associates, 1994.

valuable in terms of sharing ideas, success stories, or benchmarking one program against another.

Senior management should be trained first, followed by the orders of hierarchy of the organization. Production employees should be trained last. Once again, a new program only thrives using a top-down approach, and thus training should begin at the uppermost level of management in order for the program to gain leverage with employees.

5. Problem Identification

There are various methods to ascertain which jobs may be “problem” jobs, in other words, those jobs containing ergonomic hazards. However, there are only two basic categories: proactive initiatives (“before the fact”) and reactive initiatives (“after the fact”).

Unfortunately, reactive initiatives are most commonly used. These include: reviewing the company’s OSHA 200 log (Appendix B) and accident investigation form (Appendix C) for specific jobs with a recurrence of an MSD, reviewing the company’s first aid cases for MSDs that did not become severe enough to be logged as an OSHA recordable but may still be an active, distribution of an employee pain and discomfort survey (Appendix D), and comparing MSD rates by department or supervisor. These are some of the tools that will enable the ergonomics team to pinpoint where most of the MSDs are occurring in the organization, locate patterns amongst particular job types, (welder, assemblers, etc) and recognize any high frequency MSD reporting or ergonomics complaints based on supervisor or department. Reactive tools should be used

only as an assessment of the current situation (pre-ergonomics program implementation) and not as a method to control exposure to MSD hazards whenever possible. However, many ergonomics projects are completed (and funded) due to an employee developing carpal tunnel syndrome on a particular job, or a back surgery for example. The ergonomics team attempts to control the hazard only after an employee has obtained an MSD. This type of effort is counterproductive, because not only has an employee already suffered a debilitating condition and thus the company accumulated workers' compensation costs, but also the message it sends to the production employees can be quite damaging to the program. The message that it may send is that someone must sustain injury before the job is fixed. Obviously, this type of reaction could be detrimental to the newly formed ergonomics program. Therefore whenever possible, proactive tools should be utilized.

Proactive initiatives are those such as employee suggestion forms (Appendix E) and walkthrough risk factor audits (Appendix F). These types of tools are designed to find the injury before it happens. Employee suggestion forms are good tools, but the ergonomics team will need to evaluate the job before relying on the suggestion. Ergonomics audits are also an excellent tool to observe jobs and identify any risk factors present. This is a good tool to determine whether jobs are high-risk/low-risk (based on the number of hazards identified) and thus prioritize the team's ergonomics project list.

6. Job Studies and Evaluation

After jobs have been identified as having MSD risk factors and have been prioritized in terms of risk, job studies and evaluation must take place to determine what causal factors are attributing to the risk and what control methods must be implemented. There are many tools that can be used to perform a job study to analyze MSD risk factors. Examples of these are: work station checklists (Appendix G), utilization of the lifting/lowering, pushing/pulling or carrying equations (NIOSH, 1993) to analyze specific tasks, or video taping the job in order to determine the degree of repetitiveness (as a percent of cycle time for example) or other factors. Sometimes, a basic observation of the job will lead to the underlying cause of risk, such as the simple work station checklist. For more complex situations however, where the cause of risk is not readily apparent, both identification and quantification are required, along with the skilled ability to evaluate and interpret the results. If a member of the ergonomics team does not have this skill level, an outside consultant should be hired.

The ergonomics program documentation should identify who will be responsible for performing the job studies. Trained production employees may be able to accomplish the ergonomics observational checklists, but the ergonomics team should handle the more complex situations, as they are assumed to have more extensive training and skill in an ergonomics evaluation.

Jobs that have been found to have risk in a routine ergonomics audit should not be the only jobs studied. Jobs that employees have submitted suggestions for improvement or jobs in which employees are complaining of discomfort should also certainly be studied.

When performing a job study, the employee performing the study should always inform the job operator of what kind of study is being accomplished, the intention of the study, and also inform that the physical job elements are being studied, not the operator performing the job. Also, after the study is complete, the results should be reviewed with the operator and any suggestions they may have to improve the job taken into consideration.

7. Methods of Controlling Ergonomic Hazards

There are three way to control ergonomics hazards: engineering controls, administrative controls, or a combination of the two.

Engineering controls are generally the most effective, in that they have the best chance of eliminating the hazard completely. Many engineering controls require several revisions, that is the project may start as a simplistic change in method but after the operator uses the new method, a better method is discovered, and so on. The main point is, with each refinement the hazard gets more and more diminished, until it no longer exists. Engineering controls will directly remove or minimize the problem by modifying or eliminating the exposure to the risk factor.

Administrative controls should only be used if engineering controls cannot be implemented in a timely fashion. These controls rely on the employees to take action every time they do the job, which cannot always be counted on. Examples of administrative controls are training on lifting properly, job rotation schedules, or addition of certain personal protective equipment (vibration-reducing gloves, etc).

Based upon the results of the job study, recommendations for modifications to the job should be made by the ergonomics team. These recommendations should be presented to manufacturing engineers, production employees, and possibly maintenance personnel (if an equipment installation or moving is required) for input. Depending upon the make-up of the ergonomics team, many of the project implementations or modifications may be entirely accomplished by the team themselves. When recommendations to modify a job are made, the ergonomics team should ensure the changes happen in a timely manner. A project timeline should be established and shown to all involved parties.

Once the ergonomic improvements have been made to the job, the ergonomics team should follow-up with the operators after several weeks of utilizing the new method. This time is necessary to give the operator a chance to get accustomed to the new method and be able to truly evaluate the physical benefits. Sometimes when ergonomic improvements are implemented to reduce a certain risk factor in a job, other risk factors get introduced to the job unintentionally. Unfortunately, it is not always possible to identify this before proceeding with the new method and the only way to realize a new risk factor has been introduced is by following-up with the employee or performing another job study.

All ergonomics projects should be heavily documented. One of the best ways to document an improvement project is to video the job before the improvement was made (focusing in on the ergonomic hazards) and then after the improvement was made. Or, the use of digital photos can be powerful communication tools when doing a presentation

to management or production employees. Examples of ergonomics project documentation from the manufacturing facility in this study are shown in Appendix H.

8. Employee Involvement

Keeping production employees involved is another key ingredient to the ergonomics program. By keeping employees involved, more creative ideas can develop in terms of how to control risk factors in the workplace. If employees are trained and actively involved with the program, they will begin to recognize risk factors more easily and feel encouraged to figure out possible ergonomics solutions for the job. Production employees are, in fact, the people doing the job everyday, so it stands to reason that they may have the best ideas for improving the job. Also, if employees are involved in the solution to the problem, they are more likely to “buy in” to the ergonomic modification to their job. The ergonomics program should outline if production employees will be directly involved in the process (for example, a certain amount of hours required in the work week out of a set amount of employees), or indirectly involved (for example being involved with job studies as they are being done). However, production employees must be involved to a great degree for the ergonomics program to become successful.

9. Medical Management

The medical management aspect of the ergonomics program is one of the most important elements to consider. Medical management includes encouraging employees to report work-related MSDs as soon as possible since this promotes early diagnosis and

treatment. It is important to begin with early treatment of MSDs due to the fact that employees may be continually aggravating the condition both at work and at home and therefore making the situation much worse. If treatments such as physical therapy or cortisone injections are begun, along with restricted work activity, the condition may disappear or at least be reduced in severity. If MSDs go untreated, they may require surgery such as carpal tunnel release. When an employee reports an MSD, a job study should immediately follow to determine what is causing the problem. This is a reactive effort, but certainly necessary to prevent further occurrence. It is also necessary to validate the work-relatedness component. Many times, employees may have hobbies at home or other activity (such as sports activities) that may be the source of the MSD. The ergonomics team should review any findings supporting or otherwise from the job study with the treating physician as soon as possible. This will allow the physician to get a better picture of what kind of activity the employee was involved in that may or may not have caused the MSD.

An active relationship must be developed with all company physicians. This includes both general practitioners and orthopedic surgeons. A medical panel should be developed (the requirements vary from state to state) which consists of three general practitioners and at least 2 orthopedic surgeons. The members of the panel should be invited to tour the factory at least on a yearly basis and the ergonomics team should take the time to explain the various manufacturing process requirements. Also, the ergonomics team should point out any ergonomics improvement projects that have been accomplished at the facility. Whenever the ergonomics team cannot readily determine

the cause of a reported MSD, the company physician may be invited to study the job as well. All members of the physician's panel should be well informed that the company has light duty job assignments available at any time in order to accommodate an injured employee. This not only helps the company to minimize OSHA severity ratings (eq. 2.2) but also is better for the employee. The longer an employee stays away from work, the harder it is for them to readjust both physically and mentally upon returning.

As soon as an employee reports a suspected MSD and sees the company physician, the physician should be contacted immediately by the ergonomics team. The physician should provide a prognosis and severity level of the MSD and estimate whether or not the MSD may require surgery. The physician should also establish clear work restrictions for the employee.

Once the work restrictions have been established, the ergonomics team should communicate this information with the employee's supervisor and ensure that the job that is available for them meets all restrictions posed by the physician. The ergonomics team should monitor the employee regularly to ensure they are working within their restrictions and not exposing themselves to any additional hazards.

10. Program Administration

Once the ergonomics program has been introduced to employees, it must be continuously monitored for its effectiveness. Activities associated with the program administration may include: establishing program goals, developing the written program, measuring progress, reviewing results with other groups, and program auditing.

Goals should be established at the onset of the program. The ergonomics team should measure where the company currently stands in terms of OSHA incident, severity, and frequency rates and workers' compensation costs, where the company would like to go, and how long it will take the company to get there. Program goals can include any measurable activity pertaining to safety and ergonomics, for instance, completing a certain number of projects per quarter.

Periodically, the program should be monitored to ensure its effectiveness. The goals that have been established can be used to audit the program's progress. The results of audit should be reviewed with management so they understand the status of the program and any problems that may need to be addressed. All ergonomics projects should be kept on file along with a detailed description of cost, MSD risk factors that were eliminated, an estimate of workers' compensation costs that were potentially avoided, and any supporting testimonials from production employees. These projects should always be reviewed with management and production employees, as they are key components of the program itself.

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Appendices

Appendix A

Ergonomics Policy

Purpose

This document is intended for all John Deere Commercial Worksite Products (JDCWP) employees. It describes the processes and principles for controlling work-related musculoskeletal disorders (WMSDs). The JDCWP Ergonomics Team is responsible for implementing the process. The JDCWP management staff fully supports and is committed to the JDCWP Ergonomics Program.

Scope

JDCWP employees exposed to ergonomic stressors risk acute injuries, subchronic illnesses, and chronic illnesses. Exposure to these stressors can lead to debilitating WMSDs; therefore, these stressors should be reduced and eliminated whenever possible.

Risk factor analysis can be used to redesign jobs and reduce the risks of WMSDs. These risk factors include repetitive motion; fixed or awkward postures; forceful exertion; prolonged contact with vibrating tools and equipment; and contacting temperature extremes. There are other risk factors that can contribute to WMSDs. These factors include psychosocial and individual characteristics.

Risk factors alone cannot be used to indicate that a hazard exists. To identify WMSD hazards, risk factor identification must be combined with other information such as data on illness and injury trends, and employee complaints of discomfort.

Once a WMSD progresses from mild symptoms to pain and disability, it is very difficult to treat with success. **Early recognition and prompt treatment of employee symptoms are critical to prevent invasive, complicated, and costly medical procedures and treatments.**

Employee and management involvement is critical to the success of any efforts to prevent and reduce WMSDs. The elimination or reduction of risk factors directly affects the methods that workers use to do their jobs. If the JDCWP Ergonomics Team recommend solutions that workers and management do not accept or support, the changes will have little positive effect.

Goals

The primary goal of the JDCWP Ergonomics Program is to minimize the impact of WMSDs on JDCWP employees. The secondary goal is to reduce the severity of WMSDs through early medical management and job hazard minimization or reduction when possible. Additional goals of the program are to:

- Promote continual improvement of the control of workplace risk factors
- Ensure management leadership and employee involvement in controlling exposures to risk factors
- Ensure the employees are informed about WMSDs and the factors that can cause or aggravate them
- Enhance productivity by improving the ergonomic design of the workplace.

Specific Goals: The JDCWP Ergonomics Team's overall goal is to have zero WMSDs. Reductions of at least half will be seen each year due to the ergonomics projects and employee awareness developed throughout the factory. The team will accomplish at least 35 ergonomics improvement projects per year, and will communicate these with management and the work force on a quarterly basis.

Terminology

Abduction: Movement of a limb away from the body's midline axis, such as elevating the elbow or raising the arm to the side.

Active Health Surveillance: The systematic collection, analysis, and interpretation of data obtained through a group administered Job Requirements and Physical Demands Survey to determine the scope of potential or actual WMSDs in one or more work groups.

Administrative Control: Any procedure that significantly limits daily exposure by control or manipulation of the work schedule or manner in which work is performed. Administrative controls include but are not limited to job rotation, use of rest breaks or alternative tasks, job enlargement to increase task variability, redesign of work methods, and adjustment of work pace or number of repetitions.

Advocate: An individual who supports the injured employee in an unbiased fashion in order to aid them through all aspects of their care to recovery.

Anthropometry: The study of the physical dimensions of people, including size, breadth, girth, distance between anatomical points, and joint range of motion.

Assembly Line: A job where employees perform essentially the same tasks in the same sequence throughout the day.

Awkward Posture: A deviation from the neutral position of any particular joint. Examples include extreme flexing, extending, bending or rotating parts of the body; reaching behind the trunk; holding arms above the shoulders, etc.

Back: The trunk of the body from below the neck (cervical spine) to the tailbone (sacrum). The back includes the upper and lower back. The neck is considered an upper extremity for the purposes of this glossary.

Biomechanics: The application of mechanical principles, such as levers and forces, to the analysis of body-part structure and movement.

Case Manager: An individual who becomes familiar with injured employees and aids them in receiving prompt quality care while simultaneously coordinating appropriate dissemination of information to the employer. Case management processes assures the employee will complete treatment to the point of maximal medical improvement and assist their return to work activities in an effective and safe manner.

Center of Gravity: The center of mass of an object that determines its symmetry and ease of handling.

Contact Stress: A type of trauma inflicted by direct contact of various body parts with workpieces, tools, or work surfaces. Mechanical stress generated on tendons and nerves can lead to WMSDs.

Continuous Work: Work activities that are sustained and uninterrupted, e.g., in dynamic work, the sustained pattern of work without rest or light effort breaks. Continuous work, especially when the work is demanding, results in earlier fatigue than does intermittent work.

Customer: Any individual for whom we provide a service.

Cycle: A time interval during which a regularly occurring sequence of events is completed. A cycle can be the time to complete a job with many tasks or the time to produce one unit.

Disability: Inability to pursue an occupation because of physical or mental impairment.

Discomfort Prevalence Ratio: The percentage of employees reporting discomfort in a particular body part. For WMSDs, discomfort should be persistent and associated with the ergonomic risk factors.

Dynamics: The biomechanical aspects of the human body in motion.

Engineering Controls: Physical changes to work stations, equipment, materials, facilities, or any other relevant aspect of the work environment that reduce or prevent exposures to ergonomic risk factors.

Ergonomics: The field of study that seeks to fit the job to the person, rather than the person to the job. The evaluation and design of workplaces, environments, jobs, tasks, equipment, and processes in relationship to human capabilities and interactions in the workplace achieve this.

Extension: The straightening of a joint whereby the angle between adjacent bones usually increases. Exceptions are extension of the feet and wrists.

Fatigue: The reduction in performance ability caused by a period of excessive activity followed by inadequate recovery time. Muscle fatigue is accompanied by a buildup of lactic acid in the working muscles.

Fixed Postures: Prolonged muscle contraction without movement. Examples include stringing wire overhead and prolonged gripping of a hand tool.

Flexion: The bending of a joint whereby the angle between adjacent bones usually decreases.

Force: The mechanical effort to accomplish a specific movement or exertion. Force may be either external (a force applied, voluntarily or involuntarily, to the surface of the body) or internal (tension within muscles, tendons, and ligaments).

Hyperextension of the Shoulder: Extension of the shoulder in which the upper arm is actually behind the back; for instance, when reaching behind the back for an object.

Hyperextension of the Spine: Extension of the trunk beyond the upright position, forming a more extreme backward arch and changing the distribution of pressure on the spinal discs; for instance, in work done above shoulder height.

Impairment: An alteration of an individual's health status. A deviation from normal in a body part or organ system and its functioning.

Incidence Rate: The number of new WMSDs occurring during a year per 100 full-time equivalent workers. Incidence rates are calculated as follows:

(Number of new WMSDs in problem jobs) x (200,000 hours or 100 full-time equivalent workers) / (Work hours per year or number of full-time equivalent workers in problem jobs).

Job: A series of combination of tasks to reach a goal or produce an end product. Workers may be assigned to the same organization and have the same title, but might not do the same job if their combinations of tasks differ.

Lateral: Toward the side of the body away from the midline.

Lower Extremity: The hip, thigh, knee, leg, ankle, and/or foot.

Maintenance/Inspection: Work where employees perform a variety of activities or processes as part of their normal job duties.

Manual Material Handling: The act of pushing, pulling, carrying, holding, and lifting objects from one location to another. The movement may be done by hand, as in lifting objects and pushing hand trucks and carts, or with automated equipment or aids, as in using forklift trucks, storage and retrieval systems, or conveyors.

OSHA 200 Log: A paper or electronic record equivalent to the OSHA Form 200 used to record occupational illnesses and injuries.

Outcome Measure: A tool of data analysis that can be easily measured and related to care or services. It can be used to differentiate if the care or services are beneficial to the healing process in the injured employee.

Overtime: Time worked that exceeds the standard hours required of the employee in one week. If more than 40 hours are worked in a 7-day period, the additional hours are overtime hours.

Pacing: Controlling an employee's rate of movement through external means, such as a continuous conveyor moving at a fixed speed, production pressure, peer pressure, or pay incentives.

Passive Health Surveillance: The systematic collection, analysis, and interpretation of existing records and data to identify incidents and patterns of WMSDs and potential problem job areas.

Personal Protective Equipment: Gloves, padding, or eyeglasses worn and used for the purpose of controlling risk factors. *Devices worn on or attached to the wrist or back are not considered Personal Protective Equipment (PPE).*

Potential Problem Job: A combination of tasks for which one or more employees report a WMSD, or for which signal risk factors show a *potential* risk for developing a WMSD.

Problem Job: A combination of tasks for which an association can be shown between risk factors, employee discomfort, and reported WMSDs.

Pronation: The action of rotating the forearm so that the hand is palm down.

Radial Deviation: Bending the wrist toward the thumb side.

Recovery Time: Work periods when task demands are light or when rest breaks are scheduled, permitting a person to recover from heavy effort work such as prolonged fixed postures.

Redesign: Changes to an existing workplace or to production equipment to make it suitable for more employees; also, the re-examination of job requirements and their patterns of occurrence. Redesign is more expensive than incorporation of ergonomic principles in the initial design of a job.

Rest Allowances: Recovery time, including regularly scheduled work breaks, usually provided in jobs where heavy physical work or exposure to environmental extremes occurs. Rest allowances are built into the job standard so that productivity ratings recognize the need for additional recovery time in these jobs.

Restricted Workday Rate: The number of restricted workdays due to WMSDs occurring during a year per 100 full-time equivalent workers. Restricted workday rates are calculated as follows:

(Number of restricted workdays due to WMSDs in problem jobs) x (200,000 hours or 100 full-time equivalent workers) / (Work hours per year or number of full-time equivalent workers in problem jobs).

Risk Factors: Attributes, experiences, and exposures that increase the probability of occurrence of WMSDs. Risk factors include repetitive, forceful, or prolonged exertions; frequent or heavy lifting; pushing, pulling, or carrying of heavy objects; fixed or awkward work postures; contact stress; localized or whole-body vibration; temperature extremes; and poor lighting leading to awkward work postures. These risk factors can be intensified by work organization characteristics, such as inadequate work-rest cycles, excessive work pace and/or duration, unaccustomed work, lack of task variability, machine work, and piece rate. Specific dose-response relationships between ergonomic risk factors and WMSDs are not yet known.

Risk Factor Survey: Form used for rapid general characterization of an employee's exposure to signal risk factors.

Routine Exposure: Approximately daily; three or more days per week.

Static Exertion: Static exertions refer to physical exertions (gripping, holding a posture) in which the same position or posture is held throughout the exertion (also referred to as static loading).

Severity Rate: The number of lost workdays due to WMSDs occurring in a year per 100 full-time equivalent workers. Calculate severity rate as follows:

(Number of lost workdays due to WMSDs in problem jobs) x (200,000 hours or 100 full-time equivalent workers) / (work hours per year or number of full-time equivalent workers in problem jobs).

Signal Risk Factors: An exposure level for risk factors used to recognize jobs that have the potential to produce WMSDs. Signal risk factors are used to screen jobs that should not require further attention from those that should be surveyed.

Supination: The action of rotating the forearm outward so that the hand is palm up.

Task: The smallest unit of work that will be used for assessing worker exposures. Each task consists of a distinct activity or group of activities performed by an individual that accomplished the work objective or job.

Torque (Moment): A force that produces or tends to produce rotation; quantified as the product of the perpendicular force multiplied by its distance from the axis of rotation.

Ulnar Deviation: Bending the wrist towards the little finger side.

Upper Extremity: The hand, wrist, elbow, arm, shoulder, and/or neck.

Vibration: The oscillatory motion of a physical body. Localized (segmental) vibration, such as hand-arm vibration, is produced by contact with powered tools or equipment. Whole body vibration exposure occurs while standing or seated in vibrating environments or objects, such as trucks, heavy machinery, or while using heavy equipment such as jackhammers.

Work Analysis: The systemic investigation of work activities to identify risk factors, evaluate their probable causes, and develop controls to minimize or eliminate the identified risk factors.

Work Methods: The physical methods used to perform the tasks of a job, such as reaching, gripping, using tools and equipment, or discarding objects.

Work Practice Controls: Changing or improving procedures commonly followed in the workplace to minimize or eliminate ergonomic risk factors. Examples of work practice controls include: using proper lifting techniques in manual materials handling operations; adjusting work flow or line speed; and routine tool-sharpening and maintenance.

Work Recovery Cycles: The job pattern that defines how work is organized with respect to lighter tasks or rest. High work/recovery ratios, measured as continuous time on each type of activity, have higher risk potentials.

Work-Related Musculoskeletal Disorders: Illness or injury of the muscles, tendons, ligaments, peripheral nerves, joints, bones, and/or supporting blood vessels in either the upper or lower extremities or back, which are associated with routine exposure to ergonomic risk factors and which are not the result of an acute or instantaneous event. Commonly used terms such as "cumulative trauma disorders", "repetitive motion injury", or "repetitive trauma disorders" are included in this definition.

Workstation: An individual employee's work area, such as a desk, chair, and computer, or an individual assembly, maintenance, or inspection station.

Responsibilities

JDCWP management staff is responsible for the health and safety of their employees. This responsibility includes:

- ensuring workplaces and processes do not expose employees to known WMSD risks
- ensuring workstations, devices, tools, and equipment are properly designed and right for the job
- providing adequate resources to ensure a healthy and safe workplace
- establishing, monitoring, and supporting procedures and initiatives to identify and control recognized risk factors
- ensuring supervisors and workers receive appropriate training on the prevention of WMSDs.
- Ensuring supervisors promote, support, and uphold any ergonomics improvements made to any job

The JDCWP Ergonomics Team is a full time team consisting of a coordinator and three technicians, consisting of a machinist (part time), and two maintenance or fabrication technicians (full time). Their responsibilities are to:

- establish and identify signal risk factors that will be used to help identify problem jobs
- identify potential hazards for analysis
- review the results of WMSD trends
- advise the JDCWP management and workforce on the effectiveness of the ergonomics program and provide results of ergonomics improvements
- prioritize and perform worksite analysis
- selecting and implementing the appropriate control measures to eliminate or minimize ergonomic risk factors
- evaluate the effectiveness of the implemented control measures in eliminating or minimizing risk factors within one month after the improvement has been made

Other professional disciplines are included on the team on an ad hoc basis.

Supervisors:

- participate on the JDCWP Ergonomics Team by discussing specific ergonomic problems relating to their areas of responsibility
- encourage workers to promptly report signs and symptoms of suspected WMSDs to the Occupational Safety Department.
- assist in identifying ergonomic hazards and stressors in the workplace
- take action to eliminate or minimize ergonomic risk factors associated with WMSDs
- enforce the use of required measures to control ergonomic risk factors
- attend ergonomics training when provided
- support WMSD prevention training to employees when provided
- inform the Ergonomics Team of plans for new or modified operations, jobs, or procedures
- ensure employees with signs/symptoms of WMSDs are promptly evaluated by the Ergonomics Coordinator or authorized treating physician.
- ensure employees participate in efforts to remove ergonomic risk factors from their processes
- accommodate medical restrictions for employees with WMSDs

The Occupational Safety Director/ Ergonomics Coordinator :

- coordinates projects for the JDCWP Ergonomics Team
 - provides evaluation, medical management, and follow-up of WMSDs
 - applies the case management process to employees with WMSDs; this can include, but is not limited to: following up with all physicians on employee progress, inviting physical therapists or physicians to view the job the employee is doing to ensure no danger for re-injury or aggravation exists, and following-up with the employee on a weekly basis
-
- prioritizes and performs worksite analyses
 - assists supervisors in selecting the appropriate control measures to eliminate or minimize ergonomic risk factors

- evaluates the effectiveness of the implemented control measures in eliminating or minimizing risk factors
- investigates reported or suspected WMSDs
- assists the supervisors with modifying the workplace to accommodate medical restrictions
- establishes on-going surveillance process for JDCWP
- compiles injury/illness data to determine WMSD incidence, severity, and restricted workday rates in problem jobs and provides this information to the JDCWP Ergonomics Team and the JDCWP management staff.
- reviews the results of reported WMSDs and risk factor data for trends
- provides training to JDCWP Ergonomics Team and committee members in the basic concepts of Job Safety Analysis (JSAs), ergonomics, ergonomic worksite analysis and methodology, the administration of the Job Requirement/Physical Demand Survey, and use of assessment or measuring tools
- analyzes results of worksite analyses and body pain and discomfort survey for association among ergonomic risk factors, employee discomfort, and reported WMSDs
- reports results of these analyses to the JDCWP Ergonomics Team and the JDCWP Management Staff
- provides ergonomics awareness and prevention of WMSD training to supervisors and all JDCWP employees
- evaluates the effectiveness of the controls in reducing employee discomfort and WMSD incidence
- manage and implement the JDCWP Ergonomics program
- maintains appropriate recordkeeping and documentation
- reviews plans for new or modified operations to ensure ergonomic design principles have been considered

Methods and design engineers assist the JDCWP Ergonomics Team members on an as needed basis in the design of new equipment, processes, or tools to eliminate or reduce ergonomics hazards.

JDCWP employees:

- participate in activities designed to anticipate, recognize, evaluate, and control ergonomics risk factors
- provide suggestions for improving the work environment regarding potential or actual ergonomic risk factors
- promptly report signs/symptoms of WMSDs to their supervisor and to the Ergonomics Coordinator
- attend training
- comply with the required control measures that reduce ergonomic risk factors.

The Process

The basic elements of the JDCWP Ergonomics Program include:

- identifying potential problem jobs-use the body pain and discomfort survey, employee complaints, or as accident investigation (last resort)

- validating problem jobs-measuring
- analyzing problem jobs-determining the root cause of the risk factor
- implementing control measures to reduce employee risk factors
- anticipating ergonomic design needs for new or changed jobs
- providing medical case management
- training and educating employees and supervisors
- recordkeeping and
- **ensuring employee involvement in the job improvement process**

Identifying potential jobs: Using JSAs, suspected WMSD cases, trend analyses, etc. the JDCWP Ergonomics Team lists the jobs with the potential risks for developing WMSDs. The list of potential problem jobs is refined whenever new information becomes available. This can also be accomplished using the body pain and discomfort survey or employee complaints.

Trend Analysis

The Safety Department will use a variety of data sources for trend analysis. Examples of these sources include but are not limited to:

- Worker's Compensation Claims data
- OSHA 200 Logs
- Accident Investigation Forms
- Trend analysis using JDCWP safety and ergonomics database

Proactive Measures

JDCWP management, non-supervisory personnel, engineering personnel, and others may request the JDCWP Ergonomics Team perform an ergonomic worksite analysis for jobs/tasks or processes they suspect may be a potential problem area for ergonomic risk factors.

Methods engineers and design engineers coordinate with the JDCWP Ergonomics Team for review of new products, processes, tools, equipment, or planned changes to existing products/and production methods, to avoid ergonomic risk factors and the costs of retrofitting. The goal is to integrate ergonomic analysis in the initial design phases, using the best available technology.

Validating Problem Jobs

Potential problem jobs may be validated by the administration of the body pain and discomfort survey. JDCWP Ergonomics Team members administer the survey; the analysis is performed by Ergonomics Coordinator.

The Ergonomics Team presents their findings of the analyses. These analyses help determine whether an association can be shown between risk factors, employee discomfort, and WMSD trends.

Also, to validate problem jobs, a variety of measurement tools may be used: spring scale measurements to calculate pull and push forces, scale to measure weights to be lifted or lowered, and the NIOSH lifting equation.

Analyzing Problem Jobs

JDCWP Ergonomics Team members, who have been trained in the ergonomics process, will conduct the ergonomic worksite analyses. These analyses target the risk factors associated with the areas of the body that have been identified as having pain, discomfort, illness, or injury. Where practical, videotaping of the job will be done to assist in the evaluation and to compare and contrast changes in tasks and risk factors. Each worksite analysis attempts to either match risk factors with known solutions or quantify risk factors so solutions can be devised to reduce the risk.

When risk factors have been identified, the Ergonomics Team determines what types of control measures are available and if they would reduce risk in each particular case. The first person consulted is the employee doing the job, however.

Control Measures

Control measures include engineering, administrative controls, and personal protective equipment. Engineering controls are the preferred and first-line method of control when and where they are feasible. These measures include manipulating or changing the design of the job, workstation, tools, or equipment used by the workers. If permanent engineering controls cannot be immediately implemented, administrative measures to modify or minimize the identified risk factors are put into place. Examples of these are: training, PPE, or job rotation.

Work practice controls generally involve changing or improving procedures routinely followed by the workers. These practices include appropriate tool selection, proper orientation of the work, and arrangement of work surfaces.

Administrative controls consist of workplace requirements that reduce the duration, frequency, and forcefulness of ergonomic stressors. They may be a cost-effective and useful adjunct to engineering and work practice controls. *The disadvantage of administrative controls is that the measures can effectively mitigate the risk factors only when the workers' behavior is carefully regulated.*

Personal protective equipment such as gloves, or padding can help control risk factors such as temperature, vibration, or contact stress. Gloves and padding must be carefully selected for fit, thickness, and material to be effective. The selection must also take other safety hazards into account such as moving parts, pinch points, chemicals, etc. This equipment is provided at no cost to the JDCWP employee.

Wrist splints, back braces, and other such devices are not considered personal protective equipment and will be provided only under the direction of a qualified health care practitioner as a therapeutic device or during implementation of engineering controls to eliminate the problem.

Effectiveness of Controls

After the recommended controls have been in place and are in use, they will be reevaluated by the JDCWP Ergonomics Team to ensure no new ergonomic risk factors are introduced in the work area. When the recommended controls have been used for 6 months, the JR/PD survey will be readministered. The results will be compared to the initial survey. Reduced employee discomfort is a good indicator that the control measures implemented are effective and a good measure of the effectiveness of the Ergonomics Team in general.

Quality Performance Indicators for the Ergonomics Team

The JDCWP Ergonomics Team tracks the following quality performance indicators (at least annually) for validated problem jobs to determine the effectiveness of the JDCWP Ergonomics Program. They include but are not limited to:

- The number of workers trained
- Percentage of jobs evaluated
- Percentage of recommended controls implemented
- # of ergonomics projects effectively implemented
- WMSD incidence rate (using the number of workers in the problem job as denominator)
- WMSD severity rate
- WMSD restricted workday rate
- Body pain and discomfort survey past/present results

Medical Management

Medical management reduces WMSDs through early diagnosis and treatment. The Ergonomics Coordinator will participate in the worksite analyses and coordinate other health care professional involvement as indicated. Each employee, in the Ergonomics Awareness Training programs, will receive information about the importance of early reporting, and the process of reporting. Supervisory personnel may request evaluation if their employees report symptoms or if a significant change in production is noted and they suspect a medical cause.

When an employee presents to the Ergonomics Team with complaints of WMSDs, the employee is referred to the company physician, then the Ergonomics Coordinator acts as the Case Manager and employee advocate to ensure the employee receives prompt, quality, and cost-effective care.

The Ergonomics Coordinator or authorized treating physician may recommend that an employee return to the same job with temporary duty restrictions during their recovery or rehabilitation. The employee will provide the area supervisor with the written restrictions so that they may ensure that the employee's assigned tasks comply with the restrictions. In treating WMSDs, compliance with medical restrictions is critical to rapid recovery and

the avoidance of permanent disability. The JDCWP Ergonomics Team members will assist supervisors in accommodating duty restrictions as needed.

Training and Education

The Ergonomics Team will review all WMSD training and education materials used to promote consistency and avoid miscommunication. In the training efforts, a balance must be achieved between providing enough information for workers to recognize early signs of WMSDs and avoiding the promotion of placebo effects or interference with health care providers' ability to determine the validity of the disorder.

The Ergonomics Team will provide initial and periodic awareness education to supervisors and employees. The awareness training can take many forms including classes, briefing updates, project documentation, videos, etc. The objective of the training is to make all workers aware of the benefits of seeking appropriate medical care before symptoms of WMSDs progress to chronic disability. Awareness education will cover:

- Description of WMSDs
- Ergonomic risk factors associated with WMSDs
- Recognition of signs and symptoms associated with ergonomic disorders
- Importance of early medical intervention and reporting process
- Information about the JDCWP Ergonomics Program

Supervisors will also be given training specific to jobs that have been identified as potential problem areas, their responsibilities in the JDCWP Ergonomics Program, Job Safety Analysis methods, and control methods.

Training will be appropriately documented and filed.

Employee Involvement

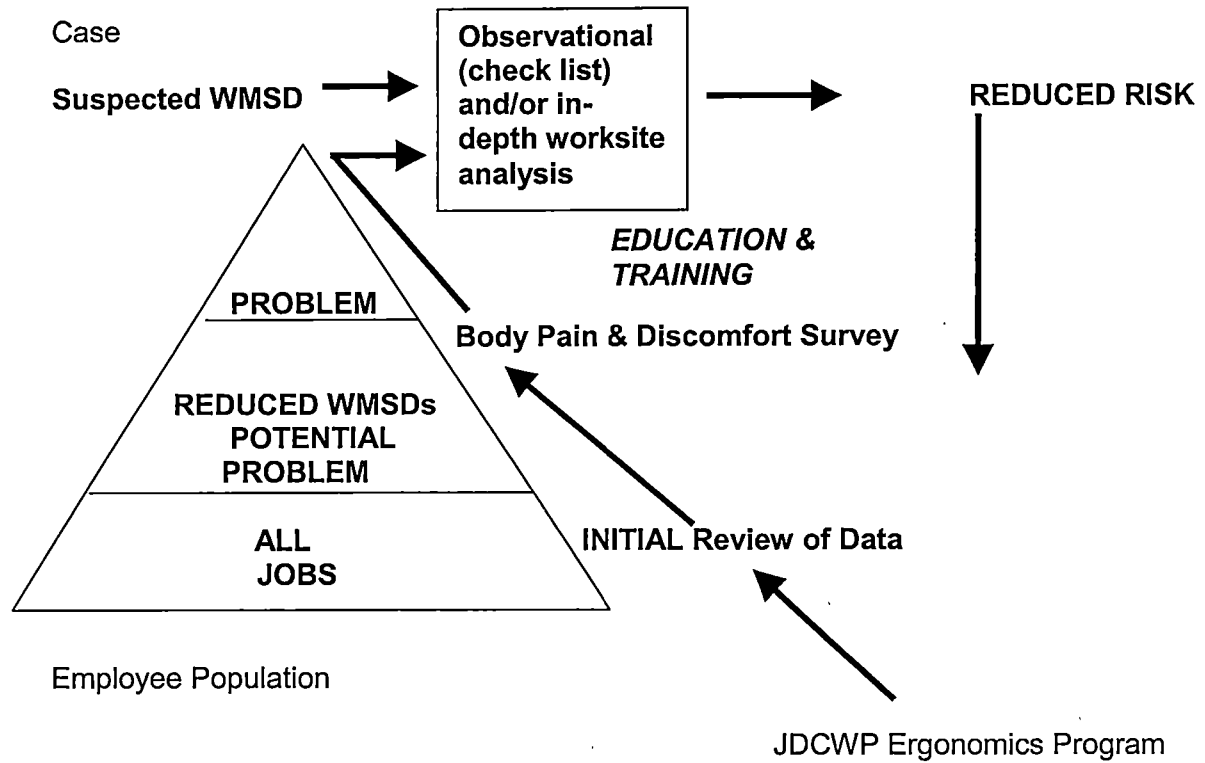
Employees doing the work are the real experts and a vital link to effective problem solving. The JDCWP Ergonomics Team will actively solicit employee input as much as possible in identifying problems and selecting control measures to reduce risk.

Worksite Analysis

Worksite analysis targets the risk factors associated with employee discomfort and recommends controls to minimize or eliminate the exposure. The JDCWP Ergonomics Team will consult on all worksite analyses performed and in selection of the recommendations for control measures to ensure that the solutions are not applied to tasks that are done at a frequency or duration that does not risk WMSDs to avoid wasting resources.

Where a basic observational worksite analysis is determined to be inadequate, the JDCWP Ergonomics Team , may do a more in-depth analysis which quantifies the exposures to the extent practical. Examples of methods used in a detailed analysis are: Vibrometry measurements, application of the NIOSH Lifting Equation, Grip and Pinch Measurements, and Postural Analysis.

JDCWP ERGONOMICS PROGRAM OVERVIEW



Appendix B

**Bureau of Labor Statistics
Log and Summary of Occupational
Injuries and Illnesses .**

NOTE: This form is required by Public Law 81-536 and must be kept in the establishment for 5 years. Failure to maintain and post can result in the issuance of citations and assessment of penalties. (See posting requirements on the other side of form.)

RECORDABLE CASES: You are required to record information about every occupational death; every nonfatal occupational illness; and those nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid). (See definitions on the other side of form.)

[illegible]

U.S. Department of Labor

For Calendar Year 19

Page 2

Form Approved
O.M.B. No. 1220-0022

Company Name						Establishment Name						Establishment Address						Form Approved O.M.B. No. 1220-0022																																																																																											
Extent of and Outcome of INJURY												Type, Extent of, and Outcome of ILLNESS																																																																																																	
<table border="1"> <tr> <th colspan="2">Injury Related</th> <th colspan="4">Medical Injuries</th> <th colspan="2">Injuries Without Lost Workdays</th> </tr> <tr> <th>Enter DATE of death.</th> <th>Enter a CHECK if injury involves days away from work, or days of restricted work activity, or both.</th> <th>Enter a CHECK if injury involves days away from work.</th> <th>Enter number of DAYS away from work.</th> <th>Enter number of DAYS of restricted work activity.</th> <th>Enter a CHECK if no entry was made in columns 1 or 2 but the injury is recordable as defined above.</th> <th colspan="2"></th> </tr> <tr> <td>(1)</td> <td>(2)</td> <td>(3)</td> <td>(4)</td> <td>(5)</td> <td>(6)</td> <td colspan="2"></td> </tr> </table>												Injury Related		Medical Injuries				Injuries Without Lost Workdays		Enter DATE of death.	Enter a CHECK if injury involves days away from work, or days of restricted work activity, or both.	Enter a CHECK if injury involves days away from work.	Enter number of DAYS away from work.	Enter number of DAYS of restricted work activity.	Enter a CHECK if no entry was made in columns 1 or 2 but the injury is recordable as defined above.			(1)	(2)	(3)	(4)	(5)	(6)			<table border="1"> <tr> <th colspan="7">Type of Illness</th> <th colspan="2">Illness Related</th> <th colspan="5">Nonfatal Illnesses</th> <th colspan="2">Illnesses Without Lost Workdays</th> </tr> <tr> <th colspan="7">CHECK Only One Column for Each Illness (Use asterisk if form for pneumoconiosis or permanent tracheitis.)</th> <th>Enter DATE of death.</th> <th>Enter a CHECK if illness involves days away from work, or days of restricted work activity, or both.</th> <th>Enter a CHECK if illness involves days away from work.</th> <th>Enter number of DAYS away from work.</th> <th>Enter number of DAYS of restricted work activity.</th> <th>Enter a CHECK if no entry was made in columns 1 or 2 but the illness is recordable as defined above.</th> <th colspan="2"></th> </tr> <tr> <td>Occupational skin diseases or disorders</td> <td>Dust (inhalation of the lungs)</td> <td>Respiratory conditions due to toxic agents</td> <td>Relating to joints of arms or hands</td> <td>Illnesses due to physical agents</td> <td>Disorders due to physical agents</td> <td>Disorders associated with repeated trauma</td> <td>All other occupational illnesses</td> <td>(8)</td> <td>(9)</td> <td>(10)</td> <td>(11)</td> <td>(12)</td> <td>(13)</td> <td>(14)</td> <td>(15)</td> </tr> <tr> <td>(a)</td> <td>(b)</td> <td>(c)</td> <td>(d)</td> <td>(e)</td> <td>(f)</td> <td>(g)</td> <td>(8)</td> <td>(9)</td> <td>(10)</td> <td>(11)</td> <td>(12)</td> <td>(13)</td> <td>(14)</td> <td>(15)</td> </tr> </table>												Type of Illness							Illness Related		Nonfatal Illnesses					Illnesses Without Lost Workdays		CHECK Only One Column for Each Illness (Use asterisk if form for pneumoconiosis or permanent tracheitis.)							Enter DATE of death.	Enter a CHECK if illness involves days away from work, or days of restricted work activity, or both.	Enter a CHECK if illness involves days away from work.	Enter number of DAYS away from work.	Enter number of DAYS of restricted work activity.	Enter a CHECK if no entry was made in columns 1 or 2 but the illness is recordable as defined above.			Occupational skin diseases or disorders	Dust (inhalation of the lungs)	Respiratory conditions due to toxic agents	Relating to joints of arms or hands	Illnesses due to physical agents	Disorders due to physical agents	Disorders associated with repeated trauma	All other occupational illnesses	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
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Appendix C

ACCIDENT INVESTIGATION REPORT (Factories/Foundries)

1. EMPLOYER/UNIT	2. ACCIDENT FILE NO.
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INJURED EMPLOYEE DATA *To be completed by First Aid Dept. — First two sections*

3. EMPLOYEE NAME AND ADDRESS					
4. SOCIAL SECURITY NO.	5. AGE	6. SEX	7. CLOCK NO.	8. DEPT. NO. AND NAME	9. SHIFT
10. OCCUPATION			11. SENIORITY CLASS NO.	12. SENIORITY DATE	13. NO. OF MONTHS ON JO

ACCIDENT AND ILLNESS DATA

14. DATE OF ACCIDENT OR ILLNESS		TIME	AM	PM	15. PLACE OF ACCIDENT OR ILLNESS
16. WAS PLACE OF ACCIDENT OR ILLNESS ON EMPLOYER'S PREMISES?		Yes ☐	No ☐	17. DID EMPLOYEE DIE?	Yes ☐
		No ☐		No ☐	18. DESCRIBE INJURY OR ILLNESS IN DETAIL, AND INDICATE PART OF BODY AFFECTED
19. NAME AND ADDRESS OF PHYSICIAN					
20. NAME AND ADDRESS OF HOSPITAL					

ACCIDENT DESCRIPTION *Information from here on to be completed by employee's supervisor and routed as shown on back of form.*

21. WHAT JOB OR TASK WAS EMPLOYEE DOING WHEN INJURED OR BECAME ILL?	22. PART & OPERATION NO.
23. HOW DID ACCIDENT OR ILLNESS OCCUR? (Be specific — How, what, why, where and when)	
24. NAMES OF WITNESS	
25. NAME THE OBJECT OR SUBSTANCE WHICH DIRECTLY INJURED THE EMPLOYEE OR CAUSED THE ILLNESS	

COMPLETE THIS SECTION IF A SPRAIN/STRAIN INJURY WAS INVOLVED:

26. IF LIFTING TASK INVOLVED, GIVE WEIGHT OF OBJECT LIFTED	27. MAJOR MANUAL TASK INVOLVED	For Office Use OSHA LOST WORK DAY CASE
28. TYPE OF CONTAINER (if involved)		
29. IF LIFTING TASK INVOLVED, GIVE WEIGHT OF OBJECT LIFTED	30. LENGTH OF SAFETY TRAINING (Ask Employee)	31. HOW LONG AGO WAS SAFETY TRAINING GIVEN? (Ask Employee)
32. IS THERE A JOB SAFETY ANALYSIS ON THE JOB?	33. WHEN WAS JSA LAST REVIEWED WITH EMPLOYEE?	34. WAS THE ACCIDENT OR ILLNESS THE RESULT OF A VIOLATION OF A KNOWN FACTORY SAFETY RULE?
35. ARE FACTORY SAFETY RULES POSTED IN THE DEPT.?	36. DATE A PERSONAL OR GROUP SAFETY CONTACT WAS LAST MADE WITH THE EMPLOYEE	
37. WAS EMPLOYEE WEARING REQUIRED PERSONAL PROTECTIVE EQUIPMENT?	38. IF NOT, NAME PERSONAL PROTECTIVE EQUIPMENT NOT WORN	
39. IF A FOOT INJURY RESULTED, WAS EMPLOYEE WEARING FOOT PROTECTION?	40. IF YES, WHAT TYPE WAS WORN?	

EVALUATION

26. IF LIFTING TASK INVOLVED, GIVE WEIGHT OF OBJECT LIFTED	27. MAJOR MANUAL TASK INVOLVED	28. TYPE OF CONTAINER (if involved)	29. IF LIFTING TASK INVOLVED, GIVE WEIGHT OF OBJECT LIFTED	30. LENGTH OF SAFETY TRAINING (Ask Employee)	31. HOW LONG AGO WAS SAFETY TRAINING GIVEN? (Ask Employee)	32. IS THERE A JOB SAFETY ANALYSIS ON THE JOB?	33. WHEN WAS JSA LAST REVIEWED WITH EMPLOYEE?	34. WAS THE ACCIDENT OR ILLNESS THE RESULT OF A VIOLATION OF A KNOWN FACTORY SAFETY RULE?	35. ARE FACTORY SAFETY RULES POSTED IN THE DEPT.?	36. DATE A PERSONAL OR GROUP SAFETY CONTACT WAS LAST MADE WITH THE EMPLOYEE	37. WAS EMPLOYEE WEARING REQUIRED PERSONAL PROTECTIVE EQUIPMENT?	38. IF NOT, NAME PERSONAL PROTECTIVE EQUIPMENT NOT WORN	39. IF A FOOT INJURY RESULTED, WAS EMPLOYEE WEARING FOOT PROTECTION?	40. IF YES, WHAT TYPE WAS WORN?
Yes ☐	No ☐	Yes ☐	No ☐	Yes ☐	No ☐	Yes ☐	No ☐	Yes ☐	No ☐	Yes ☐	No ☐	Yes ☐	No ☐	Yes ☐

2931C-5/81

(Continued on reverse side)

41. CAUSAL FACTORS (Events & conditions that contributed to accident)
(A) EQUIPMENT-RELATED:

41. CAUSAL FACTORS (Events & conditions that contributed to accident)
(A) EQUIPMENT-RELATED:

(B) ENVIRONMENT-RELATED:

(C) PEOPLE-RELATED:

(D) MANAGEMENT-RELATED:

42

43. DID YOU DISCUSS INJURY OR ILLNESS WITH EMPLOYEE AFTER INCIDENT AND REVIEW WAYS TO PREVENT A RECURRENCE?

Time Out

Time Inc.

Time Inc.

Hospital:

Supervisor:

Gen. Supervisor**Gen. Supervisor**

Divisional Supt.

Suppl. of 141g

Safety Director

Date of Report.

Prepared by

Official Position

☐ Fatality (Col. 1 & 2)☐ Lost workday case (days away from work) (Col. 3 & 10)

_____ No. of days away from work (Col. 4 & 11)

☐ Lost workday case (restricted activity) Col. 5 & 12)

No. of days of restricted work activity (Col. 5 & 12)

☐ Non-fatal case without lost workdays (Col. 8 & 13)

Appendix D

Body Part Discomfort Survey

Date 01-23-01

1. Department Boom 2. Job Title Welder
3. Approximately how long have you been performing your current job? 6 months
4. Do you currently or periodically experience pain or discomfort that you believe may be the result of, or aggravated by your present job?

Yes X No

(If you answered "no" to the above question, do not continue.)

5. Did you first experience this pain in your present job? Yes No X

If "no", please indicate the job you were in when the pain first appeared.

Homecell Rear subs

6. Do you believe this pain or discomfort is the result of, or aggravated by a specific tool or task within your job? Yes X No

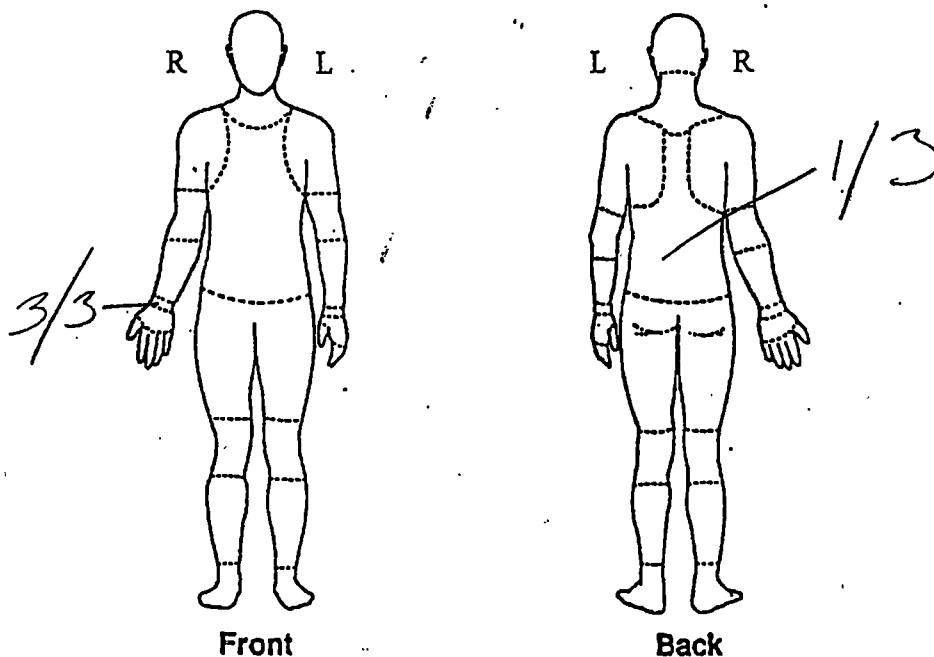
If "yes", which tool or task? Constant Rotation of hand

(over)

7. On the following front and back body part diagrams, make an indication within or near any body region in all the places where you experience work related discomfort. Use two numbers. The first number should reflect the intensity of that discomfort, the second number the frequency - according to the following scales:

Intensity	Frequency
1 - Just Noticeable	1 - Seldom
2	2
3 - Some Discomfort	3 - Occasional
4	4
5 - Moderate Discomfort	5 - Frequent
6	6
7 - Very Uncomfortable	7 - Almost Always
8	8
9 - Unbearable	9 - Constant

For example, if you have some discomfort frequently in your right elbow, you would put at 3-5 at or near the right elbow area on the diagram.



Appendix E

**Safety or Ergonomics
Suggestion Form**

FORM MUST BE FILLED OUT COMPLETELY

DATE: _____

Name: _____

Shift: _____

Dept. Name _____

Description of Your Work Station: _____

What specific area/object does your suggestion apply too?

What is your suggestion for improving this area/object?

(USE BACK IF NECESSARY)

How do you think your suggestion will affect employees in this area?
(ex. Improve postures, improve safety, less repetition, etc)

Appendix F

WALKTHROUGH SURVEY FORM

LOCATION: _____ DATE: _____

COMPLETED BY: _____

DEPARTMENT: _____

[illegible]

COMMENTS:

Appendix G

ERGONOMICS INNOVATION WORKSHEET

DEPARTMENT _____

JOB _____

STEPS OF THE JOB

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

SHIFT ☐ 1ST ☐ 2ND ☐ 3RD

NORMAL OPERATIONS ☐ YES ☐ NO

IF NO, DESCRIBE _____

SUMMARY-ACTION ITEMS

Based on your findings what are the action items from this evaluation?

Action items can include both:
 1. Recommendations to make specific changes
 2. Assignments to investigate an issue further

ACTION ITEM

PARTY RESPONSIBLE

DEADLINE

ERGONOMICS ISSUES

DIRECTIONS: This column serves as a "mind-jogger" to help identify issues. The purpose is to help you think about the job, rather than document precise job conditions.

If the checklist is not always appropriate, indicate this on the right hand column. For example, if the job is repetitive only at certain times, mention when.

IDEAS FOR IMPROVEMENT / COMMENTS

DIRECTIONS: This side of the page is more important.

If any questions are answered "yes", "high", "extreme", etc., list what improvements may be possible. Include employee and supervisor comments.

HAND / WRIST

Wrist repetitions: Left: ☐ low ☐ medium ☐ high
Right: ☐ low ☐ medium ☐ high

Bent wrist:
Left: ☐ mostly neutral ☐ often bent ☐ severely bent
Right: ☐ mostly neutral ☐ often bent ☐ severely bent

Gripping force: Left: ☐ light ☐ medium ☐ heavy
Right: ☐ light ☐ medium ☐ heavy

Vibrating tool:
☐ none ☐ low ☐ heavy

Pressures on the palm: ☐ none ☐ light ☐ heavy

Static load on hand/wrist: Left: ☐ none ☐ occasional ☐ constant
Right: ☐ none ☐ occasional ☐ constant

☐ Power Tool
☐ Different Tool
☐ Improved Tool
☐ Dampen Vibration
☐ Layout Changes
☐ Tilted Work Surface
☐ Work Methods
☐ Angled Tool Grip
☐ Improved Tool Grip
☐ Use Power Grip
☐ Grip Wrap
☐ Automate Job
☐ Fixture For Product
☐ Better Gloves
☐ Better Maintenance
☐ Eliminate Task

ARM

Arm repetitions: Left: ☐ low ☐ medium ☐ high
Right: ☐ low ☐ medium ☐ high

Elbow away from body:
Left: ☐ neutral ☐ medium ☐ extreme*
Right: ☐ neutral ☐ medium ☐ extreme*
(* above or behind shoulder)

Pushing/pulling force on arm: Left: ☐ light ☐ medium ☐ heavy
Right: ☐ light ☐ medium ☐ heavy

Static load on arm: Left: ☐ none ☐ occasional ☐ constant
Right: ☐ none ☐ occasional ☐ constant

☐ Power Assisted Press
☐ Mechanical Assist
☐ Change Layout
☐ Tilted Work Surface
☐ Tilted Packaging Box
☐ Use Machines
☐ Use Fixture For Part
☐ Use Fixture For Tool
☐ Bend Tool Handle
☐ Improved Heights
☐ Arm Supports
☐ Counter Balance Tool
☐ Counter Balance Arms
☐ Eliminate Task

IDEAS / COMMENTS

BACK		IDEAS / COMMENTS
Repetitive back motions: Loads or forces on back: Lifting ☐ low ☐ medium ☐ high Carrying ☐ low ☐ medium ☐ high Pushing ☐ low ☐ medium ☐ high Pulling ☐ low ☐ medium ☐ high Awkward postures: Bending over ☐ low ☐ medium ☐ extreme* Bent neck ☐ low ☐ medium ☐ extreme Twisting ☐ low ☐ medium ☐ extreme Other ☐ low ☐ medium ☐ extreme (* or constant)	☐ Add Another Lifter ☐ Reduce Weight Lifted ☐ Raise Load Off The Floor ☐ Lower Load To Shoulder ☐ Redesign Package ☐ Add Handles ☐ Use Scissors Lift ☐ Use Power Tilter ☐ Change Layout ☐ Use Tilted Surface ☐ Use Mechanical Aid ☐ Automate Job	
SITTING/STANDING		IDEAS / COMMENTS
Stand constantly on a hard surface: ☐ no ☐ yes Inadequate chair: ☐ no ☐ yes Stay in one position constantly: ☐ no ☐ yes	☐ Add Foot Rest ☐ Use Anti-fatigue Mats ☐ Use Cushioned Insoles ☐ Better Stool/Chair ☐ Sit-lean Stand	
HEIGHTS AND REACHES		IDEAS / COMMENTS
Long reaches: ☐ ok ☐ depends on individual ☐ all employees Work done at uncomfortable heights: ☐ ok ☐ depends on individual ☐ all employees Work surface heights in poor relationship with each other: ☐ no ☐ yes Employees bump into things: Head ☐ no ☐ yes Arms ☐ no ☐ yes Body ☐ no ☐ yes Knees ☐ no ☐ yes Feet ☐ no ☐ yes Employees lean against edge or uncomfortable equipment surface: ☐ yes ☐ no	☐ Reduce Surface Size ☐ Tilted Work Surface ☐ Provide Cut-outs ☐ Use Lazy Susan ☐ Spring Load Bins ☐ Adjustable Stand ☐ Removable Stands ☐ Chutes And Hoppers ☐ Smaller Lot Size ☐ Adjustable Work Height ☐ Adjustable Chair ☐ Adjustable Platform ☐ Align Work Heights ☐ Pad Edges ☐ Eliminate Obstacles ☐ Redesign Job	

TOOL DESIGN		IDEAS / COMMENTS
Grip excessively large or small:	☐ no ☐ yes	☐ Supply Smaller Tools
Sharp edges or pressure points on grip:	☐ no ☐ yes	☐ Supply Larger Tools
Does tool "jerk" when used:	☐ no ☐ yes	☐ Modify Tool Handle
Is tool too heavy:	☐ no ☐ yes	☐ Use Torque Bar
Does tool vibrate:	☐ no ☐ yes	☐ Counter Balance Tool
Is tool designed for right-handers only:	☐ no ☐ yes	☐ Use Lighter Tool
		☐ Fixture Tool
		☐ Ambidextrous Tool
		☐ Dampen Vibration
		☐ Supply Gloves
		☐ Eliminate Job
WORK METHODS		IDEAS / COMMENTS
Are there significant differences in the way various employees do the job:	☐ no ☐ yes	☐ Video Tape Methods
If yes, is one method better:	☐ no ☐ yes	☐ Motion Analysis Study
Do any employees need additional training to help improve smooth work methods:	☐ no ☐ yes	☐ Employee Training
		☐ Redesign Job
		☐ Employee Meetings
		☐ Standardize Job
		☐ Standard Tool Location
		☐ Standard Part Location
ABNORMAL CONDITIONS		IDEAS / COMMENTS
Equipment not functioning smoothly:	☐ n.a. ☐ yes	☐ Maintenance Needed
Product piled up:	☐ n.a. ☐ yes	☐ Work Load Balanced
Double handling:	☐ n.a. ☐ yes	☐ Work Flow Analysis
Hot/cold air discharges directly on workers:	☐ n.a. ☐ yes	☐ Ventilation Deflectors
Poor lighting	☐ n.a. ☐ yes	☐ Supply Fan
Floor needs repair/unusually slippery:	☐ n.a. ☐ yes	☐ Task Lighting
Any other similar issues:	☐ n.a. ☐ yes	☐ Increase Lighting
		☐ Floor Maintenance
		☐ Replace Lights
		☐ Good Housekeeping
		☐ Machine Maintenance
		☐ Better Parts

EMPLOYEE DISCOMFORT

Where do employees typically experience the most discomfort?

Hands/Fingers:	☐ none	☐ low	☐ medium	☐ high
Wrists:	☐ none	☐ low	☐ medium	☐ high
Forearms:	☐ none	☐ low	☐ medium	☐ high
Elbows:	☐ none	☐ low	☐ medium	☐ high
Shoulders:	☐ none	☐ low	☐ medium	☐ high
Neck:	☐ none	☐ low	☐ medium	☐ high
Back:	☐ none	☐ low	☐ medium	☐ high
Legs:	☐ none	☐ low	☐ medium	☐ high
Feet:	☐ none	☐ low	☐ medium	☐ high

QUALITY

Do any of the ergonomic issues contribute to errors, scrapped products, inefficiencies, lower yields, extra costs, etc.?

☐ no ☐ yes

These questions are often best answered by a group in the conference room.

OVERALL

Compared with other jobs in this facility, the ergonomic risk factors are:

☐ low ☐ medium ☐ high

What is (are) the worst part (s) of this job?

Are any of the following feasible?

ADMINISTRATIVE CHANGES

- ☐ Job Enlargement
- ☐ Job Rotation
- ☐ More Frequent, Shorter Rest Breaks
- ☐ Exercise Breaks
- ☐ Reduced Workload
- ☐ Improvements in Work Methods

INNOVATION POTENTIAL

What improved types of tools are possible?

Are fixtures or hold down devices possible?

What types of mechanical assists might be used?

What changes in layout would help?

What could provide more mobility in work posture?

Would improvements in the overall material handling system help?

Would changes in the overall work process help?

Is there a completely different way of doing the job?

Provide sketch here (if useful)

IMPORTANT: Turn to cover page and fill out *Action Items* section!

EVALUATOR(S) _____

DATE _____

Appendix H

Microsoft PowerPoint - [ErgoConf]

File Edit View Insert Format Tools Slide Show Window Help

Times New Roman 24 B I U

Weld Fixture Clamps

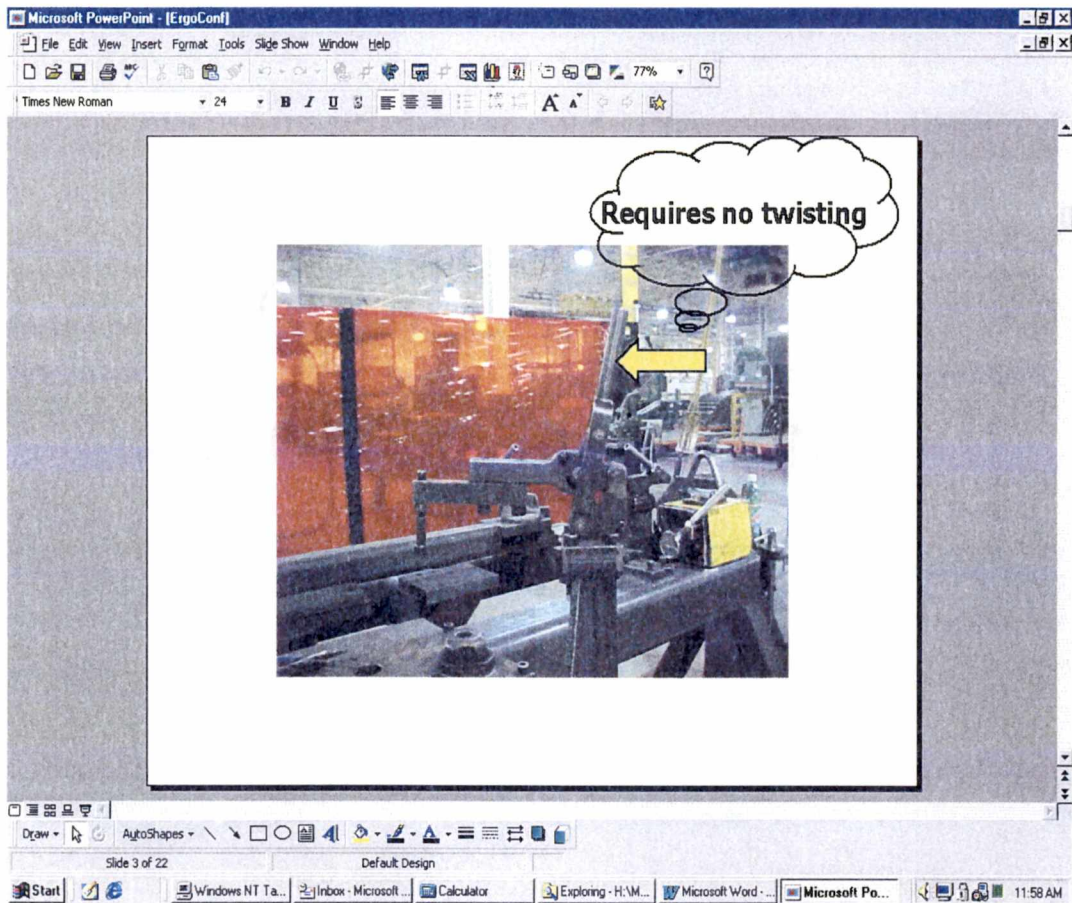
12 clamps: 4 fixtures

Must manually turn with applied force

8 turns per cycle

Slide 2 of 22 Default Design

Start Windows NT T... Inbox - Microsoft ... Calculator Exploring - H:\M... Microsoft Word - ... Microsoft Po... 11:57 AM



Microsoft PowerPoint - [ErgoConf]

File Edit View Insert Format Tools Slide Show Window Help

Times New Roman 24 B I U

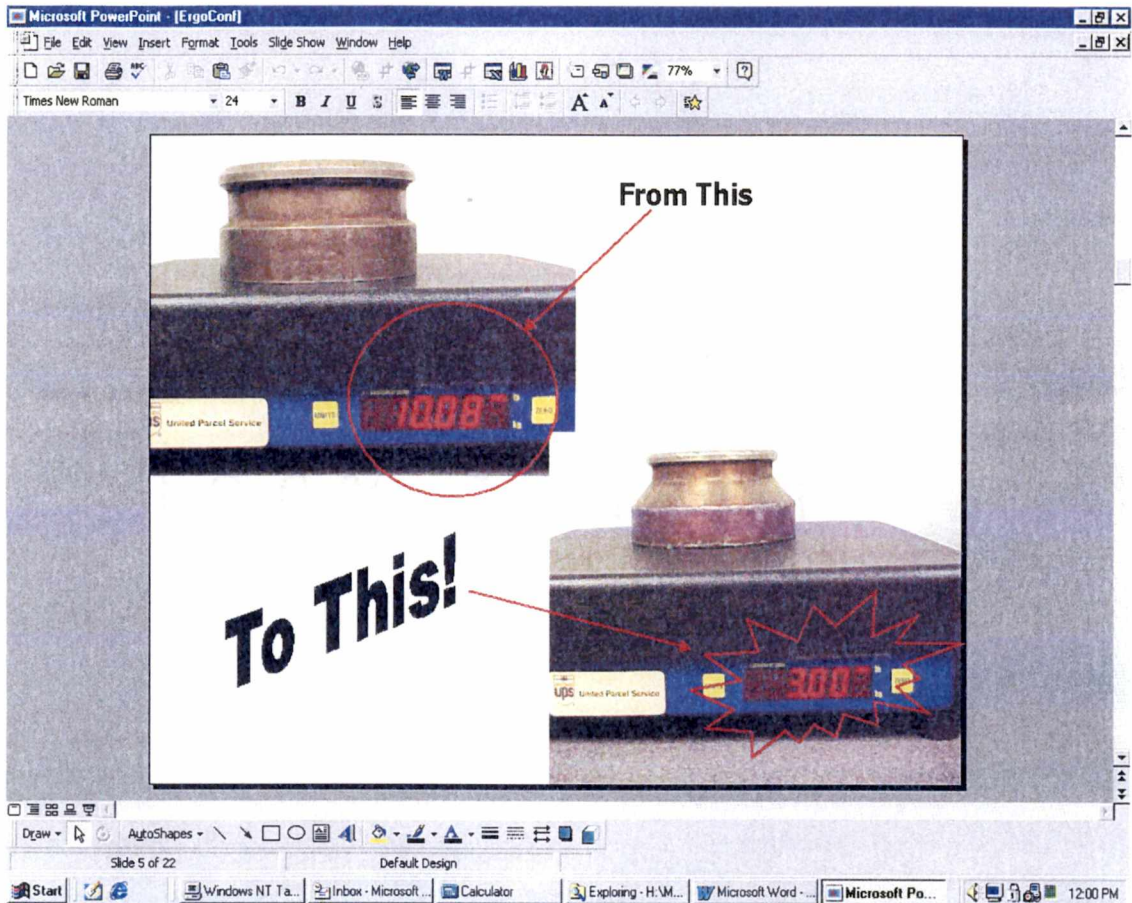
Steel Locators

10 lb steel locator;
One-handed lowering with
awkward posture



Slide 4 of 22 Default Design

Start Windows NT T... Inbox - Microsoft ... Calculator Exploring - H:\M... Microsoft Word - ... Microsoft Po... 11:59 AM



Microsoft PowerPoint - [ErgoConf]

File Edit View Insert Format Tools Slide Show Window Help

Times New Roman 24 B I U

ROPS Assembly Method



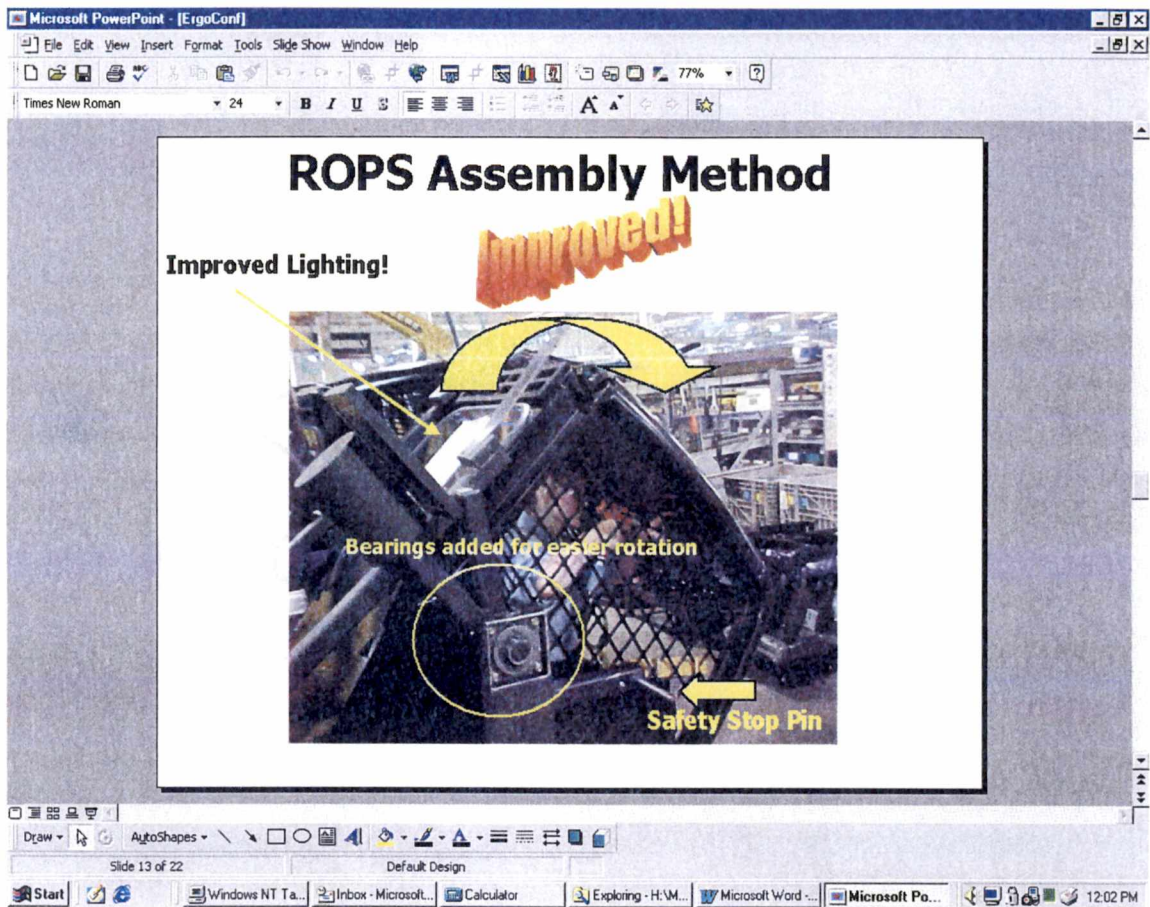
Ouch!

Cycle Time ~12mins

Produced neck, shoulder, & elbow problems

Slide 12 of 22 Default Design

Start Windows NT Ta... Inbox - Microsoft ... Calculator Exploring - H:\M... Microsoft Word - ... Microsoft Po... 12:01 PM



Vita

Jennifer Lynne Lipford-McMullen was born in Dyersburg, Tennessee on April 23, 1973. She grew up in Kingsport, Tennessee, attended high school at Sullivan South, and graduated in May of 1991. After high school, she attended the University of Tennessee, Knoxville. She graduated in December of 1995 with a Bachelor's of Science degree in Engineering Science and Mechanics, with a concentration in Biomedical Engineering.

After working as an office manager for 4 months, she obtained a job with National Seating Company in Vonore, Tennessee in April of 1996. There she worked as a manufacturing engineer for 9 months assisting with QS9000 implementation and overseeing any production issues with the press and welding areas of the factory. She then took a job as a product design engineer for 6 months and designed seating components using solid modeling software and the finite element method. Finally, she worked as a seat comfort engineer and project engineer for one year. In this role, she designed methods to test comfort levels of seats along with overseeing issues of several automotive OEMs. In the summer of 1998, she enrolled in the University of Tennessee, Knoxville Graduate School as an Industrial Engineering student, to further pursue her career goals with human factors and ergonomics. She has attended school entirely through the Distance Education program in order to continue working full- time.

In July of 1998, she began working for John Deere in Loudon, Tennessee as a production engineer for 18 months. In this role she did basic industrial engineering functions and promoted ergonomics. Since January of 2000, she was appointed as ergonomics coordinator.

In this role, she leads an ergonomics team of two technicians and manages the ergonomics program at John Deere.

She was married in August of 1999 and is expecting her first child in June of 2001.