An Analysis of Ergonomic Risk Factors Relating to

Strains at Company XYZ

by

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ABSTRACT

The purpose of this study was to evaluate the type as well as magnitude of ergonomic-related risk factors that may be present in the inspector and packer operations at Company XYZ. In order to achieve this purpose various goals were developed to quantify the presence of as well as extent of common risk factors (i.e., force, posture, duration, temperature extremes and repetition) that may be present in the inspector and packer operations. Analyze past injury/illness-based losses that have occurred with employees who work inspector and packer operations-related jobs. To identify the extent that Company XYZ is engaged in management-based practices that are conducive to preventing the occurrence of musculoskeletal injuries/illnesses. The tools used to evaluate the extent of ergonomic-related risk factors included job analysis, employee survey and analysis of past injury and illness-based losses. The researcher was able to determine the risk factors (force, posture, duration, temperature extremes and repetition) associated with ergonomic-based losses. It appears that while the overall workers compensation expenses may be decreasing at Company XYZ, the worker compensation claim costs associated with only MSDs, CTDs and RMDs are continuing to increase. The types of ergonomic risk factors which were found in the production area were forward flexion of the neck and back, twisting of the spine and flexion of the hands and wrists. With the results of this data engineering and administrative controls were recommended to eliminate or reduce ergonomic risk factors.

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CHAPTER I: INTRODUCTION

It appears that the occurrence of work-related injuries and illnesses, specifically cumulative trauma disorders (CTDs), repetitive motion disorders (RMDs) and musculoskeletal disorders (MSDs) which are caused by ergonomic hazards, are increasing in the United States. According to the Occupational Safety and Health Administration (OSHA), in recent years there has been a dramatic increase in work-related injuries and illnesses caused by ergonomic hazards such as CTDs, RMDs and in particular, MSDs. It has been estimated that more than 50% of the American workforce will suffer from MSD injuries, leading to employers paying between $15 billion and $20 billion in workers' compensation for MSDs every year (Spellman & Whiting, 2000). In the plastic industry, MSDs account for numerous injuries, which are related to activities such as manual material handling, removing and picking parts due to repetitive motions, as well as the need for individuals to exert high forces and assume non-natural/awkward postures (Ohio Bureau of Workers' Compensation, 2002).

Company XYZ (termed XYZ because of confidentiality) is a plastic thermoforming and extrusion company that employs 444 people in four locations around the United States. The location of the four sites consists of two located in Wisconsin and one in both North Carolina and Arkansas. The total number of team members in Wisconsin is 323, while North Carolina has 67 and Arkansas has 54.

Company XYZ's operation runs 24 hours a day, four days a week. The remaining three, 12-hour shift days take place on the weekends (Friday through Sunday) except for specific holidays that the company is closed. The majority of team member's work four, 10-hour days per week and during the busy seasons, when mandatory overtime is generally required. The average age of team members is 41 years old and the majority of the team members have been working at Company XYZ for over 11.82 years, which indicates an aging workforce and low turnover rate. Production team members, specifically the inspector and packer jobs which require highly repetitive movements, have experienced musculoskeletal-based strains from handling various sized parts as well as from activities associated with adjusting machines. While robotic-based engineering controls, as well as other practices (i.e., job rotation program, job station redesign, awareness training, and material handling systems) have also been implemented, the above repetition and postural-type ergonomic problems that still exist are creating injuries and subsequent worker compensation losses. Therefore, it appears that the Company XYZ's production area inspector and packer operations contain a variety of ergonomic-based risk factors that are contributing to the occurrence of musculoskeletal injuries and worker compensation losses.

Purpose of the Study

The purpose of this study is to evaluate the type as well as magnitude of ergonomic-related risk factors that may be present in the inspector and packer operations at Company XYZ.

Goals of the Study

The goals of this study are to:

1. Quantify the presence of as well as extent of common risk factors (i.e., force, posture, duration, temperature extremes and repetition) that may be present in the inspector and packer operations.

2. Analyze past injury/illness-based losses that have occurred with employees who work inspector and packer operations-related jobs.
3. Identify the extent that Company XYZ is engaged in management-based practices that are conducive to preventing the occurrence of musculoskeletal injuries/illnesses.

Background and Significance

While increases in worker compensation costs are believed to correlate with an aging workforce and low turnover rates at Company XYZ, it is probable that such financial losses are also attributable to the design of the work environment as well as the procedures that the employees utilize to perform their job. With low turnover rates, the likeliness of MSDs, CTDs and RMDs injuries are likely to increase, along with worker compensation costs. By identifying jobs or working conditions that combine postural, repetition and force related risk factors, this may indicate areas that are responsible for the occurrence of musculoskeletal problems. The level of risk associated with developing a musculoskeletal illness/injury often depends on "how long a worker is exposed to these conditions, how often they are exposed, and the level of exposure" (National Institute of Occupational Safety and Health, 2006, 3).

While it is expected that improvements in the design of the inspector and packer work stations would reduce the occurrence of musculoskeletal injuries/illnesses and therefore minimize associated worker compensation costs, it could also be expected that such workplace improvements would decrease other process inefficiency issues like worker absenteeism, product downgrading and low worker morale.

Limitations of the Study

This study has a number of limitations. They have been identified as:

1. It is difficult to determine if MSDs, CTDs, and RMDs are entirely work related or if hobbies outside of work are contributing to such injuries. Because MSDs are a progressive injury, it's hard to pin-point when the exact injury occurred.
2. Previous employment at other companies/jobs may have lead to ergonomic injuries that are not related to the inspector and/or packer positions being studied in this paper.
3. This study is limited to the dates between 2/1/07 and 5/1/07.

Definitions of Terms

Cumulative Trauma Disorders (CTDs). "Is typically the result of an accumulation of stressors, rather than the result of a one-time event" (Chengalur, Rodgers & Bernard, 2004, p. 655).

Duration. "Is the length of exposure to a risk factor" (Ergo Web, 2007).

Ergonomics. "The study of the design of work in relation to the physiological and psychological capabilities of people" (Chengalur et al., 2004, p. 658).

Force. "A physical influence exerted on an object which tends to cause a change in velocity" (Stamler, Jr, 1993, p. 121).

Musculoskeletal Disorders (MSD). "Injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilage and spinal disc" (Ergo Web, 2007).

Posture. "A qualitative description of the general position of the body" (Stramler, Jr, 1993, p. 260).

Repetition. "Is the number of a similar exertions performed during a task" (Ergo Web, 2007).

Repetitive Motion Disorders (RMD). "A family of musculoskeletal or neurological illnesses or symptoms that appear to be associated with repetitive tasks in which forceful exertions of the fingers, or deviations or rotations of the hand, wrist, elbow, or shoulder are required" (Chengalur et al., 2004, p. 672).

Temperature Extremes. "Temperature and humidity are important environmental elements that clearly influence worker comfort" (Sanders, 1997, p. 319).

Workers' Compensation. "An insurance system which provides for payment to employees or their families in the event of an occupational illness, injury, or fatality resulting in the loss of wages, regardless of any negligence" (Stramler, Jr, 1993, p. 385).

CHAPTER II: LITERATURE REVIEW

The purpose of this study was to evaluate the type as well as magnitude of ergonomic-related risk factors that may be present in the inspector and packer operations at Company XYZ. Work-related injuries and illnesses due to ergonomic injuries and illnesses, specifically cumulative trauma disorders (CTDs), repetitive motion disorders (RMDs), and musculoskeletal disorders (MSDs) may lead to an increase in workers compensation costs. Therefore, this chapter will focus on ergonomic related issues including: general industry loss data, aging workforce, ergonomic risk factors, type of ergonomic analysis, types of controls and analysis of effective ergonomic programs.

General Industry Loss Data

It is apparent that throughout the years, general industry loss data indicates that a significant number of MSDs, CTDs and RMDs injury and illnesses are occurring due to ergonomic-based risk factors found in the workplace. MSDs are widespread occupational health problems, and can result in severe consequences for both employees and the employer. MSDs have been a problem in industry for a number of years. Sanders (2004) found the following:

> MSD cases tend to be very costly, largely because of extensive lost time. While the overall average (median) for lost time cases was 6 days, tendonitis and other musculoskeletal disorders averaged a median of 10 to 11 days away from work, and carpal tunnel syndrome averaged 27 days. Cases caused by repetitive motion averaged 19 days of lost time (p. 46).

As the United States moves towards a high-tech society it is probable that the hidden costs of working are occurring as a result of work-related musculoskeletal disorders. "Work-Related Musculoskeletal Disorders (WMSDs) are musculoskeletal disorders caused or made worse by the work environment" (National Institute of Occupational Safety and Health, 2006, 2). According to the National Institute of Occupational Safety and Health (2006), "WMSDs often lead to a reduced worker productivity, lost time from work, temporary or permanent disability and an inability to perform job tasks and an increase in workers compensation costs" (2). It is likely that work-related injuries such as MSDs are difficult to diagnose because the physical damage incurred by the human body doesn't produce the basic signs and symptoms of a typical work-related injury. While there may be numerous situations in the workplace that may cause injury to the human body, McMahan and Phillips (1999) sum it up well by stating that "given that the average worker spends over one-third of his/her time on the job, the work environment is an appropriate place for creating effective ergonomic design" (p. 201).

Specifically focusing on ergonomic based injuries and illnesses, research indicates that the manufacturing of plastic products is above average for the rate of accidents in U.S. Manufacturing. According to the Ohio Bureau or Workers' Compensation, "the rate of occupational injuries in lost workdays nationally was 21 percent higher for plastics processing in 1997 than for all U.S. manufacturing" (Ohio Bureau of Workers' Compensation, 2002, 3). OSHA, in 2000 indicated that 241,800 illnesses associated with "repeated trauma" were reported in the United States, with 69% in the manufacturing sector (as cited in Sanders, 2004). In the plastic industry, many injuries are musculoskeletal-related, and caused by cumulative trauma (Ohio Bureau of Workers' Compensation, 2002). Work activities in the plastic industry, include removing and packaging parts, along with material handling, have been associated with the occurrence of CTDs (Ohio Bureau of Workers' Compensation, 2002). With the above data presented based on general industry data loss, it appears that effective loss prevention controls need to be implemented into the workplace to minimize the presence of certain risk factors and therefore reduce the cost associated with CTD and MSD-created injuries and illnesses.

Aging Workforce

It is generally accepted that the physical aging process brings about certain limitations in an individual's abilities. According to Sanders (2004), "as a whole the world is aging because of increasing life expectancy and decreasing population growth" (p. 11). Research has indicated workers may have to remain in the work force longer due to the decrease in population growth and the expanding economy (Schwerha & McMullin, 2002). As the United States is experiencing a shift in the aging workforce, according to McMahan and Phillips (1999), the median age of a worker in the workforce in the year 2000 was 40 years. McMahan and Phillips also went on to state:

> It is crucial for us to acknowledge the current demographic changes in the workforce and to address: (a) how Cumulative Trauma Disorders (CTDs) impact the aging worker and (b) what potential ergonomic solutions might best reduce the debilitating effects of these illnesses, enhance quality of life in the working individual, and reduce the tremendous cost to businesses and our nation (p.199).

It is apparent that normal aging of the body, including wear and tear, are factors in the occurrence of CTDs. "These musculoskeletal changes include: (a) a reduction in joint mobility and manual dexterity; (b) a decrease in muscle strength; and (c) a slowing of reaction and movement times" (McMahan & Phillips, 1999, p. 200). Various forms of repeated exposure over time and changes in the older workers reaction time, body resilience and depth perception most likely correlate with a higher risk of injury, even though this group tends to have fewer injuries overall (Sanders, 2004). This disproportionate relationship between the perceived probability of injury occurrence and the actual frequency of injury indicates that business/industry may need to be vigilant in promoting the prevention of employee losses.

It appears that the health of aging workers in relation to the risk of developing a CTD should be a concern for employers trying to stay competitive in industry. Organizational, individual and environmental aspects may be considered when implementing cost-effective designs that may reduce older workers' risk of injury and illness. These designs are likely to "minimize the risk of developing a CTD, create a better quality of life for workers and reduce the tremendous financial losses and medical costs to companies and the economy" (McMahan & Phillips, 1999, p. 202). In order to prevent the occurrence of CTDs in employees, it is probable that the organization would need to first identify the ergonomic risk factors that contribute to such losses.

Ergonomics Risk Factors

Common risk factors related to ergonomic based injuries and illnesses such as MSD, CTD and RMDs include force, posture, repetitive motions, temperature extremes and duration. "Cumulative trauma disorders occur in the musculoskeletal and nervous systems and may be caused or aggravated by repetitive motions, forceful exertions, vibration, mechanical compression (hard and sharp edges), or sustained or awkward postures" (McMahn & Phillips, 1999, p. 199). Given that the American Industrial

Hygiene Association (2006) has identified that cumulative trauma disorders are a major cause of lost time in many labor-intensive industries (13), such as manufacturing and plastic molding industries, it is probable that there would be a high need for these business/industrial entities/companies to analyze the work environment for such risk factors and eliminate those which are the greatest threat to the organization.

"In order to properly analyze and correct these factors, job-related tasks must be evaluated for each of the risk factors" (American Industrial Hygiene Association, 2006). According to Sanders (2004), it is extremely difficult to isolate risk factors because several risk factors usually occur together in work environments (p. 197). While it may be difficult to isolate the risk factors which contribute to the occurrence of CTD's.

Force.

It is apparent that force occurs in almost all types of activities. For example force may be used on a work piece, lifting or holding a tool. "In industry, force is commonly expressed as the amount of effort required by a worker to overcome external loads through pushing, pulling, grasping, or handling objects" (Sanders, 1997, p. 135). The act of dynamically lifting a work piece and the act of statically holding that piece in position both require force, generated by muscles and transmitted through tendons, and exerted by body segments on the work piece (Sanders, 2004). According to Sanders (1997), force has been implicated as a factor in CTDs, especially when combined with other risk factors (p. 135). "Another important ergonomic factor is force as related to grip . . . in gripping action, parts of the hand are used in mechanical opposition to each other to exert force on an object and hold it in place" (Sanders, 1997, p. 200). Therefore, it appears that while performing force type activities at the workplace, ergonomic controls that will likely reduce ergonomic-based injury and illness should be implemented.

Posture.

It appears that the type of posture a worker assumes when performing a specific task correlates with workstation design. If the dimensions of the workstation are inappropriate to the worker, the likelihood of discomfort increases (Pheasant & Haslegrave, 2006). Postures which go past the range of comfort often lead to "level of discomfort will probably increase gradually as the joint posture becomes more extreme, but will obviously depend on the length of time for which the posture is held and on the general body postures" (Pheasant & Haslegrave, 2006, p. 106). It appears that variations in working postures are desirable to avoid levels of discomfort where potential injury and illness may occur.

It is apparent that work in awkward postures can be harmful when movements extend tissues beyond the normal range of motion, causing a tear or strain, and that it is especially harmful when awkward movements are combined with force (Sanders, 1997). "The rules of good body mechanics suggest that neutral body postures are most efficient and effective" (Sanders, 1997, p. 318). "Work that incorporates extremes of wrist flexion and extension and radial and ulnar deviation may cause problems, especially when combined with grasp . . . constant stretching and compression of the nerves against adjacent tissues may contribute to CTS" (Sanders, 1997, p. 141). It appears that while employees are working, neutral body postures will likely decrease the level of problems associated with awkward postures.

Repetitive motions.

Repetition may be defined as the same motion being performed within a given time period (Sanders, 2004). According to the National Institute of Occupational Safety and Health (1997), in recent years, reports of repetitive motion injuries have risen dramatically in workplaces across the country. These problems, frequently termed "cumulative trauma disorders" are being reported at alarming rates in all types of workplaces (1). The National Institutes of Neurological Disorders and Stroke (2006) indicate that repetitive motion disorders (RMDs) are a family of muscular conditions that result from repeated motions performed in the course of normal work or daily activities, and therefore it appears to affect individuals who perform repetitive tasks while working. "RMDs occur most commonly in the hands, wrists, elbows, and shoulders, but can also happen in the neck, back, hips, knees, feet, legs, and ankles" (National Institute of Neurological Disorders and Stoke, 2006, 1). With RMDs on the rise in the workplaces it appears that controls that help reduce repeated motions may help reduce the occurrence of RMDs to the worker.

It is likely that workers may be exposed to many repetitive tasks while working and it appears that repetitive trauma disorders increase when multiple factors are introduced, such as "work environment, job duties, equipment, and how you use your body." Repetitive disorders can decrease when "increased awareness of your posture and work habits are necessary to enable you to work safely and avoid the problems associated with repetitive trauma disorders" (University of California – Los Angeles, 2006). The most common occurrences of repetitive movements involve the fingers, wrists, and neck (Sanders, 1997, p. 318). In occupational safety and health fields, it appears that repetitive injuries to muscle, other connective tissues, and the joints of the human body have become a major problem. "MSDs account for large portions of occupationally-reported illness and injury as well as worker compensation costs" (Chengalur, Rodgers & Bernard, 2004, p. 449). Researchers now understand the processes that can lead to overexertion due to repetitive activities. With this knowledge, engineering as well as managerial interventions can prevent the occurrence of repetitive injuries (Kroemer, 2006). It is apparent that research has shown that interventions to help reduce and eliminate repetitive motions will likely reduce ergonomic related losses.

Temperature extremes.

It is apparent that temperature extremes, such as heat and cold exposure, can be a considerable concern as it relates to the interaction that exists between workers and their work environment. When workers are exposed to either heat or cold stress in the workplace, the environment may not be suitable workplace for workers. "When there is good balance in the heat flow with little physiological adjustment, the environment is generally considered comfortable. When the balance is disturbed so that there is a significant physiological involvement, discomfort and health effects are more likely." (Chengalur et al., 2004, p. 589). It has been found that heat stress may lead to increase levels of overexertion injuries and frequency of these incidents (Chengalur et al., 2004). "Cold stress is more associated with loss of cognitive and psychomotor function than with increased cardiopulmonary demands. While cold-related disorders are possible, the decreases in manual manipulation performance and increased risk for accidents and injuries are important effects of cold stress" (Chengalur et al., 2004, p. 589). It is apparent that the type of environment that a worker is exposed to specifically, temperature extremes related to hot and cold stress, directly affects a person's ability to perform work and ultimately my lead to health issues.

Duration.

Duration is defined as the length of exposure to a risk factor (Ergo Web, 2007). It appears that the duration of a given task likely contributes to the risk level experienced by the workers. It is likely that with situations where workers are exposed to long durations and moderate physical activity that a worker needs longer breaks, which may allow the body to recover (NC State University, 2007). In addition, it is probable that combing the risk factor of duration with other risk factors such as force, posture, repetitive motions and temperature extremes may accelerate the occurrence and magnitude of ergonomic-based injury and illness.

Type of Ergonomic Analysis

There does exist a variety of accepted ergonomic tools, which can be used to determine the risk factors of the job in relation to the human body. Following is a summary of these analytical methods:

BRIEF™ survey.

The BRIEF™ Survey stands for Baseline Risk Identification of Ergonomic Factors. The BRIEF™ Survey is an initial screening tool to determine ergonomic acceptability (See Appendix A). This tool is used to examine nine body areas (left and right hands and wrists, elbows, shoulders and neck, back and legs) for ergonomic risk factors and physical stressors. The survey identifies risks associated with posture, force, duration and frequency when observing the nine body areas. Each of the nine categories is scored to determine risk ratings. The risk ratings are used to determine high, medium or low risk for each body area. With risk ratings, prioritization of interventions can be made. The last portion of the survey identifies physical stressors, which include vibration, low temperature, soft tissue compression, impact stress and glove issues.

NIOSH lifting equation.

The NIOSH Lifting Equation is used to determine manual lifting and lowering weight limits. Safe weight limits for manual lifting jobs can be determined using the revised NIOSH lifting guide (See Appendix B). "There are two key components to the guide–the lifting index and the recommended weight limit–which can help determine if a job is safe" (Peate & Lunda, 2002, p. 112). The recommended weight limit (RWL) is defined for a specific set of task conditions as the weight of the load that "75 percent of female and 99 percent of male workers can lift safely" (Peate & Lunda, 2002, p. 112). The RWL reflects the potential hazard or physical strain related to the lifting task. RWL can be calculated using information from load constant, horizontal, vertical, distance, asymmetric, frequency and coupling multipliers. Once the RWL is determined the lifting index can be assessed. The lifting index provides an estimate of the physical stress associated with a specific task.

Employee survey.

The employee survey created by Humantech, Inc. identifies areas of discomfort or pain for workers. The body parts are hands/wrists/fingers, elbows, shoulders, neck, back, legs and headache/eye strain. Each body part (i.e. category) uses severity and frequency of pain or discomfort related the employees' job (See Appendix C). The categories are also broken down by into medical issues related to each area of the body. The survey asks two questions related to the job to determine the most difficult part of the job and improvements that can be made to the job.

Analysis of past ergonomic-related losses.

It is generally accepted in the safety/risk control profession that a company's past loss records should be analyzed in order to quantify the extent of human-based scrap that has occurred. To analyze past ergonomic-related losses, a medical data form may be used to determine the body area affected, description of the injury/illness, date the injury/illness occurred on, number of lost days and number of restricted days (See Appendix D). Using the illness/injury portion of the data form may allow for a summarization of body areas most affected. The intent of the form is to allow for prioritization and intervention strategies of a specific task and workstation where loss is occurring.

Using these ergonomic analysis tools, which may allow for trends analysis to be determined for areas that losses are occurring at. Once trends are determined, controls and ergonomic-based interventions and programs may be implemented.

Types of Controls

The use of engineering and administrative hazard control approaches as well as the employment of personal protective equipment (PPE) are deemed to be accepted intervention strategies to eliminate or at least reduce ergonomic risk factors, such as force, posture, duration, temperature extremes and repetition for work related musculoskeletal disorders (WMSDs) (Cohn, Gjessing, Fine, Bernard & McGlothlin, 1997). Following is a summary of these forms of control that are available:

Engineering controls.

According to Cohn et al. (1997), engineering controls are "the preferred approach to prevent and control WMSDs is to design the job–including (1) the workstation layout, (2) selection and use of tools, and (3) work methods–to tale account of the capabilities and limitations of the workforce" (p. 31). The authors recommend the following engineering control strategies to reduce ergonomic risk factors:

- Changing the way materials, parts, and products can be transported
- Changing the process or product to reduce worker exposures to risk factors
- Modifying containers and parts presentation
- Changing workstation layout
- Changing the way parts, tools, and materials are to be manipulated
- Changing tool designs
- Changes in materials and fasteners
- Changing assembly access and sequence

The goal of using engineering controls first is to design the problem out of the process, which may reduce the chances of injury and illnesses. When the risk of traumatic injuries is reduced, MSD conditions may continue to be problematic (Sanders, 2004). Engineering solutions can be determined once tools such as the BRIEF™ Survey and the NIOSH Lifting Equation have identified the most prevalent risk factors. "For example, workstations, work-tools and work methods can be modified to eliminate repetitive movements, excessive forces and/or awkward postures. There are various engineering solutions, each of which may be suitable for certain situations" (Tayyari & Smith, 1997,

p. 176). It is apparent that engineering controls are the first recommended choice due to eliminating or reducing the hazards in the workplace.

Administrative controls.

Reducing shift length, job rotation, scheduling breaks, job variation, work pace and training are all administrative controls that may be implemented by management. Administrative controls are management-dictated work practices and policies, which are designed to reduce or prevent exposures to ergonomic risk factors. It should be noted that engineering controls are the preferred method for preventing and controlling ergonomic risk factor, but when engineering controls are not feasible or not immediately available, administrative controls may be the next option (Tayyari & Smith, 1997).

Personal protective equipment (PPE).

Research has indicated, "one of the most controversial questions in the prevention of WMSDs is whether the use of personal equipment worn or used by the employee (such as wrist supports, back belts, or vibration attenuation gloves) are effective" (Centers for Disease Control and Prevention, 1997). It is probable that personal protective equipment is viewed as the last recommended control made for protection behind engineering and administrative controls. Typical PPE used for ergonomic control may include, but not limited to back belts, wrist splints and braces. The Centers for Disease Control and Prevention (1997) found the following:

> Although these devices may, in some situations, reduce the duration, frequency, or intensity of exposure, evidence of their effectiveness in injury reduction is inconclusive. In some instances they may decrease one exposure but increase

another because the worker has to "fight" the device to perform his or her work (6).

Based on the research found for PPE it is clear that engineering and administrative controls are recommended, before PPE. Unless engineering and administrative controls are not feasible to use, then PPE is recommended. It is apparent through research that the best way to eliminate or control ergonomic risk factors is first through engineering controls, followed by administrative and lastly is personal protective equipment. The more controls that are in place that do not rely on humans, the better the implementations are, especially when the workstation is fit to the person rather than the person fit to the workstation.

Analysis of Effective Ergonomic Programs

It is likely that one effective way to reduce the risk of MSDs within an organization is to establish programs for managing ergonomic based activities. According to Tayyari and Smith (1997), "job demands should not exceed workers' capabilities and limitations. If this is not the case, then the worker is being exposed to work stresses that can adversely affect safety and health as well as the company's productivity" (p. 408). Research has shown that top management must support ergonomic programs if such an effort/system is going to succeed. Therefore, it is likely that ergonomic programs need to consistent with the company's overall goals and objectives. According to Dwyre and Costello, components of an effective ergonomics program include quantifying the problem severity, benchmarking and setting goals, budgeting for the program, educating staff and defining roles, providing injury case management, consider the total solution, don't purchase ergonomic liability, justify improvements and track performance and communicate (Dwyre & Costello, 2001). The key component of effective ergonomic program is to have top managements support. With top management support the program will most likely be implemented more easily, allowing for ergonomic-based risks to decrease. When a program is supported from the top, it will likely meet the goals and objectives of the company.

Summary

A review of literature suggest that that general industry loss indicates that a significant number of MSDs, CTDs and RMD injury and illnesses are occurring due to ergonomic-based risk factors found in the workplace. It appears that plastic manufacturing is above average in relation to rates of accident in U.S. Manufacturing. It is apparent that the world is aging because of increasing life expectancy and decreasing population growth. With the aging workplace it is likely that normal aging of the body including wear and tear are factors in the occurrence of CTDs.

It is apparent that it is difficult to isolate risk factors because several risk factors usually occur together in work environments. It appears that CTDs occur in the musculoskeletal and nervous systems and are caused or aggravated by ergonomic risk factors. A variety of accepted ergonomic tools, which can be used to determine the risk factors of the job in relation to the body are used in industry. The different types of controls used are engineering, administrative and personal protective equipment. The use of engineering and administrative control approaches as well as PPE are deemed to be accepted strategies to eliminate or at least reduce ergonomic risk factors. It is likely that one effective way to reduce the risk of MSDs within an organization is to establish programs for managing ergonomic based activities.

CHAPTER III: METHODOLOGY

The purpose of this study was to evaluate the type as well as magnitude of ergonomic-related risk factors that may be present in the inspector and packer operations at Company XYZ. In order to achieve this purpose, various goals were developed as follows:

1. Quantify the presence of as well as extent of common risk factors (i.e., force, posture, duration, temperature extremes and repetition) that may be present in the inspector and packer operations.
2. Analyze past injury/illness-based losses that have occurred with employees who work inspector and packer operations-related jobs.
3. Identify the extent that Company XYZ is engaged in management-based practices that are conducive to preventing the occurrence of musculoskeletal injuries/illnesses.

The sections that will be addressed in this section include subject selection and description, instrumentation, data collection procedures, data analysis, and limitations.

Subject Selection and Description

Participants were chosen based on the department they work in, specifically focusing on the production area. The participants will include the inspector and packer team members who work at the two facilities in Wisconsin, and one each in North Carolina and Arkansas. In order to promote their involvement in this study, the researcher approached each subject individually in order to ask him/her about participating in the study.

After the participants agreed to participate in the study, the researcher explained in detail the informed consent, survey and the process of returning the completed information. During the explanation of the informed consent, the researcher assured the participants that no names would be linked to the information submitted. It was also explained that by signing the informed consent sheet that the participants had agreed to be part of this research. Next, the researcher explained the survey to the participants. The participants were told that the researcher would be available if questions arose during the completion of the survey. Lastly, the researcher placed the informed consent and survey back into the envelope give it to the participants and asked them to seal the envelope and returned to the Safety Department, addressed to the researcher.

Instrumentation

The following instrumentation was used to collect and analyze the data:

- An Employee Survey created by Humantech, Inc. (See Appendix C). (Humantech Inc., 2003).
    - The survey includes a basic overview of have long the employee has worked at the facility and how long the employee has worked in that particular job
    - The participants fill out a discomfort portion, asking what is the severity and frequency of discomfort or pain on different body parts
    - The survey ends with two questions: what is the most difficult part of the job and what improvements you would like to see for this job?
- Medical Data form created by Humantech, Inc. (See Appendix D). (Humantech, Inc., 2003).

  - "This form is used to capture injury/illness information related to a particular task or workstation for the purposes of prioritization and intervention" (Humantech Inc., 2003).
  - Basic overview of the department and job type and where the injury/illness occurred
  - Breaks the medical data down into categories which include:
    - Body area
    - Description of injury/illness
    - Date
    - Number of Lost Days
    - Number of Restricted Days
  - Lastly, the body areas are marked in an injury/illness summary box
- BRIEF™ Survey – Baseline Risk Identification of Ergonomic Factors (See Appendix A). (Humantech Inc., 2003)
  - Initial screening tool to determine ergonomic acceptability
  - Examines nine body areas for ergonomic risk factors and physical stressors
- NIOSH Lifting Equation Worksheet – National Institute for Occupational Safety and Health (See Appendix B). (Humantech Inc., 2003)
  - Used to determine manual lowering limits and lifting work
  - "There are two key components to the guide–the lifting index and the recommended weight limit–which can help determine if a job is safe" (Peate & Lunda, 2002, p. 112).

    - "The revised NIOSH lifting guide recognizes the importance of dynamic assessment and can help determine safe weight limits for manual lifting" (Peate & Lunda, 2002, p. 112).
- Carry Guidelines Worksheet (See Appendix E). (Humantech Inc., 2003)
    - Breaks the employees job down to site, station, department, shift and product
    - The Carry Guide line determines the maximum acceptable weight using these sections:
        - Gender of the employee performing carry
        - Height of the hands from standing surface while performing the carry
        - Percentage of the population performing the carry
        - Distance of the carry
        - Frequency of the carry

Data Collection Procedures

The process of surveying the inspector and packer team members at Company XYZ allowed for the required data collection. Once the subject had agreed to participate in the study, he/she was provided with a copy of the questionnaire and was allowed to complete such during work time. The survey took approximately 15 minutes for the subject to complete. The subjects were asked to return the survey within one week. An envelope was provided to return the survey in, which was labeled with the researcher's full name. Upon completion of the survey, the subject was asked to seal the envelope before returning it to the Safety Department. After the Safety Department collected the surveys, they were stored in a locked filing cabinet until further analysis was performed.

Data Analysis

The data analysis was performed using the following methodology:

- The workstations were analyzed using BRIEF™ Survey, NIOSH Lifting Equation Worksheet and Carry Guidelines Worksheet.
- Common risk factors (force, posture, duration, temperature extremes and repetition) were quantified using BRIEF™ Survey, NIOSH Lifting Equation Worksheet and Carry Guidelines Worksheet. The process of completing these assessment-based forms will involve the researcher watching the subjects from a safe and unobtrusive viewing distance.
- A review of worker compensation cases and incident reports was performed by focusing on past injury/illness based losses from MSD, RMD and CTD. Company XYZ has provided the researcher with past injury/illness based loss information which did not have any employee identifier information attached to it.
- Management-based practices and procedures that are designed to prevent the occurrence of musculoskeletal injuries/illnesses were analyzed. Company XYZ provided the researcher with any/all policies and procedures, which may identify internal practices related to the identification and control of ergonomic based stressors.
- Past ergonomic assessments for various risk factors were analyzed by the researcher; force, posture, duration, temperature extremes and repetition were reviewed to correlate with the recent forms of analysis that were performed.

Limitations of the study

This study has a number of limitations. They have been identified as follows:

1. It is difficult to determine if MSDs, CTDs, and RMDs are entirely work related or if hobbies outside of work are contributing to such injuries. Because MSDs are a progressive injury, it's hard to exactly pin-point when the injury occurred.
2. Previous employment at other companies/jobs may have contributed to the occurrence of ergonomic injuries that were not related to the inspector and/or packer positions being studied in this paper.
3. This study is limited to data which was collected between the dates between 2/1/07 and 5/1/07.

CHAPTER IV: RESULTS

The purpose of this study was to evaluate the type as well as magnitude of ergonomic-related risk factors that may be present in the inspector and packer operations at Company XYZ. In order to achieve this purpose, various goals were developed as follows:

1. Quantify the presence of as well as extent of common risk factors (i.e., force, posture, duration, temperature extremes and repetition) that may be present in the inspector and packer operations.
2. Analyze past injury/illness-based losses that have occurred with employees who work inspector and packer operations-related jobs.
3. Identify the extent that Company XYZ is engaged in management-based practices that are conducive to preventing the occurrence of musculoskeletal injuries/illnesses.

Instrumentation

An Employee Survey created by Humantech, Inc. was given to the inspector and packer team members at Company XYZ. A Medical Data form created by Humantech, Inc. was used to analyze worker compensation cases and incident reports focusing on past injury/illness based losses from MSD, RMD and CTD. The BRIEF™ Survey, NIOSH Lifting Equation Worksheet and Carry Guidelines Worksheet were used to analyze common risk factors (force, posture, duration, temperature extremes and repetition).

Presentation of Data Collected

To quantify the presence of as well as extent of common risk factors (i.e., force, posture, duration, temperature extremes and repetition) that may be present in the inspector and packer operations, the researcher analyzed the workstations using the BRIEF™ Survey, NIOSH Lifting Equation and Carry Guidelines Worksheet.

BRIEF™ Survey, NIOSH Lifting Equation and Carry Guidelines Worksheet

The researcher examined the inspector and packer operation jobs that are both manual and automated with the analysis tools. It appears through the BRIEF™ Survey that manually picked jobs are cited more possessing times as moderate-to-high hazards in terms of risk factors, than automated jobs (See Appendix F). The data indicates much larger risks associated with manually picked jobs. The NIOSH Lifting Equation for three jobs of the packer position indicated that the actual load weight of the object being lifted was greater then the weight recommended. The Carry Guideline Worksheet that was performed on six jobs for the packer position indicated that all carries were within the maximum acceptable weight limit.

By using the risk identification tools and subsequently analyzing the collected data, hazardous situations could be identified. The regions of body which were identified as being at risk include the neck, shoulders, elbows, hands and wrists and back.

The two posture-related risks associated with the neck are as follows:

- Forward flexion of the neck when the employee is looking down at the web for the inspector job
- Twisting of the neck, which results from placing parts on the pickers table

It appears that the shoulder region is vulnerable to the following risks:

- Adverse posture occurring when the shoulders are raised forward and outward as the worker is reaching for parts on webs at the inspector jobs

- Arms that are raised outward greater then 45 degrees when the worker is picking parts from the side and stacking parts on the picker table
- Arms that are raised forward greater than 45 degrees when the worker is typically reaching for parts on the web, especially when large parts are picked
- Shrugged shoulders that occur when the worker is stacking parts on the picker table
- Arms that occasionally reach behind body when the inspectors are stacking parts on the pickers table
- Posture that are held greater than 10 seconds, and shoulders that are held forward and outward during the picking jobs
- More than 10 pounds of force is exerted by the worker at any given time

The elbow region of the worker's body only had one main issue as follows:

- Elbows may be full extended when the inspector is picking parts out of the web

The moderate-to-high risks associated with hands and wrists are as follows:

- A pinch grip which is greater than two pounds is required by the worker when he/she is picking parts
- Flexion of the hands and wrists is required when the worker is picking parts, especially when he/she is reaching to the far side of larger parts
- A combination of flexed and extended wrist postures, along with ulnar and radial deviations.
- Pinch grip postures that are held longer than 10 seconds

It appears that from the data collected that the back hazards are as follows:

- An unsupported back resulting from having to sit on a stool with no backrest
- A forward flexion posture having to be held for more than 10 seconds

- Forward flexion of the back occurring for greater than two minutes as a result of having to reach to pick parts
- Flexion of the spine forward greater than 20 degrees, when the worker is reaching forward to pick parts, both when seated and standing
- Twisting of the spine which occurs when the worker is placing parts on the picker table
- Sideways bending of the spine which occurs when the worker is picking parts on a few jobs

See Appendix F

Analysis of Past Injury and Illness-Based Losses

The researcher analyzed past injury/illness-based losses that have occurred with employees who work inspector and packer-related jobs. The analysis included the past five years for all locations. The data collected was based on ergonomic risk factors that resulted in MSDs, CTDs and RMDs. Injury and illness-based losses that the researcher focused on occurred in the production area department where the inspector and packers work. The researcher included crew leaders, machine tenders and machine technicians along with inspector and packers because often when the facilities are busy, all of these people inspect and pack parts.

Data collected for Company XYZ from 2001 to 2006.

Wisconsin	
Strain	23
Pain	5
Cumulative Trauma	3
Soreness	1

Table 1. Wisconsin Injury and Illness Losses

As indicated in Table 1, the leading illness and injury-based losses for Company XYZ are strains. At the Wisconsin facilities, the losses are in the following order: strains, pain, cumulative trauma and soreness. The most cited strains were in the back, followed by the wrists. The activities being performed while the strain occurred included lifting boxes above shoulders, boxing parts, grabbing parts ahead of cycle (the cycle time is the amount of time the mold opens and closes in a minute, which means the inspector is attempting to pick parts faster than is necessary), placing boxes on skids as well as inspecting and packing parts. For wrist strains, inspecting and packing parts was the leading cause of injury and illness.

North Carolina	
Strain	8
Cumulative Trauma	5
Soreness	1

Table 2. North Carolina Injury and Illness Losses

Table 2 above indicates that North Carolina's leading ergonomic-based injury and illness are strains, followed by cumulative trauma and soreness. The injury and illness strains are occurring from activities associated with lifting pallets, boxing parts, lifting boxes onto skids, picking and inspecting parts.

Arkansas	
Strain	2
Pain	1

Table 3. Arkansas Injury and Illness Losses

Arkansas has had two strains, which occurred during the picking and inspecting of parts and placing boxes on skids. It should be noted that Arkansas hasn't had an ergonomic-based injury or illness incident occur since 2003.

It appears from the data collected that Company XYZ should be the most concerned about strains that are occurring from jobs that relate to inspector and packer positions. There is some indication that the strain injuries and illnesses are related to employees performing repetitive motion-based activities for multiple years.

See Appendix G

Survey Results

An employee survey was used to determine the possible existence of management-based practices that are conducive to preventing the occurrence of musculoskeletal injury and illnesses. The survey indicated which position the employees currently work in and the department, shift length, job rotation, length of time at the facility, length of time as an inspector and packer operator, possible existence of discomfort or pain, the employee's perception of the most difficult part of job and lastly, potential improvements the employees would like to see for their job. The survey was distributed to the inspector and packer operators working in the production department.

The results of the survey indicated that the shift length the inspector and packer operators work was four, 10-hour days and five hours overtime when it is required.

The first survey question asked how long worked at this facility and how long he/she worked at this particular job (only 1 surveyed employee had been working a different job) at Company XYZ. Following is a summary of the length of time that employees have been working at the packer and inspector positions:

- 19 years
- 22 years, 4 months
- 18 years, 7 months
- 7 years, 1 month
- 7 years
- 21 years total; 8 years as an inspector and packer
- 20 years
- 16 years, 5 months
- 18 years, 4 months
- 4 months
- 14 years, 4 months
- 19 years, 3 months
- 7 years, 10 months

The next question asked the employee, as a result of doing this job, did he/she routinely experience discomfort or pain. The table below is a combination of all survey responses:

Body Parts	L	R	Severity	Severity	Severity	Severity
			1=Mild L & R	2=Moderate L & R	3=Severe L & R	4=Unbearable L & R
Hands/Wrists/Fingers	7	5	5 & 5	7 & 6	1 & 1	0 & 1
Elbows	2	2	6	2	0	0
Shoulders	5	4	0	7	5	2
Neck			1	8	4	2
Back			3	5	3	3
Legs			3	6	1	1
Headache/Eye Strain			5	3	4	1
Other: Feet			0	2 & 2	2	2

Table 4. Total Discomfort Survey – Severity

Body Parts	L	R	Frequency	Frequency	Frequency
			A=Seldom	**B=Often**	**C=Always**
Hands/Wrists/Fingers	7	5	6	8	0
Elbows	2	2	9	1	0
Shoulders	5	4	1	11	2
Neck			2	9	3
Back			3	8	3
Legs			7	6	0
Headache/Eye Strain			7	7	0
Other: Feet			1	3	2

Table 5. Total Discomfort Survey - Frequency

The above two tables are a combination of the data received for the discomfort and pain surveys (See Appendix H) given to the inspector and packer operators. From the data on the two tables it was determined that the workers experienced discomfort or pain in the hands/wrists/fingers, shoulders, neck and back at a moderate level in the severity category and often level in the frequency category. The discomfort or pain in the elbows was mild in the severity category and seldom in the frequency category. The discomfort or pain in the legs resulted in mild severity category with seldom frequency.

Headache/eye strain was mild in severity and often in frequency. Results of discomfort or pain in the feet ranged from unbearable to moderate for severity with a reported frequency of being often.

The final two parts of the survey asked the workers to identify the most difficult part of the job and possible improvements that they would like to see made to the inspector and packer operator jobs. Following are the specific questions and the employees response to such:

What is the most difficult part of this job?

- Lifting heavy boxes and reaching for the parts
- When you have a job where you can't sit; repetition
- Standing for long periods on one person jobs; repetition; picking fast parts
- Working on machines that require frequent repetitive motion from the same body parts for five hours at a time
- Standing for the majority of the day. Some heavy lifting
- Repetitive pain, manually picked jobs seem to be the worse; job rotation not always the best i.e. manual jobs vs. automated jobs
- Being on feet for 10 hours
- Reaching, extending arms up and out
- Some jobs are very fast paced and only have one person on them, sometimes too much work
- Standing for 10 hours on hard floors. The repetition, I think we should, on nights switch every 15 minutes like days does; not have picking tables too low, some are like that and sometimes hurt your back

- 12 hour days = sleep loss; heavy boxes and five high
- When picking jobs from the side of machine. It really hurts my shoulders and also my feet
- Lifting with arms extended. Picking parts and putting heavy boxes above our heads on finished skids

What improvements would you like to see for this job?

- More comfortable chairs for when you are able to pick and sit at the same time. Make job match metal versus steel rule
- More match metal jobs/robot picking jobs
- One person jobs-rotate people off every 2 to 3 hours; rotate them on to something other than another one person job; match metal jobs; keeping better track of schedule board for people in order to keep from getting same people on fast jobs, hard on body picking machines
- Get management to realize machines can't always be run at "warp speed." Too much repetition causes strain and stress on pickers mentally and physically. To fix this problem 1) get younger employees 2) slow machines down 3) more match metal tools 4) more robot picking machines. One machine also causes discomfort due to repetitive bending at the waist and reaching and lifting parts, I don't know how to amend that particular situation
- To find a pair of steel toe shoes that are light and comfortable; the awkward lifting done on certain machines
- More match metal jobs; with molds that are three deep leads to stretching too much

- Make molds shallower – 3 and 4 deep too far to stretch to pick parts
- Put two people on some one person jobs that are expected way too much
- Make sure pickers are comfortable on their jobs with picking table height, not too low or too high; Get floor mats that don't trip you all the time
- Switch every 15 minutes to avoid repetitive motion injuries from happening to people
- They really try to work ergonomically with table adjustments. Rotations and weight limits on boxes. Some machines do not have table adjustments so reaching forward on five up items can be hard
- No jobs being picked from side or long reaches for parts when picking from the front
- Who ever decides how the job is to be picked, how heavy rows of parts are, how many bags we are trying to get the parts in without damaging the bags and boxes and how high we have to lift the boxes. The fact that the most pickers are women between 5' and 5'7" not 6' men. Even if when scheduling people on jobs if the crewleader would think about the height of the picker and match them up-tables could then be adjusted to the picker. We would not have to do as much bending or reaching.

It is apparent from the above survey results that management-based approaches of aligning the work demands to the workers' abilities could be improved upon. With ideas from the inspector and packers, the results from the risk assessment as well as the injury and illness data there exists a strong potential to make ergonomic improvements at Company XYZ.

Discussion

It appears at Company XYZ, that MSDs, CTDs, and RMDs are following the general industry loss trend where injury and illnesses are occurring due to the presence of ergonomic-based risk factors found in the workplace. The severe health problems associated with these types of losses indicate that, although the overall workers compensation expenses may be decreasing at Company XYZ, the worker compensation claim costs associated with only MSDs, CTDs and RMDs are continuing to increase. Research has found that it is likely that work-related injuries, such as MSDs, are difficult to diagnose because the physical damage incurred by the human body doesn't produce the basic signs and symptoms that may be found in other work-related injuries. This data has been found at Company XYZ in the inspector and packer positions where strains from repetition are occurring over the years. The data associated with musculoskeletal-related injuries found in the plastic industry, are similar to what seems to be occurring at Company XYZ. This indicates that many injuries are musculoskeletal-related and caused by cumulative trauma, from activities such as inspecting and packaging parts. With musculoskeletal-related injuries and illnesses that are chronic in nature, an aging workforce which coupled with low turnover rates, may lead to ergonomic-related injury and illnesses from various forms of repeated exposure over time at Company XYZ.

By using different analysis tools, the researcher was able to determine the risk factors (force, posture, repetitive motions, temperature extremes and duration) associated with ergonomic-based losses. It appears that force may be an issue when workers are statically holding or gripping, parts and boxes. At Company XYZ, the inspector and packer positions appear to have posture related issues of the shoulder, back, hands, wrists and fingers, and it is likely that repetitive motion injury and illnesses have increased in the past years and Company XYZ. It is apparent that variations in working postures are desirable to avoid levels of discomfort where potential injury and illness may occur.

With engineering and administrative controls and ergonomic-based management programs, it seems likely that the exposure to ergonomic risk factors may be reduced. The duration inspector and packer operators spend on manual machines and steel rule jobs seem to be the most cited problem area, according to the employee survey. It seems that workers may be exposed to greater risks when they are on a machine that they are performing both the inspector and packer jobs. It appears that the machine is moving too quickly and not allowing for the employee to rest between cycles.

The variety of accepted ergonomic tools, which are used to determine the risk factors of the inspector and packer positions in relation to the human body, allowed the researcher to determine trends and areas where losses are occurring. It appears that inspector and packer operators may be in a position where jobs are exceeding the workers' capabilities. With the results from these tools, engineering and administrative controls can be implemented to improve workstations at Company XYZ.

CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to evaluate the type as well as magnitude of ergonomic-related risk factors that may be present in the inspector and packer operations at Company XYZ. In order to achieve this purpose, various goals were developed as follows:

4. Quantify the presence of as well as extent of common risk factors (i.e., force, posture, duration, temperature extremes and repetition) that may be present in the inspector and packer operations.
5. Analyze past injury/illness-based losses that have occurred with employees who work inspector and packer operations-related jobs.
6. Identify the extent that Company XYZ is engaged in management-based practices that are conducive to preventing the occurrence of musculoskeletal injuries/illnesses.

Instrumentation

An Employee Survey created by Humantech, Inc. was given to the inspector and packer team members at Company XYZ. A Medical Data form created by Humantech, Inc. was used to analysis worker compensation cases and incident reports focusing on past injury/illness based losses from MSDs, RMDs and CTDs. The BRIEF™ Survey, NIOSH Lifting Equation Worksheet and Carry Guidelines Worksheet were used to analyze common risk factors (force, posture, duration, temperature extremes and repetition).

Conclusions

- Based on the data analyzed, it is apparent that the implementation of an ergonomic-based program and the subsequent application of workplace controls are needed at

Company XYZ. While progress has been made with regard to workstation design, robots and job rotation, it seems that additional engineering as well as administrative controls are needed.

- Based on research on aging workforces, it appears that management-based programs need to focus on ergonomic-based risk factors (force, posture, repetitive motions, temperature extremes and duration) related to MSDs, CTDs, and RMDs.
- With regard to injury and illness-based losses, it is apparent that strains are occurring on a chronic base, which potentially leads to greater worker compensation losses.
- Based on the employee survey, job analysis and loss data collected, the risks associated with inspecting parts are repetitive motions, awkward postures and excessive exposure time. Workstation design, design of the product as well as the amount of horizontal reach all seem to contribute to the occurrence of ergonomic-based issues.
- Ergonomic-based risks associated with the packer position awkward postures, repetitive motions and excessive exposure time. Based on the data collected, it seems that the fast paced manual-based jobs, with only one person on that job are where most losses are occurring and where the employees seem to have the most concern.

Recommendations

With engineering and administrative controls being the preferred means of reducing the occurrence of ergonomic-based injuries and illnesses, the researcher recommends the following risk reduction-based controls for Company XYZ:

Engineering Controls.

Elbows.

- Eliminate the need to fully extend the elbows when picking parts. This can be accomplished by knocking parts out of web prior to the point in which they reach the operator.
- Increase the angle of the pick table in order to reduce the need for extended reaches and thus bring the picker and the part closer together

Shoulders.

- Knock the parts out of web prior to the point in which parts reach the operator.
- Angle the pick table downward in a flatter position to encourage a more neutral posture when picking parts from the side, and also lower the table that parts are being set and stacked.
- Bring the picker as well as the part closer together by angling pick table up to reduce the need for extended reaches.
- Alter the manner in which the parts (i.e. amount of product that are stacked in specific rows) are picked to ensure that pickers are encouraged to place parts on table, rather than waiting for the next cycle to set of parts on the table.

Hands and wrists.

- Knock the parts out of web prior to the point in which the parts reach the operator as well as design smaller notches in web to allow for easier part release. Knocking parts out of web prior to the point in which they reach the operator will eliminate some or all of the risk posture issues.
- Angle the table up to encourage a more neutral wrist posture.

Back.

- Management should ensure that all chairs which are used by the worker who inspect parts have adequate back supports and foot rests. More comfortable as well as adjustable chairs would assist the inspector and pickers to pick and sit at the same time.
- Raise and tilt the work toward the worker to provide better access. Use a sit/stand stool to lower the worker and also attempt to locate parts well within arms' reach.
- Position skids at least one or two steps from the beginning of lift when placing the finish product on skid. By implementing this procedure, the redesign of the workstation layout may eliminate trunk twisting by locating objects within arm's reach. Stack parts at a 45 degree angle from the body, rather than a 90 degree angle
- Allow for picker table height's to adjust vertically and on an angle. With adjustable picker tables anthropometric based designs may be used to fit 95% of the workforce.

General Engineering Controls.

- Have more jobs that are match metal (large presses that rapidly cut parts out prior to reaching the workers) and robot picked.
- Potentially slow the speed down or ensure that two workers are inspecting and packing on jobs that are fast-paced.
- Make the molds more horizontally shallow, because when molds are three to four deep, the horizontal reach for the furthest part tends to be excessive.

Administrative Controls.

Neck.

- Train the inspectors to raise and tilt the parts that have been picked, allowing for their neck to be more upright position.
- Ensure that when stacking picked parts, that the parts are at a 45 degree angle from the body, rather than a 90 degree angle.

Hands and wrists.

- Parts are typically held in a pinch position, and therefore it is recommended that management train pickers to place parts on stacker table more often. Possibly work with the design team to engineer a product that would not need to be held in a pinch position.

General Administrative Controls.

- Rotate the employees out of higher stress jobs every two to three hours.
- Try to avoid having the same people being put on fast paced jobs.
- Avoid designing jobs that require the worker to continuously pick from the side or utilize long reaches for parts when picking from the front.
- Consider placing two people on one person jobs that tend to run at a faster-pace.
- Rotate the inspector and packer jobs every 15 minutes to allow for different body motions/parts to be utilized.

Area of Further Research

The researcher recommends topics that should be explored further to help minimize additional risks that currently exist within the organization's process to include the following:

- Expand the analysis of ergonomic-based risk factors to the prototype, shop and tool setup areas of the plant, which may decrease the risk factors related to the inspector and packer operators. By starting from the beginning, controls can be implemented prior to reaching the production floor that may reduce the likelihood of RMD, CTD and MSD issues.
- Expand the number of surveys administrated to include all the production employees. With more surveys to analyze, a more accurate trends analysis may be determined.

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Appendix A: BRIEF™ Survey

BRIEF™ Survey – Baseline Risk Identification of Ergonomic Factors

Version 3.0

Step 1

Complete Job Information

Job Name: ____________ Site: ____________ Station: ____________

Date: ____________ Dept: ____________ Shift: ____________ Product: ____________

Step 2

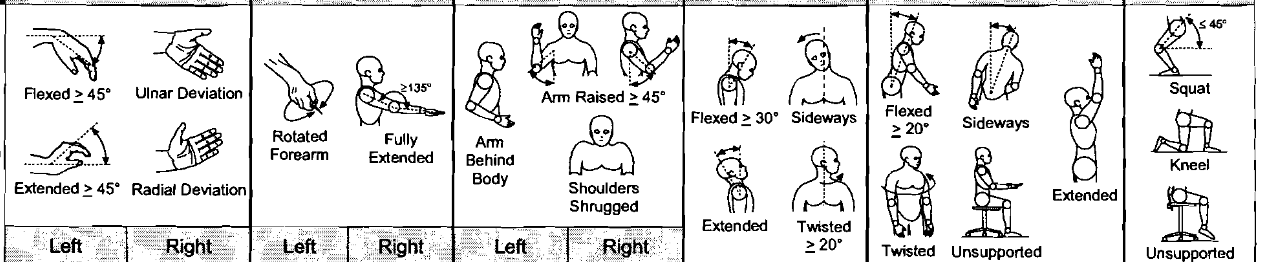
Identify Risks

▼

2a. Mark Posture and Force boxes when risk factors are observed.

▼

2b. For body parts with Posture or Force marked, mark Duration and/or Frequency box(es) when limits are exceeded.



	Hands and Wrists		Elbows		Shoulders		Neck	Back	Legs
	Left	Right	Left	Right	Left	Right			
2a. Posture	☐	☐	☐	☐	☐	☐	☐	☐	☐
Force	Pinch Grip or Finger Press ≥ 2 lb (0.9 kg), or Power Grip ≥ 10 lb (4.5 kg) ☐	☐	≥ 10 lb (4.5 kg) ☐	≥ 10 lb (4.5 kg) ☐	≥ 10 lb (4.5 kg) ☐	≥ 10 lb (4.5 kg) ☐	≥ 2 lb (0.9 kg) ☐	≥ 25 lb (11.3 kg) ☐	Foot Pedal ≥ 10 lb (4.5 kg) ☐
2b. Duration	≥ 10 sec. ☐	≥ 10 sec. ☐	≥ 10 sec. ☐	≥ 10 sec. ☐	≥ 10 sec. ☐	≥ 10 sec. ☐	≥ 10 sec. ☐	≥ 10 sec. ☐	≥ 30% of day ☐
Frequency	≥ 30/min. ☐	≥ 30/min. ☐	≥ 2/min. ☐	≥ 2/min. ☐	≥ 2/min. ☐	≥ 2/min. ☐	≥ 2/min. ☐	≥ 2/min. ☐	≥ 2/min. ☐
Score									
Risk Rating	H M L	H M L	H M L	H M L	H M L	H M L	H M L	H M L	H M L

Step 3

Determine Risk Rating

In the Score box, write the number of risk factor categories (0-4) checked for each body part. Using the table at right, circle the corresponding Risk Rating for each body part. ▶

Score		Risk Rating
3 or 4	=	High (H)
2	=	Medium (M)
0 or 1	=	Low (L)

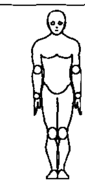
Step 4

Identify Physical Stressors

Mark physical stressors observed:

- ☐ Vibration (V)
- ☐ Low Temperatures (L)
- ☐ Soft Tissue Compression (S)
- ☐ Impact Stress (I)
- ☐ Glove Issues (G)

▶ Use the corresponding letters to show location of stressors. ▶



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Appendix B: NIOSH Lifting Equation Worksheet

NIOSH Lifting Equation Worksheet

Step 1

Complete Job Information

Job Name: ____________ Site: ____________ Station: ____________

Date: ____________ Dept: ____________ Shift: ____________ Product: ____________

Step 2

Fill in the Model Inputs

Step 3

Use the NIOSH Spreadsheet to calculate the Lifting Index

NIOSH Lifting Guidelines

DESCRIPTION

Job Title ____________

Model Inputs:	Enter Data	Multipliers:
Horizontal Location (H) (min 10", max 25")	___ in (10" is best)	HM =
Vertical Location (V) (min 0", max 70")	___ in (30" is best)	VM =
Travel Distance (D) (min 10", max 70")	___ in (10" is best)	DM =
Angle of Asymmetry (A) (min 0°, max 135°)	___ deg (0 is best)	AM =
Coupling (1=good, 2=fair, 3=poor)	___ (1 is best)	CM =
Duration (Enter 1, 2 or 8 hrs. only)	___ hr(s) (1 is best)	Dur =
Frequency (min 0.2, max 15 lifts/min)	___ l/m (0.2 is best)	FM =
Load Weight	___ lb	

Model Outputs:

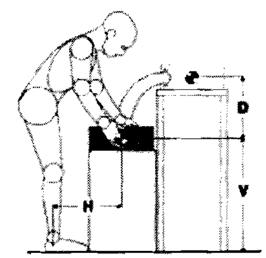
Recommended Weight Limit (RWL): ______ **lb.**

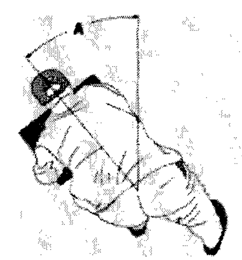
Lifting Index (LI = Load/RWL): ______

Frequency Independent RWL: ______ **lb.**

Frequency Independent LI: ______

Recommendations:





Appendix C: Employee Survey

Employee Survey

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Identification

Job Name: ____________ Date: ____________

Dept: ____________ Analyst: ____________

Tape Seq: ____________ Tape Time: ____________

Workstation Name/Number: ____________

Work Cycle

Shift Length: ____________

Production Standard: ____________

Production Mix: ____________

Rotation? Y N Total Exposure: ____________

Discomfort Survey

How long have you worked at this facility? Months ______ Years ______

How long have you worked at this particular job? Months ______ Years ______

As a result of doing this job, do you routinely experience discomfort or pain in your:

Body Part	L	R	Severity	Frequency	Medical	Comments
Hands/Wrists/Fingers			1 2 3 4	A B C		
Elbows			1 2 3 4	A B C		
Shoulders			1 2 3 4	A B C		
Neck			1 2 3 4	A B C		
Back			1 2 3 4	A B C		
Legs			1 2 3 4	A B C		
Headache/Eye Strain			1 2 3 4	A B C		
Other:			1 2 3 4	A B C		

Severity — 1 = Mild, 2 = Moderate, 3 = Severe, 4 = Unbearable

Frequency — A = Seldom, B = Often, C = Always

What is the most difficult part of this job?

What improvements would you like to see for this job?

Version 3.0

Appendix D: Medical Data

Medical Data

Identification

Job Name: ____________________

Dept: __________ Date: __________

Zone: __________ Analyst: __________

Station: __________ **Record:** __________

Directions

- Record all injuries/illnesses that can be tracked to this workstation.
- Mark the appropriate body areas in the Injury/Illness Summary box.

Injury/Illness Summary
Body Area
Hand/Wrist
Elbow
Shoulder
Neck
Back
Legs

Body Area	Description of Injury/Illness	Date	# Lost Days	# Restricted Days

This form is used to capture injury/illness information related to a particular task or workstation for the purposes of prioritization and intervention. The information for this form can be extracted from the plant medical log, OSHA 200 log, worker's compensation forms, etc. Medical information should be regarded as confidential.

Version 1.0

Appendix E: Carry Guidelines Worksheet

Carry Guidelines Worksheet

Step 1

Complete Job Information

Job Name: ______________ Site: ______________ Station: ______________

Date: __________ Dept: __________ Shift: __________ Product: ______________

Step 2

Fill in the required inputs

Step 3

Use the MMH Guidelines Spreadsheet to calculate the Maximum Acceptable Weight

Carry Guidelines

DESCRIPTION

Gender	
Height	
Percent	
Distance	
Frequency	

Appendix F: Manually-Picked Jobs High and Moderate Hazard Trends (from BRIEF Analysis)

Appendix F: Manually-Picked Jobs High and Moderate Hazard Trends (from BRIEF Analysis)

Body Part	Times Cited High Hazard	Times Cited Moderate Hazard	Recommendations
Neck: Posture Occurring > 2/min (forward flexion when looking down at web	2	6	Raise and tilt objects being viewed to keep neck more upright
Neck: Twisted (mainly when placing parts on the table to the picker's left side	1	6	Stack parts at a 45 degree angle from the body, rather than a 90 degree angle
Neck: Forward flexion (looking down at web)	2	2	Raise and tilt objects being viewed to keep neck more upright
Neck: Posture held > 10 seconds (typically forward flexion of the neck)	1	0	Raise and tilt objects being viewed to keep neck more upright

Body Part	Times Cited High Hazard	Times Cited Moderate Hazard	Recommendations
Elbows: Posture occurring > 2/min (full extension when picking)	0	8	Eliminate the need to fully extend the elbows when picking
Elbows: Full extension (picking parts)	0	8	Knock parts out of web prior to them reaching the operator, bring picker/part closer together, angle pick table more severely to reduce the need for extended reaches

Body Part	Times Cited High Hazard	Times Cited Moderate Hazard	Recommendations
Shoulders: Posture Occurring > 2/min (typically shoulders raised forward and outward when reaching for parts on web)	2	8	Knock parts out of web prior to them reaching the operator
Shoulders: Raised outward > 45 degrees (picking parts from the side, stacking parts on table)	1	6	Knock parts out of web prior to them reaching the operator, angle the table severely downward to encourage a more neutral posture when picking parts from the side, lower the table parts are being set on
Shoulders: Raised forward > 45 degrees (typically reaching for parts on web - especially large parts	2	5	Knock parts out of web prior to them reaching the operator, bring picker/part closer together by angling pick table more severely to reduce the need for extended reaches
Shoulders: Shrug (stacking parts on table)	0	1	Knock parts out of web prior to them reaching the operator, lower table that parts are being stacked on
Shoulders: Behind body (stacking parts on table to the picker's left side	0	1	Knock parts out of web prior to them reaching the operator
Shoulders: Posture Held > 10 seconds (shoulders held forward and outward when picking job	1	0	Knock parts out of web prior to them reaching the operator, alter the way the parts are picked somehow to ensure that pickers are encouraged to place parts on table rather than waiting for parts between cycles in an awkward posture
Shoulders: 10+ lbs. of force	1	0	Knock parts out of web prior to them reaching the operator

Body Part	Times Cited High Hazard	Times Cited Moderate Hazard	Recommendations
Hands and Wrists: Pinch Grip > 2 lbs. (picking parts)	7	1	Knock parts out of web prior to them reaching the operator, smaller notches
Hands and Wrists: Flexion (picking parts, especially when reaching for the far side of a larger part)	6	1	Knock parts out of web prior to them reaching the operator, angle the table more severely to encourage a more neutral wrist posture
Hands and Wrists: Posture Occurring > 30/min (combination of all risk postures)	4	1	Knock parts out of web prior to them reaching the operator, eliminate some or all of the risk postures
Hands and Wrists: Extension (picking parts)	2	1	Knock parts out of web prior to them reaching the operator
Hands and Wrists: Posture Held > 10 sec. (pinch grip)	6	0	Knock parts out of web prior to them reaching the operator, parts typically held in a pinch position, encourage pickers to place parts on table more often
Hands and Wrists: Ulnar Deviation (picking parts)	5	0	Knock parts out of web prior to them reaching the operator, angle of the tables is a problem. When seated or standing the angle of the wrists in relation to the parts is not conducive to good ergonomic practices. The closer to perpendicular the hands and wrists are in relation to the parts, the less the chance that ulnar deviation is a problem.
Hands and Wrists: Radial Deviation (picking parts)	1	0	Knock parts out of web prior to them reaching the operator, similar recommendations to ulnar deviation

Body Part	Times Cited High Hazard	Times Cited Moderate Hazard	Recommendations
Back: Unsupported backs (seated on stools with no backrest)	4	4	Only use seats with back supports and foot rests
Back: Posture held > 10 seconds	4	2	Only use seats with back supports. Raise and tilt the work to provide better access. Use a sit/stand stool to lower the worker. Locate objects well within arms' reach
Back: Posture occurring > 2 min (forward flexion of back when reaching to pick parts	3	2	Raise and tilt the work to provide better access. Use a sit/stand stool to lower the worker. Locate objects well within arms' reach
Back: Flexed forward > 20 degrees (usually to reach forward when picking parts both seated and standing)	1	2	Raise and tilt the work to provide better access. Use a sit/stand stool to lower the worker. Locate objects well within arms' reach
Back: Twisting (when placing parts on table to picker's left side	1	1	Position lift destination at least 1 or 2 steps from beginning of lift for skidding products. Redesign workstation layout to eliminate trunk twisting by locating objects within arm's reach. Stack parts at a 45 degree angle from the body, rather than a 90 degree angle
Back: Sideways bending	1	0	

Appendix G: Injury and Illness-Based Losses for Company XYZ

Appendix G: Injury and Illness-Based Losses for Company XYZ

Wisconsin

Year	Dept.	Job	Injury Category	Injury Description	Activity Performed When Injured
2001	Prod.	Crew Leader	Cumulative Trauma	Numbness in hands	Picking and Inspecting Parts
2001	Prod.	Inspector Packer	Strain	Back strain	Placing boxes on skid, felt pull in back
2001	Prod.	Inspector Packer	Strain	Arm/wrist tingling	Picking and Inspecting Parts
2001	Prod.	Inspector Packer	Strain	Pulled back muscle	Picking and Inspecting Parts
2001	Prod.	Inspector Packer	Soreness	Right shoulder soreness	Picking and Inspecting Parts
2002	Prod.	Inspector Packer	Pain	Back pain	Lifting 30# boxes
2002	Prod.	Inspector Packer	Strain	Back strain	Repetitively working on MM jobs
2002	Prod.	Inspector Packer	Strain	Back strain	Picking and Inspecting Parts
2002	Prod.	Inspector Packer	Strain	Back strain	Reached to grab parts ahead of cycle
2002	Prod.	Machine Technician	Strain	Back strain	Removing tooling from machine and strained back
2002	Prod.	Inspector Packer	Cumulative Trauma	Wrist soreness	Picking and Inspecting Parts

2002	Prod.	Inspector Packer	Strain	Finger strain	Picking and Inspecting Parts
2002	Prod.	Machine Tender	Strain	Back strain	Putting boxes on skid above shoulder height
2002	Prod.	Inspector Packer	Pain	Back pain	Picking and Inspecting Parts
2002	Prod.	Crew Leader	Pain	Cumulative trauma	Repetitive motions over the years
2002	Prod.	Inspector Packer	Strain	Back strain	Lifting a box onto 5th layer of skid
2002	Prod.	Inspector Packer	Pain	Foot pain	Standing for lengthy periods of time
2003	Prod.	Inspector Packer	Strain	Back strain	Lifting a 13# box
2003	Prod.	Inspector Packer	Strain	Wrist Strain	Picking and Inspecting Parts
2004	Prod.	Machine Technician	Strain	Back strain	Picking and Inspecting Parts
2004	Prod.	Inspector Packer	Strain	Wrist Strain	Picking and Inspecting Parts
2004	Prod.	Inspector Packer	Strain	Wrist Strain	Picking and Inspecting Parts
2004	Prod.	Machine Tender	Strain	Back strain	Boxing parts
2004	Prod.	Inspector Packer	Strain	Cumulative trauma	Repetitive motions over the years
2004	Prod.	Inspector Packer	Strain	Back strain	Picking and Inspecting Parts

2004	Prod.	Inspector Packer	Strain	Hand strain	Making boxes
2004	Prod.	Inspector Packer	Strain	Back strain	Picking and Inspecting Parts
2004	Prod.	Machine Technician	Strain	Wrist Strain	Picking and Inspecting Parts
2005	Prod.	Inspector Packer	Strain	Shoulder pain	Picking and Inspecting Parts
2005	Prod.	Machine Technician	Pain	Wrist pain	Repetitive motions over the years
2006	Prod.	Inspector Packer	Cumulative Trauma	Cumulative trauma	Picking and Inspecting Parts
2006	Prod.	Inspector Packer	Strain	Wrist Strain	Picking and Inspecting Parts

North Carolina

Year	Dept.	Job	Injury Category	Injury Description	Activity Performed When Injured
2001	Prod.	Inspector Packer	Strain	Back strain	Lifting pallet
2001	Prod.	Machine Technician	Strain	Arm strain	Boxing parts
2001	Prod.	Inspector Packer	Strain	Back strain	Lifting boxes onto skid
2002	Prod.	Inspector Packer	Cumulative Trauma	Cumulative trauma	Picking and Inspecting Parts
2002	Prod.	Material handler	Strain	Back strain	Hand loading skids
2002	Prod.	Inspector Packer	Cumulative Trauma	Cumulative trauma	Picking and Inspecting Parts

2002	Prod.	Inspector Packer	Strain	Finger strain	Pushing box through tape machine
2003	Prod.	Inspector Packer	Strain	Hip strain	Lifting boxes onto skid
2003	Prod.	Inspector Packer	Strain	Back strain	Picking and Inspecting Parts
2004	Prod.	Inspector Packer	Strain	Back strain	Picking and Inspecting Parts
2006	Prod.	Material handler	Soreness	Wrist soreness	Repetitive motion on Revlon line
2006	Prod.	Material handler	Cumulative Trauma	Cumulative trauma	Repetitive motion on Revlon line
2006	Prod.	Inspector Packer	Cumulative Trauma	Cumulative trauma	Repetitive motion on Revlon line

Arkansas

Year	Dept.	Job	Injury Category	Injury Description	Activity Performed When Injured
2001	Prod.	Inspector Packer	Strain	Back strain	Picking and Inspecting Parts
2002	Prod.	Inspector Packer	Pain	Back pain	Placing boxes on skid, felt pull in back
2003	Prod.	Inspector Packer	Strain	Back strain	Placing boxes on skid, felt pull in back

Appendix H: Total Discomfort Survey Results

Appendix H: Total Discomfort Survey Results

Body Parts	L	R	Severity	Frequency	Medical	Comments	1	
Hands/Wrists/Fingers			1	B			Severity	Frequency
Elbows			1	B			1 = Mild	A = Seldom
Shoulders			2	B			2 = Moderate	B = Often
Neck			2	B			3 = Severe	C = Always
Back			1	B			4 = Unbearable	
Legs			2	B				
Headache/Eye Strain			2	B				
Other:			2	B				

Body Parts	L	R	Severity	Frequency	Medical	Comments	2	
Hands/Wrists/Fingers			2	B			Severity	Frequency
Elbows			1	A			1 = Mild	A = Seldom
Shoulders			3	C			2 = Moderate	B = Often
Neck			3	C			3 = Severe	C = Always
Back			4	C			4 = Unbearable	
Legs			2	B				
Headache/Eye Strain			3	B				
Other: Feet			2	A				

Body Parts	L	R	Severity	Frequency	Medical	Comments	3	
Hands/Wrists/Fingers			1	A			Severity	Frequency
Elbows			2	A			1 = Mild	A = Seldom
Shoulders			2	B			2 = Moderate	B = Often
Neck			2	B			3 = Severe	C = Always
Back			2	B			4 = Unbearable	
Legs				A				
Headache/Eye Strain				A				
Other:								

Body Parts	L	R	Severity	Frequency	Medical	Comments	4	
Hands/Wrists/Fingers			3	B		Gloves - Vinyl & Latex too much - fingers	Severity	Frequency
Elbows							1 = Mild	A = Seldom
Shoulders			Both 3 & 4	B	Seen Doctor	Several strains & pinched nerves (lots of knots)	2 = Moderate	B = Often
Neck			3	B			3 = Severe	C = Always

Back			3	C			4 = Unbearable
Legs			4	B		Feet the most	
Headache/Eye Strain			4	B	Seeing Doctor	Keeping track of when and where here	
Other:							

Body Parts	**L**	**R**	**Severity**	**Frequency**	**Medical**	**Comments**	**5**	
Hands/Wrists/Fingers			1	A			**Severity**	**Frequency**
Elbows			2	A			1 = Mild	A = Seldom
Shoulders			2	A		Eli lily - Runs on B - 31, puts the most strain on my shoulders and neck	2 = Moderate	B = Often
Neck			2	A			3 = Severe	C = Always
Back			3	B			4 = Unbearable	
Legs			1	A				
Headache/Eye Strain			1	A				
Other:								

Body Parts	**L**	**R**	**Severity**	**Frequency**	**Medical**	**Comments**	**6**	
Hands/Wrists/Fingers			1	A			**Severity**	**Frequency**
Elbows			1	A			1 = Mild	A = Seldom
Shoulders			3	B			2 = Moderate	B = Often
Neck			2	B			3 = Severe	C = Always
Back			1	A			4 = Unbearable	
Legs			2	A				
Headache/Eye Strain			1	A				
Other: Feet			3	C				

Body Parts	**L**	**R**	**Severity**	**Frequency**	**Medical**	**Comments**	**7**	
Hands/Wrists/Fingers			2	A		Once in a while - wrist	**Severity**	**Frequency**
Elbows						Nothing	1 = Mild	A = Seldom
Shoulders			4	B			2 = Moderate	B = Often
Neck			4	B			3 = Severe	C = Always
Back			2	A			4 = Unbearable	
Legs						Fine		
Headache/Eye Strain			Both 2 & 3	B		Use to be worse		
Other: Feet			Both 3 & 4	B				

Body Parts	L	R	Severity	Frequency	Medical	Comments	8	
Hands/Wrists/Fingers			2	A			Severity	Frequency
Elbows							1 = Mild	A = Seldom
Shoulders			2	C			2 = Moderate	B = Often
Neck			2	C			3 = Severe	C = Always
Back			Both 2 & 3	B			4 = Unbearable	
Legs			1	A				
Headache/Eye Strain			3	B				
Other: Feet								

Body Parts	L	R	Severity	Frequency	Medical	Comments	9	
Hands/Wrists/Fingers			L=2 & R=4	B	Yes	Carpal tunnel = both	Severity	Frequency
Elbows				A			1 = Mild	A = Seldom
Shoulders			3	B			2 = Moderate	B = Often
Neck			3	B			3 = Severe	C = Always
Back			4	B			4 = Unbearable	
Legs			3	B				
Headache/Eye Strain			2	A				
Other: Feet & Knees			4	B				

Body Parts	L	R	Severity	Frequency	Medical	Comments	10	
Hands/Wrists/Fingers			2	B			Severity	Frequency
Elbows			1	A			1 = Mild	A = Seldom
Shoulders			2	B			2 = Moderate	B = Often
Neck			2	B			3 = Severe	C = Always
Back			2	B			4 = Unbearable	
Legs			2	B				
Headache/Eye Strain			1	A				
Other:								

Body Parts	L	R	Severity	Frequency	Medical	Comments	11	
Hands/Wrists/Fingers			1	B			Severity	Frequency
Elbows			1	A			1 = Mild	A = Seldom
Shoulders			2	B			2 = Moderate	B = Often
Neck			2	B			3 = Severe	C = Always
Back			1	A			4 = Unbearable	
Legs			1	A				

Headache/Eye Strain			1	A		
Other:						

Body Parts	**L**	**R**	**Severity**	**Frequency**	**Medical**	**Comments**	**12**	
Hands/Wrists/Fingers			2	A		Crush cuts when they don't come out	**Severity**	**Frequency**
Elbows			1	A			1 = Mild	A = Seldom
Shoulders			2	B		Reaching	2 = Moderate	B = Often
Neck			1	A			3 = Severe	C = Always
Back			2	B			4 = Unbearable	
Legs			2	B				
Headache/Eye Strain			1	B		Headaching to dust		
Other:								

Body Parts	**L**	**R**	**Severity**	**Frequency**	**Medical**	**Comments**	**13**	
Hands/Wrists/Fingers				B			**Severity**	**Frequency**
Elbows				A			1 = Mild	A = Seldom
Shoulders				B			2 = Moderate	B = Often
Neck				B			3 = Severe	C = Always
Back				B			4 = Unbearable	
Legs				A				
Headache/Eye Strain				A				
Other: Feet				C				

Body Parts	**L**	**R**	**Severity**	**Frequency**	**Medical**	**Comments**	**14**	
Hands/Wrists/Fingers			2	B			**Severity**	**Frequency**
Elbows							1 = Mild	A = Seldom
Shoulders			3	B		Extending arms outward lifting up and pulling out motion	2 = Moderate	B = Often
Neck			Both 3 & 4	C			3 = Severe	C = Always
Back			4	C			4 = Unbearable	
Legs			2	A				
Headache/Eye Strain			3	B		Lighting is too bright. Too much glare		
Other:								