ERGONOMIC ANALYSIS OF PRODUCTION COOKS

AT XYZ HIGH SCHOOL

By

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ABSTRACT

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Production cooks at XYZ High School have experienced a variety of cumulative trauma disorders that have lead to an unreasonable amount of worker's compensation cost and lost workdays. This group of personnel consists of nine employees who work in the food service department. Each day, these employees perform a variety of routine and non-routine activities that pose varying degrees of risk. In this study, three routine jobs performed on a daily basis were selected for analysis. These tasks included the food serving stations, dishwashing area, and food carrier loading. Selection of jobs was determined through observations and a symptom survey by the researcher prior to the study on the basis of risk factors posed to employees. The symptom survey and body parts map were utilized to determine the location and severity of ailments. Significant results of the surveys concluded that 57% of the cooks in the department reported pain in their hands and wrists with the most common ailment being numbness (73%) of unspecified body parts. Results of the body parts map concluded that the most common areas of pain were in the hands, wrists, and lower back. Quantitative measurements of

each job were collected with three types of instrumentation including a force gauge, goniometer, and video camera. After data was collected, jobs were analyzed with the Rapid Upper Limb Assessment (RULA) and the NIOSH Lifting Equation. Significant results of the analysis methods determined a recommended action level of 4 for the dishwashing station, an action level of 3 for the serving stations, and an action level of 4 for food carrier loading. The food carrier-loading task was also analyzed with the NIOSH Lifting Equation. Results determined a calculated RWL of 5.4 lbs. and a lifting index (LI) of .93 - 5.5. Conclusions of the study found a combination of inadequate work practices, equipment, and workstation design to be a significant contributing factor in the development of CTDs. Recommended controls included a combination of engineering and administrative measures to mitigate future occurrences of injuries. Engineering control recommendations included removal of a stacking rack in the dishwashing area, height adjustment of the food carriers, and replacement of hand tools used for serving. Administrative control recommendations included training on lifting techniques, work processes, early detection of CTDs, and job rotation.

TABLE OF CONTENTS

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Chapter 1

Introduction

Every year more people are injured between the ages of 18-64 from repetitive motion injuries to the human musculoskeletal system than any other category of disorder. The average employee loses nearly two days of work each year as a result of these disorders (Putz-Anderson, 1988). Work-related musculoskeletal disorders occur when there is an interface problem between the physical environment of a job and the physical capacity of the human body (OSHA, 2002). Unfortunately, workers often overlook ergonomic illnesses until symptoms become permanent or chronic due to the fact that usually are not a result of a single incident. Rather, these injuries develop over time from repeated exposure to microtrauma. Recently, the term cumulative trauma disorder or CTD has widely been used to classify injuries that occur from repeated exposure over time (Putz-Anderson, 1988).

In general, it is likely that management has also overlooked CTDs in industry for a number of reasons. One of these is the fact that ergonomics has been considered to be an added cost of production that decreases competitiveness. Ergonomic programs have often been viewed with skepticism because there has not been enough reliable occupational research conducted documenting CTDs and the cost justification of controls. Also, OSHA has been unsuccessful in passing ergonomics standards that would require companies with high incidence rates to implement intervention programs and proactively monitor employees who report cumulative trauma problems before they become problematic. Nevertheless, in many cases, risk managers and ergonomic professionals have pin-pointed CTDs as a source of major loss in industry from incurred worker's compensation costs that adversely affect a company's insurance-related experience modification rate (EMR). It is important that industry professionals tackle this problem and conduct further research in this area to improve the profitability and competitiveness of businesses in today's economy. It is also vital to protect the health and safety of today's workforce from the detrimental effect of these illnesses and thus possibly influence worker compensation costs.

One area of particular ergonomic concern in industry is the field of food service. Very little research can be found on this topic, although it appears that there is a moderate amount of loss incurred. The food service department at XYZ High School has experienced a significant amount of loss due to cumulative trauma illnesses in the past year. The staff consists of 9 employees who work 40 hours per week during a 180-day school calendar year and their loss-based costs appear to occur primarily in worker's compensation and lost workdays. The target group of personnel who have been experiencing these injuries are the production cooks in the Food Service Department. Injuries that have accrued thus far include elbow tendonitis, a pinched neck nerve, a torn rotator cuff, and a herniated disk. Upon visual inspection of the environment, it seemed apparent that the workstation design was unable to accommodate the range of anthropometric differences between employees. Consequently, it is highly possible that these injuries experienced by the production cooks at XYZ High School are the result of inadequate workstation design as well as poor work practices.

Purpose Statement

The purpose of this study will be to identify the extent that workstation design as well as work practice risk factors are contributing to the occurrence of cumulative trauma disorders for kitchen employees at XYZ High School.

Goals of this Study

- Identify the prevalence of musculoskeletal discomfort that employees at XYZ High School are experiencing.
- Conduct a workstation analysis utilizing current ergonomic tools.

Background and Significance

Production cooks at XYZ High School perform a wide variety of tasks that fall under the category of high repetition. Table 1 illustrates these tasks in the form of a job hazard analysis that was conducted by risk management personnel at the school prior to the study. As noted in the overexertion/repetitive motion column of this table, nearly 50% of the tasks production cooks perform fell under the category of repetitive motion. Due to the nature of this particular job, it is critical that the source of these injuries is detected in order to develop engineering and/or administrative controls to help prevent further CTDs from occurring.

Through the analysis of ergonomic deficiencies in the food service department, a number of benefits will be derived. The XYZ High School will develop a clearer understanding of the current working conditions of the facility and thus may be able to accommodate the workforce accordingly. These accommodations could enable the school district to positively affect worker's compensation costs as well as working conditions for the employees. The general field of food service would most likely benefit from this study by the fact that a contribution will be made to the general pool of knowledge in this area, which at this time is lacking.

Risk Control.. Job Process Hazard Analysis
Summary of Risks by Equipment

Mechanical & Physical Hazards of Food Service Process System

Equipment Exposure	Burns	Chemical	Temperature Extremes	Struck By	Caught In	Cuts	Over Exertion/ Repetitive Motion	Slips & Falls
Braising Pans	✔		✔				✔	
Combi Ovens	✔	✔	✔		✔		✔	
Convection Ovens	✔	✔	✔		✔		✔	
Meat Slicers						✔		
Food Processors					✔	✔		
Mixers					✔		✔	
Dishmachines	✔	✔	✔		✔			
Hot Serving Carts	✔	✔			✔		✔	
Cold Servings Carts					✔			
Bread Slicer						✔		
Dough Divider & Rounder					✔			
Refrigeration							✔	✔
Freezer			✔				✔	✔
Carts				✔		✔		
Knives						✔		
Spills on Floor								✔
Lifting							✔	
Data Input							✔	
Delivery System	✔		✔	✔	✔	✔	✔	✔

Operational Expectations Food Service . . . . Revised August, 1999 11

Table 1.

Assumptions

- Participants in the study will answer questions truthfully and accurately.
- Participants in the study will display their normal or unusual work practices when they are being video taped.
- There is a very limited amount of research available on food service ergonomics. Because of this, studies from general industry had to be used in order to draw parallels.

Definition of Terms

There are a number of terms that need to be defined for clarity and reader comprehension in this paper. They are as follows:

Ergonomics - The study of relationships between worker and the working environment to achieve an optimum in efficiency, safety, health, and well being of employees (Putz-Anderson,1988).

Anthropometry - Measurement and collection of body dimensions that are used as design criteria to improve functioning, efficiency, and safety of humans in the work environment (Putz-Anderson, 1988).

Tendonitis - A form of tendon inflammation that occurs when a muscle or tendon is repeatedly tensed (Putz-Anderson, 1988).

Microtrauma - Miniscule amounts of damage that happen over time that contribute to cumulative trauma disorders (Putz-Anderson, 1988).

Experience Modification Rate (EMR) - Comparison of the actual losses charged to an employer during the experience period with the losses that would be expected for an average employer reporting the same exposures in each classification (turnernw.com).

Musculoskeleton - Body structure that is comprised of muscles, tendons, ligaments, bones, joints, and nerves. This structure provides the primary components for muscular activity (Putz-Anderson 1988).

Chapter 2

Literature Review

Introduction

In today's workforce, losses incurred from CTDs continue to be a growing problem. According to the Bureau of Labor Statistics (2002), musculoskeletal injuries are among the most prevalent and costly of all lost time injuries in almost every industry. These injuries have been known to cause a great deal of pain and suffering among affected workers that often lead to lost production and poor quality work. An area of study that attempts to address these problems is ergonomics. According to ANSI, ergonomics is "A multidisciplinary activity dealing with the interactions between man and his total working environment, plus such traditional and environmental aspects as atmosphere, heat, light, and sun, as well as tools and equipment of the workplace." Simply put, ergonomics is the science of fitting the job to the worker. When the combination of the job and worker mesh well and work in harmony, productivity, employee satisfaction, and a reduction in injuries is usually the outcome. In order to proactively address ergonomic issues, it is important to recognize the signs and symptoms of CTDs as well as potential risk factors before they become a problem. When analyzing processes for signs of CTDs, there are numerous instrumentation tools and analysis methods that can be used. Once potential risk factors are determined and analyzed, a variety of controls can be implemented in order to reduce exposure to these risks. The purpose of this literature review will be to present a variety of case studies, risk factors, signs and symptoms of CTDs, analysis methods, instrumentation and controls, to create a basis for making recommendations at XYZ High School.

Case Studies

A variety of case studies have been documented which highlight a number of ergonomic injuries and risk factors that have been encountered in general industry. The purpose of documenting these cases is to demonstrate the need for proper intervention and control of these potential loss-producing situations. To this date, very little research has been conducted in the area of food service and cafeteria ergonomics. Due to the high incidence of injuries and losses incurred in the industry, specifically those at XYZ High School, it is imperative to address these issues and demonstrate the need for further research.

Risk of Shoulder Tendonitis in Relation to Shoulder Loads in Monotonous Repetitive Work

Shoulder tendonitis is commonly experienced among workers in industry who perform repetitive movements on a daily basis. Frost, Bonde, Mikkelsen, Andersen, Fallentin, Kaergaard, & Thomsen (2002) conducted a study quantifying ergonomic exposures associated with the occurrence of shoulder disorders. In the beginning of the experiment, researchers hypothesized that repetitive work might contribute to the onset of tendonitis in the shoulder. The study, which was named PRIM or Project on Research and Intervention in Monotonous Work, consisted of 4,162 workers who participated from a variety of different industries. Quantification of physical exposures was based on four steps of assessment. First, ergonomists visited each work site and classified tasks as either repetitive or controlled. Repetitive tasks were defined as those that involved continuous movements and controlled tasks were characterized by varied job tasks. The second step in the process involved aggregating repetitive tasks with comparable levels of physical exposure. Third, workers were videotaped from three different camera angles for 10 task cycles. From the video footage, quantitative data on shoulder movements per minute, force requirements, and pauses between cycles was collected. Assessment of peak force was determined by directing employees to assign a number from one and five for each task. Parameters for force requirements included (<10%) of maximum voluntary contraction or (MVC) for light, (10-29% MVC) for somewhat hard, (30-49% MVC) hard, (50-79% MVC) very hard, and (>80% MVC) near maximal. The final step in the analysis included allocating time-weighted exposure measures to participants. These measures were calculated by adding the products of exposure medians to the proportion of time in a working week. Results of the study found that there were 88 subjects who fell under the criteria for tendonitis with a total of 58 showing tendonitis in the dominant shoulder. Overall, shoulder tendonitis was found to be two to three times higher among workers who performed repetitive tasks. The study also found that a combination of repetition, force, and lack of adequate rest between tasks was associated with the onset of tendonitis (Frost, et al., 2002). Thus, repetition has been found to be a significant risk factor in the development of shoulder tendonitis.

Effects of Wrist Posture, Pace and Exertion on Discomfort

Cumulative trauma injuries related to the wrist are often the result of exposure to a number of risk factors over a period of time. A study by Carey & Gallwey (2001) was conducted to investigate the effects of exertion, pace, level of flexion/extension, and radial/ulnar deviation on discomfort during repetitive motion. According to the findings of a study conducted by Corlett & Bishop (1976), discomfort has been considered to be an important factor in the development of CTDs since it has been proven to precede these conditions. In order to further examine the association of discomfort and the development of CTDs, Carey & Gallwey (2001) selected sixteen right-handed male college students to participate in an evaluation. The experimental procedure involved seating subjects in a height adjustable chair with their arms at an angle of approximately 45 degrees in the coronal plane and the elbow at 90 degrees. An electrogoniometer was attached to the right wrist of the subjects for angular measurement. At that time, maximum voluntary contraction was determined for a downward exertion of the arm with the palm of the hand in the downward position. Next, force was applied to the hand via the use of a metal plate and maximum angular deviation was measured in each direction with the electrogoniometer. A personal computer was used to plot the maximum range of motion for each individual on a XY axis as well as seventeen other wrist positions throughout the full range of motion. A number from 1-10 (10 being extreme discomfort) was then assigned to a visual analog scale at the end of each interval relating to the level of discomfort experienced by the subject. Results of the study demonstrated that extreme flexion resulted in higher discomfort compared to other conditions and all extreme positions caused more discomfort than the neutral position. Also, a combination of high force and pace was found to increase discomfort at extreme positions. Exertion was found to be the most significant factor in discomfort followed by wrist angle and pace (Carey & Gallwey, 2001). Thus, a combination of poor wrist posture, pace, and exertion has been found to cause discomfort in employees.

The Effect of Maximum Voluntary Contraction on Endurance Times for the Shoulder Girdle

In repetitive job tasks, worker's endurance times can depend heavily on the amount of muscular force that is expended during movements. A study by Garg, Hegmann, Schwoerer, & Kapellusch (2002) was conducted to investigate endurance times of maximum voluntary contraction for the shoulder girdle. Subjects for the study included twelve healthy female college students who were predominantly right-handed. Anthropometric measurements were recorded including overall height, shoulder height, weight, upper and lower arm length, active range of motion, and grip strength. During the study, subjects were instructed to lift dumbbells with weight adjustments of 50g. increments while standing on a platform. A suspended tennis ball was used as a target for lifts. Variables that were recorded during the lifts included endurance time, surface EMG, subjective ratings including exertion related to the shoulder and elbow, and a fatigue and pain scale. Regarding both scales, 0 denoted no fatigue or pain and 10 signified extreme levels of these conditions. Maximum voluntary contractions were calculated after subjects were instructed to hold the weight for four seconds. Endurance times were measured at percentage intervals of maximum voluntary contraction for five different shoulder positions. The study defined endurance time as the maximum amount of time a weight could be held by a subject in a particular posture. Surface electromyography was monitored over the trapezius muscle and the deltoid. Results of the study showed that endurance time decreased in a non-linear fashion as the percentage of maximum voluntary contraction increased. Also, the shoulder flexion angle was found to have a significant effect on endurance. Endurance time was found to decrease as the shoulder flexion angle increased to 120 degrees. As endurance time rose to 100%, subjects reported high levels of fatigue and exertion for all postures tested (Garg et al., 2002). Thus, a combination of excessive force and posture has been found to decrease endurance times in the shoulder girdle.

Occupational Risk Factors for Radial Tunnel Syndrome in Industrial Workers

Radial tunnel syndrome is a common wrist CTD found in industry that is often the result of a number of risk factors. A study by Roquelaure, Raimbeau, Dano, Martin, Pelier-Cady, Mechali, Benetti, Mariel, Fanello, & Penniau-Fontbonne (2000), was conducted to evaluate risk factors associated with radial tunnel syndrome. The study was performed in three plants where production-line work was common. Subjects were selected from those who had a previous medical history of radial tunnel syndrome, carpal tunnel syndrome, or other CTDs. The method used to study the subjects included electromyographic analysis of the extensor digitorum communis, extensor pollici longus, and extensor indicis muscles. In order to test the motor conduction of the radial nerve, distal latency and motor conduction velocity was tested. The method used to test the radial nerve included supermaximally stimulating the elbow to measure motor conduction velocity at the forearm and wrist. Next, the third digit was stimulated and recordings were taken over the median nerve with bipolar surface electrodes. Results of the study found that there were a number of occupational risk factors involved in the development of radial tunnel syndrome. It was concluded that forces exerted over 1kg. at a rate of >10 times per hour was the main risk factor associated with radial tunnel syndrome. Also, static loads applied to the hand for a prolonged period was found to be associated with radial tunnel syndrome. Extreme postures at the elbow such as full extension and twisting was found to be stressful on the radial nerve (Roquelaure et al., 2000). Thus, a variety of factors have been found to cause a significant effect on the development of radial tunnel syndrome. These include excessive force, static postures, extreme postures, and inadequate rest.

Ergonomic Risk Factors

There are a number of risk factors associated with the development of cumulative trauma injuries in industry. Among the most prevalent of these risk factors include force, vibration, repetition, thermal stressors, and posture (Putz-Anderson, 1988). A clear understanding of these factors is important when conducting root cause analysis of ergonomic problems as well as assigning proper controls, whether administrative or engineering, to help reduce the severity of loss incurred in an organization.

Force

The amount of force required for performing tasks is one of the many risk critical factors in the development of CTDs. According to Ergonext, (2001), force is an effort that is mechanical in nature, which is used to execute or prevent movement. Functions that require forceful exertions place excessive loads on the musculoskeletal system including muscles, joints, ligaments, and tendons. Workers may exert excessive force on work pieces, tools, or against gravity in order to stabilize their bodies (Ergonext, 2001). As a result of these forces and increased muscle effort, circulation is reduced to the muscle causing fatigue to set in more rapidly. Fatigue from excessive force can also be the result of an imbalance of proper recovery and work time. When insufficient recovery time is encountered, soft tissue injuries can occur including sprains and strains (Putz-Anderson, 1988).

Vibration

In today's workforce, it is possible for employees to become exposed to vibration in different forms. According to Grandjean (1988), "vibrations are mechanical oscillations produced by either regular or irregular periodic movements of a body during its resting position." The most common avenues of vibration transmission include exposure to hand tools such as grinders and sanders as well as powered vehicles including forklifts, trucks and trains. The use of vibrating tools coupled with repetitive motion and force can lead to various CTDs including vibration white finger, carpal tunnel syndrome, and trigger finger (Tayyari & Smith, 1997).

Published literature has shown that there are various types of vibrations. Two general types include free vibrations that result from a system oscillating at its natural frequency and forced vibrations, which are caused by external forces (Chaffin & Anderson, 1991). With respect to the human body, vibration can be broken down further into whole body and segmental vibration. Whole body vibration is transmitted to the body via a supporting structure such as a truck seat to the buttocks. Results of an experiment conducted by Weaver (1979), conclude that the human body is most sensitive to vibrations between 4 and 8 Khz. with resonance occurring at 5hz. At these low frequencies, internal organs begin to vibrate which can lead to serious trauma and possible hemorrhaging if not controlled properly (Tayyari & Smith, 1997). Segmental vibration occurs when vibration enters the body through specific body parts such as the feet or parts of the upper extremity. Unlike whole body vibration, segmental vibration can cause injury to the fingers, elbows, shoulders, and wrists. Injuries from this type of vibration are often due to prolonged use of hand tools (Tayyari & Smith, 1997). Thus, a number of different types of vibration can lead to the onset of CTDs.

When employees in the workforce are exposed to vibration there are a number of factors that must be taken into account. According to Grandjean (1988), there are four important factors that need to be observed when attempting to control the effects of vibration. These include:

- Point of application to the body
- Frequency of oscillations
- Acceleration of oscillations
- Duration of effect

Common application points where vibration can be transmitted to the body include the feet and buttocks. Frequency oscillations that are close to the natural frequency of the body can cause resonance or whole body vibration. The acceleration of vibrations can contribute to the overall vibrational load. Injuries from vibration can increase at a rapid rate as workers are exposed to long durations. It is important to understand and identify these four factors when developing controls relating to vibration exposure (Grandjean, 1988).

Repetition

Repetition is another known risk factor that contributes to the onset of CTDs. Repetition is an important variable to take into account when controlling CTDs because it can act as a modification factor compounding excessive force and improper posture. NIOSH (1997) published their definition of repetition as motions that are repeated over long periods of time, which can lead to fatigue and muscle-tendon strain. Tasks that are highly repetitive in nature require a fast rate of muscle velocity and contraction meaning that more recovery time is needed between cycles. Normally, tendons and muscles can recover from excessive force and stretching if there is enough time between exertions. However, when these motions are performed with inadequate recovery time and coupled with awkward movements or forceful exertions, muscle fatigue and strain begin to set in (NIOSH 1997). Even though these tasks may require a minimal amount of force, the addition of high repetition can act as a source of trauma leading to CTDs (Putz-Anderson, 1988).

When conducting task analyses, there are a number of guidelines that have been introduced to identify repetitive work. NIOSH (1997), has established guidelines delineating quantitative measures of repetitive work. The figure given by NIOSH that constitutes high repetition for a job task is a cycle time of less than thirty seconds. Likewise, a task cycle time of more than thirty seconds is considered low repetition. Estimates of repetition dealing with specific body part manipulations vary depending on the amount of force applied and the area of the body that the force is applied to. The following points in Table 2 depict these guidelines:

Table 2.

Body Part	Repetition
Hands	>20,000 repetitions per 8 hr. work shift
Shoulder	>2.5 repetitions per min.
Upper Arm/Elbow	>10 repetitions per min.
Forearm/Wrist	>10 repetitions per min.
Fingers	>200 repetitions per min.

According to NIOSH, the hands should not exceed 20,000 repetitions per shift. During job tasks, the shoulder should not exceed 2.5 repetitions per minute. The arms and wrists fall into the category of no more than 10 repetitions per minute and the fingers should not exceed 200 repetitions per minute. These guidelines were introduced with the understanding that each body area may have different abilities to tolerate repetitious movements.

Thermal Stressors

It appears that the human body has great capacity to adapt to different thermal environments. However, the body does have its limitations. When these limitations are taxed, exposure to excessive temperatures can cause injuries, illnesses, accidents and a reduction in productivity (Tayyari & Smith, 1997). Thermal stressors fall into two categories that include heat and cold stress.

When employees are assigned to work in excessively warm environments, the potential for a condition known as heat stress must be approached with caution. Tayyari and Smith (1997) defined heat stress as the total load of all heat factors, whether internal or external, on the human body. Factors that affect the body internally include metabolic heat, degree of acclimatization, and body temperature. Factors that affect the body externally include air temperature, radiant heat, humidity, and clothing thermal resistance. When the human body is exposed to excessive heat, blood capillaries near the surface of the skin expand to transfer heat from the core of the body to the skin where sweat glands can aid in evaporative heat loss. At the same time, the body works to dissipate metabolic heat by attempting to reach thermal equilibrium with the environment through convection, conduction, and radiation (Grandjean, 1988). When heat stress occurs at lower levels, no health damage is incurred. However, when these stresses exceed a person's capacity a number of heat-related disorders can occur. Included these disorders include heat stroke, heat exhaustion, heat cramps and prickly heat (Tayyari & Smith, 1997). Thus, it is important to identify and control the factors that are associated with these conditions to protect the health and safety of employees.

Cold stress is the opposite of heat stress in that there is a lowering of the body's core temperature (Ergoweb, 2002). This form of thermal stressor is often not as common on the job as heat stress. Nevertheless, cold stress should not be underestimated due to the lack of productivity and discomfort that often occurs. Exposure to extreme cold conditions causes contraction of the capillaries near the surface of the skin in order to route blood to the core of the body to preserve heat for vital body organs (Ramsey, 1985). Some effects of cold exposure include numbness, weakness, shivering, and low body temperature. According to MacFarlane (1963), a number of injuries can result from excessive cold conditions including chilblains, hypothermia, and frostbite. Just as in heat stress, it is important to be aware of the factors that contribute to cold stress conditions to protect employees.

Posture

Posture refers to the position of the body in terms of the angle between two adjacent body segments while performing various work activities (Ergonext, 2001 & Ergoweb, 2002). Certain jobs require a variety of awkward postures that pose stress to upper extremity joints and soft tissues (Putz-Anderson, 1988). According to Chaffin & Anderson (1991), posture is also one of the major variables that affect static and dynamic strength. Proper posture is very important because it determines how much force and stress will be placed on the joints and muscles of the body. Tasks that add repetition to repeated or sustained awkward postures such as bending of the knees, wrists, hips, or shoulders also imposes increased stress on these joints (NIOSH, 1997). Risk factors associated with awkward posture are defined by body positions that deviate from the neutral position (NIOSH, 1997). In other words, the more a joint is deviated from its natural position the greater risk there is for injury.

According to Ergonext (2001), awkward postures can be placed into three categories that include:

- **Extreme postures -** Postures that are close to the end of motion range. These positions require more support from ligaments and muscles. They may also exert compressive forces on blood vessels and nerves.
- **Non-extreme postures related to gravitational loading -** Postures that expose a joint to gravitational loading increase forces on muscles and

tissues. An example of this would be extending an arm out from the body for a period of time.

- **Non-extreme postures related to musculoskeletal geometry** - Postures that change the geometry of the musculoskeletal system.

There are a number of different postures that can adversely affect the body when the limits of motion are reached. As shown in Table 3, flexion, extension, radial/ulnar deviation, bending, and twisting can affect the various parts of the upper extremity.

Table 3.

Body Part	Posture associate with injury
Wrist	Flexion, extension, ulnar/radial deviation
Shoulder	Abduction/flexion, hands above shoulders
Neck	Flexion/extension, forward/side bending
Low Back	Bending and twisting of the waist

(Ergoweb, 2002)

Common Cumulative Trauma Injuries Found in Industry

Cumulative trauma injuries are often the result of risk factors that are improperly managed and identified in the work environment. Some common CTDs typically found today's workforce include tendonitis, carpal tunnel syndrome, back injury, thoracic outlet syndrome, and vibration syndrome (Putz-Anderson, 1988). Due to the scope and varying degrees of severity related to these injuries, it is likely that proper diagnosis can be a daunting task. Nevertheless, it would seem highly important for industry professionals to understand the nature of these injuries as well as the related symptoms in order to protect the human and financial assets of their organization.

Tendonitis

Tendonitis is an inflammation injury that occurs within tendons throughout the body (American College of Rheumatology, n.d.). Areas of the musculoskeletal system that are often affected by this condition include the hand, wrist, elbow and shoulder. Tendonitis is often the result of repetitive movements that require tensing over long periods of time. This injury may be primary in nature due to cases of rheumatoid arthritis or secondary as a result of physical injury (Tayyari & Smith, 1997). Examples of physical injuries include direct blows to the tendon itself, strains, and repetitive trauma. As cases of tendinits increase in severity, fibers located within the tendons of the associated employees can tear apart and become thickened, bumpy and irregular. Also, injured areas may calcify in tendons that do not contain sheaths (Putz-Anderson, 1988). Some characteristic symptoms of tendonitis include pain in the affected area, dull aching, swelling, and burning sensations (Tayyari & Smith, 1997). Sufficient rest time is critical in healing damaged tissue because permanent damage can result (Frost et al., 2002). Thus, it is important to understand the characteristics and symptoms of tendonitis to prevent it from occurring in the workforce.

Carpal Tunnel Syndrome

Carpal Tunnel Syndrome (CTS) is a cumulative trauma injury that entraps or pinches the median nerve in the carpel tunnel of the wrist due to swollen tendon sheaths (Putz-Anderson, 1988). This illness received its name from the eight bones or carpals that form a tunnel-like structure in the wrist. This structure is filled with flexor tendons that control finger movement and provide a pathway for the median nerve to reach sensory cells in the hand (NIOSH, 1997). CTS is often developed from occupational exposure to repeated and forceful movements over time that pinch the median nerve (Tayyari & Smith, 1997). This condition can also occur from excessive bending of the wrist, stressful wrist postures, and exposure to vibrating tools (NIOSH, 1997). According to Tayyari and Smith (1997), there are a number of symptoms that are associated with CTS. They are as follows:

- Numbness, tingling or painful burning
- Fingers may be difficult to move
- Reduction in grip strength
- Loss of feeling in fingers
- Fingers may feel swollen

Given the importance that the upper extremities play in bodily function, it is vital to proactively approach these symptoms of carpal tunnel syndrome and treat them early to avoid severe damage to nerves over prolonged periods of time.

Thoracic Outlet Syndrome

Thoracic outlet syndrome is a neurovascular disorder that affects the neck and shoulders by compressing the nerves and blood vessels in the thoracic outlet (Canadian Centre for Occupational Health Safety, 1997). This injury is often the result of conditions that require restricted postures such as carrying heavy loads or reaching above shoulder level. When muscles become inflamed and swell, they compress the blood vessels between the neck and shoulders causing discomfort. Symptoms associated with thoracic outlet are similar to carpal tunnel syndrome and include weakness, fatigue, pain, numbness, and tingling (Hand Surgery Center, 1997). It would therefore seem likely that this condition can be very difficult to diagnose due to the fact that the symptoms are very close to those of other cumulative trauma disorders.

Back Injury

Back injuries are one of the most common problems in the workforce today. One of the ailments that occur in this area is degenerative disk disease that can pinch or press against nearby nerves. Chronic lumbar strain, extreme twisting, pushing or pulling, scoliosis, and unstable or dislocated vertebra cause many low back injuries. Age is another factor in the development of low back problems. This is due to the fact that disks become less resilient over time and can bulge into the spinal canal causing pain and pinching nearby nerves (Tayyari & Smith, 1997). Symptoms of back injuries can be divided into two main types that include mechanical and compressive pain. Mechanical pain stems from inflammation caused by injuries to a disk that are usually the result of disk degeneration. Compressive pain occurs when nerve roots are pinched or irritated from incidences such as herniated disks (Medical Multi Media Group, n.d.).

Vibration Syndrome

Vibration syndrome, also known as vibration white finger, poses adverse circulatory and neural effects on the hands due to vibration exposure (NIOSH, 1983). Vibration, which is often generated by hand tools, can be transmitted through the fingers via forceful gripping and prolonged exposure (Putz-Anderson, 1988). This illness is characterized by narrowing of the blood vessels in the hand and finger blanching. Common symptoms of this condition include tingling and numbness in the fingers, whitening of the fingertips, and eventual loss of sensation (Tayyari & Smith, 1997).

Instrumentation

In this study, three types of instrumentation were used to analyze tasks including a goniometer, video camera, and an axial force gauge. These devices were useful in quantifying human and work related variables that placed excessive demands on the employees. Examples of these variables included force, cycle time and posture. These tools were also helpful in objectively analyzing data in order to aid in the development of controls.

Goniometer

A goniometer is a manual measuring device that is similar to a protractor. This tool is commonly used for measuring different body postures and analyzing movement. As observed by the researcher, a goniometer is useful in determining joint movements that are near the limits of the maximum range of motion. When used in unison with a video camera, a goniometer can be used in taking angular measurements of frame-by-frame analysis of work tasks. Once this data is determined, it can be used in conjunction with the many ergonomic analysis tools to determine what controls need to be implemented.

Video Camera

The video camera is useful tool in determining quantitative and qualitative data in a process. This tool can be used with a jog-shuttle VCR to slow work processes down in a frame-by-frame manner for analysis of fine movements that could otherwise easily be missed at normal speed. This tool can also identify extraneous factors such as poor lighting. The video camera is commonly used in conjunction with a goniometer to determine angular measurement data for equations. As observed by the researcher, ninety-degree degree views of the body should be recorded for effective analysis. Once data has been gathered and risk factors have been identified, the video camera is useful in measuring the effectiveness of controls once implemented.

Single Axial Force Gauge

The single axial force gauge is used in determining object mass and analyzing force. As observed by the researcher, working tasks that are commonly measured with this device include lifting, pulling, and pushing. Most force gauges supply readings in units of pounds or kilograms. This device is also useful in determining the exertion capabilities of a person. Measurements from this device can only be taken from one axis at a time.

Analysis Methods

Within this study, three types of qualitative analysis methods were used. These include the NIOSH lifting equation, the Rapid Upper Limb Assessment (RULA), and a symptom survey. These methods are often used after a task analysis has been conducted with instrumentation. Data that is collected from instrumentation is substituted into the equations of the analysis methods. From the results of the analysis tools, risk levels can be identified and evaluated in order to determine suitable controls for a particular task.

NIOSH Lifting Equation

The NIOSH lifting equation is a mathematical-based ergonomic analysis tool that is used for assessing physical stressors of manual lifting tasks. The main outcome of this equation is to determine the recommended weight limit (RWL) of objects to be lifted. The RWL is defined as the load that nearly all healthy workers can handle without risk. The equation uses six variables that include horizontal, vertical, distance, asymmetry, frequency, and coupling multipliers to determine the RWL. These variables are taken into account because the risk of handling objects depends highly on the location, how far it is to be moved, how often the object will be moved, the hand-to-object grasp, and the degree of twisting involved in the lift. Aside from RWL, this equation can also quantify levels of physical stress associated with a specific lifting task in terms of a variable called the lifting index or LI. This variable shows the relationship between the recommended weight limit RWL and the actual amount of weight lifted in a task. Within the equation, LI increases in direct proportion to the risk that is posed to the employee during the task. As a whole, each variable that is determined for this equation can be used as an aid in determining ergonomic design improvements. These include:

- Multipliers can be used to identify the magnitude of a problem related to a specific component.
- The RWL can be used to determine new acceptable weight limits.
- The LI can be used to assess the level of stress encountered by a worker during the task.
- The LI can also be used to classify degrees of risk associated with a job in order to determine tasks that need immediate attention and redesign.

RULA (Rapid Upper Limb Assessment)

RULA is an ergonomic tool that is used to evaluate exposure to postures, repetition, force, and muscle activity that contribute to CTDs. This tool is not designed to be a comprehensive analysis, but rather a quick and easy screening instrument. The focus of RULA is to help in determining the root cause of cumulative trauma injuries in the hands, neck, arms, and shoulders. A RULA analysis can be broken up into three steps that include observation, scoring and recording, and determining an action level. The RULA assessment can be viewed in Appendix A. The observation process of RULA includes determining the part of a task that poses the highest risk of postural loading. Some factors that may be taken into consideration include duration of the posture and degree of deviation. Also, while observing, it is possible to score each side of the body independently if desired. The second step of a RULA analysis is scoring the posture. In this step, scores are assigned to movements associated with different parts of the upper extremity. Tables are provided on the RULA work sheet that allows calculation of a grand score. The final step includes comparing the grand score to the four action levels in order to determine the degree of risk. The four action levels include:

- **Action level 1**

  Scores of 1 or 2 indicate acceptable postures if not repeated for long periods.

- **Action level 2**

  Scores of 3 or 4 indicate a need for further investigation and possible changes.

- **Action level 3**

  Scores of 5 or 6 indicate changes are required soon.

- **Action level 4**

  A score of 7 indicates investigation and changes are required immediately.

Symptom Survey

Symptom surveys are an important tool used in the early detection of CTD to determine information relating to pain and discomfort of employees. Symptom surveys are also an important tool because they document the number of workers at a particular job who may be susceptible to developing CTDs. In determining the results of a symptom survey, caution must be taken when analyzing the results due to the fact that all answers are subjective in nature and an individual's tolerance to pain may vary from person to person. A sample symptom survey can be viewed in Appendix A.

Controls

Ergonomic controls are typically characterized as measures implemented to counteract the potential loss associated with the development of CTDs in the work environment. These controls are typically the result of identification and analysis of ergonomic risk factors in the work environment. Ergonomic controls can be implemented as a means to proactively address ergonomic issues before they arise as well as reactively address incidents after they occur. There are two categories of controls that have been developed to address ergonomic problems. These categories include engineering and administrative controls.

Engineering Controls

Engineering controls involve making physical changes to machinery, equipment, tools, or processes in order to suppress the onset of CTDs. These controls are highly desirable because once in place, they are permanent and require a minimal amount of energy and resources in training. Engineering controls are probably the most effective method for controlling cumulative trauma hazards because they focus on eliminating risk at the source. Problems with engineering controls are less likely to be an issue compared to administrative controls and personal protective equipment because the human factor is eliminated. In order for these controls to be effective, it is vital to gain input from employees since they will be using the modified equipment on a daily basis. Often times, employees will not use newly designed equipment if they believe it interferes with their work or productivity. After engineering controls have been implemented, it is critical to monitor and measure the effectiveness of the changes and make adjustments if necessary. There are many different examples of engineering controls. A few of them include:

- Suspending tools in order to reduce weight.
- Utilizing pistol grip tools when performing horizontal operations and straight tools when performing vertical operations to help eliminate awkward postures.
- Changing orientation of tools and workstation layout to reduce excessive movement.
- Using adjustable workstations to fit the job to the worker.

(Ergonext, 2001)

Administrative Controls

Administrative controls deal with procedures, methods, and standards implemented by management to help control risk. Administrative controls also change the way work is distributed in order to reduce duration, frequency, and magnitude of risk factors. In most cases, engineering controls are the preferred method of reducing exposure. However, administrative controls can be useful as an alternative to engineering controls if they are impractical or unfeasible. Initially, these controls are less expensive than engineering controls but the trade-off is the addition of the human factor, which is often not as dependable. Also, administrative controls do not completely eliminate hazards. Therefore, additional management energy is required to ensure policies are being followed. Examples of administrative controls include:

- Job rotation- Allows workers to change tasks so they are not exposed to the same risk factors for long periods of time.

- Exercise programs- Improves conditioning, flexibility, and circulation.
- Training- Ensures workers are aware of risks.
- Establishing proper work methods- Positioning of tools, technique, and efficiency. (Ergonext, 2001)

Summary

This literature review has summarized various case studies and risk factors associated with the development of CTDs. The case studies reviewed present scientific data of CTDs occurring in industry and the need for these illnesses to be properly identified and controlled. In identifying ergonomic deficiencies, there are a number of different types of instrumentation that can be utilized including a video camera, goneometer, and force gauge. Data from these instruments can be used in the various analysis methods described including RULA, the NIOSH Lifting Equation, and symptom surveys. Results of analysis methods can then be used to develop engineering or administrative controls depending on what is best suited to the situation.

Chapter 3

Methodology

Introduction

The study conducted at XYZ High School was designed by taking into account a number of different research methods. These methods included selection of subjects, research instrumentation, procedures, and analysis methods. Information gathered from the literature review in Chapter 2 was utilized to create a foundation for the listed procedures. The purpose of this methodology was to demonstrate an overall view of the research conducted as well as articulate the techniques and procedures used to complete this study.

Subject Selection

Subjects at XYZ High School were selected from a target group of nine employees in the Food Service Department who were production cooks. This group of employees was selected to participate in the study due to the fact that they may be at high risk for developing CTDs. Also, there had been a relatively high incidence rate of injuries in the department. In the past year, three employees out of nine (or 33% of the workforce) experienced lost workdays and received worker's compensation as a result of CTDs. Before the study was conducted, all participants were instructed on their rights as human subjects and were asked to complete a consent form. Participation in the study was strictly voluntary and subjects were given the option to withdraw at any time for any reason.

Research Instrumentation

This study involved the use of three instruments that were used to gather data from the Food Service Department at XYZ High School. These instruments included a video camera, goniometer, and a force gauge. The tools were selected as a means of quantitatively measuring ergonomic risk factors to be used in the analysis methods. As described in Chapter 2, each of these instruments served a particular purpose. The video camera was used to document tasks for review in slow motion. From the videotape, an on-screen analysis was conducted using the goniometer to take angular measurements of the body. The purpose of the force gauge was to determine the mass of objects lifted for use in the NIOSH Lifting Equation and the required force of movements in RULA.

Procedures

The collecting of data for this study was performed at XYZ High School on December 2-4, 2002. Prior to the study, an informational meeting was conducted to inform production cooks of the experiment. All procedures, risks, and confidentiality issues were addressed to ensure the health and safety of the subjects. During this meeting, production cooks were instructed to fill out a symptom survey and body parts map to describe areas of pain related to their job tasks on a daily basis. After the meeting, an observation of the work environment was performed to familiarize the researcher with job tasks performed by the participants and to determine which stations would be selected for analysis. During the observation, knowledge gathered in Chapter 2 from research was utilized in identifying ergonomic risk factors and CTD symptoms. Also, results of the symptom surveys were used to determine the location and types of pain experienced by the employees. Selection of tasks for analysis was difficult due to the fact that while many jobs were repetitive in nature, they were performed on a non-routine basis. This was related to the fact that different items were served on the menu each day at the cafeteria. Therefore, the tasks involved in the preparation of each daily menu constantly changed and it would not have been practical to analyze those jobs. During the observations prior to the study, the researcher determined that a number of tasks were that were performed on a daily basis. Three of these routine tasks were selected for review on the basis that they had the potential to threaten the health and safety of the employees. These jobs included:

- The dishwashing station
- Loading boxes of food into carriers for transport to outside area schools
- Food serving stations

The dishwashing station was selected because it was determined to be repetitive in nature and caused the employees to perform extreme bending postures when retrieving food trays from underneath the stacking rack. The procedure of loading boxes into carriers was chosen because of the extreme postures involved in lifting and lowering items and handling a variety of different weights throughout the process. The food serving station was for review because of the highly repetitious and extreme postures posed to the wrist. The procedures involved in gathering data for analysis of the dishwashing station and the food serving stations were quite similar in nature. First, the researcher videotaped a number of cycles for each job activity to analyze the movements involved in performing each task. After taping each job, the jog shuttle VCR was used to analyze each job for extreme postures, forceful movements, and repetition. During this analysis, a goniometer was placed on a TV screen while reviewing the tapes to determine the angle of deviation for the body parts required by RULA. The force gauge was used to determine the load factor required for the equation (reference Appendix B for RULA analyses). Loading of food into carriers was analyzed by taking measurements for the NIOSH Lifting Equation to determine the recommended weight limit (RWL) that the employees could safely handle for an 8-hour workday. First, the horizontal location from the midpoint of the ankles to the center of the load was recorded. Next, the vertical location from the ground to the midpoint between the hands was taken at the lowest point of the lift. In addition, the distance that was vertically traveled while lifting the load was determined. Other factors that were taken into consideration included the angle of rotation between the midpoint of the hands and the midpoint of the ankles, the frequency of the lifts, and the coupling multiplier that quantified the hand to object grip. After the RWL was determined from these measurements, the force gauge was used to determine the weight of the objects handled by the employees for calculating the lifting index (LI). The LI was used to determine the level of risk posed to the employee for the lifting tasks performed.

Analysis Methods

Various analysis methods were used in this experiment to study information gathered from subjects and job tasks. These methods included a symptom survey, RULA, and the NIOSH Lifting Equation. Results of these tools were utilized in both a qualitative and quantitative manner. A symptom survey consisting of a questionnaire and body parts map was used in this study to retrieve qualitative information directly from employees on the extent and location of injuries as well as pain and discomfort experienced in different areas of the body. The questionnaire was used as a tool for employees to verbally describe pain and symptoms. The body parts map was used to specifically identify areas of the body where pain and discomfort were experienced. Information gathered from these surveys was then used as a qualitative aid in determining which tasks were to be selected for study. The NIOSH Lifting Equation and RULA were used to quantitatively analyze data collected from the instruments used in this study and recommend controls to XYZ High School. The NIOSH Lifting Equation was used with the force gauge to analyze and quantify physical stressors associated with manual lifting tasks. RULA was used in conjunction with a video analysis and a goniometer to evaluate awkward postures, repetition, and force.

Summary

A variety of techniques were used in assembling the methodology of this study. First, subjects were selected on the basis that there was a specific group of employees who were experiencing CTD injuries at XYZ High School. This group of workers included the production cooks in the Food Service Department. After reviewing the symptom surveys, high-risk jobs were selected for analysis by the researcher on the basis of repetition, extreme postures, and forceful movements. After the jobs were selected, ergonomic instrumentation including a video camera, goniometer, and force gauge was used to collect quantitative data for each job. Analysis methods including RULA and the NIOSH Lifting Equation were used to determine the action level and recommended weight limit for the jobs selected. The results of the analysis methods were then used to create a basis for recommending the controls to XYZ High School.

Chapter 4

Results

Introduction

The results of this study have been a culmination of the methodology described in Chapter 3. As previously discussed, three forms of analysis were utilized in determining the level of risk associated with each task. These tools included a symptom survey/body parts map, RULA, and the NIOSH Lifting Equation. The tasks that were selected for review included the dishwashing station, food serving areas, and food carrier loading. Results from these activities were used as a basis for recommending controls to the Food Service Department at XYZ High School.

Symptom Survey Results

Prior to conducting the study, a symptom survey and body parts map were given to production cooks at XYZ High School to determine the location, extent of pain, lost time, and previous medical treatment of employees. Seven out of nine employees in the Food Service Department responded to the survey. In compiling the results, each respondent was coded with a number to protect their identity. Also, the answers to each question were presented in a table format for comparison between employees. An example of the actual survey can be referenced in Appendix B.

Results of the survey concluded that all production cooks at the school had experienced pain at one time or another while performing tasks. The body parts map showed that the most common areas of pain included the lower back, wrists, and hands.

In the questionnaire, the highest percentage (57%) of reported pain was in the hands and wrists. The second highest percentage (29%) of reported pain was in the upper back, lower back, and fingers. A total of 14% of the cooks reported pain in their ankles, feet, elbows, and forearms. In terms of symptoms, the highest percentage (73%) was numbness. Forty-three percent of the employees reported symptoms of tingling and aching and 29% of the production cooks experienced general pain. Also, 14% of the cooks reported weakness, swelling and stiffness. Fifty-five percent of the cooks experienced pain within 7 days prior to the study. When the employees were questioned on the source of their injuries, the most common response was related to improper lifting technique. Other responses included repetitive motion, handwork, washing dishes, lifting frying baskets, and physical condition of muscles. When asked to rate the severity of pain on a scale of 1-10, responses ranged from 0-5 at the time of the study to 5-10 when symptoms were at their worst. Seventy-one percent of the production cooks had received medical treatment in the past for their pain symptoms. When questioned about the types of treatment employees felt would improve their condition, surgery was the most common response. A personal doctor was the most common treatment choice with a chiropractor being second. Those who had pain symptoms and did not receive treatment responded that their symptoms were not severe enough to seek treatment. In the past year, one day of lost work and restricted duty was the highest severity rate reported. The detailed information from the 16 survey questions is as follows:

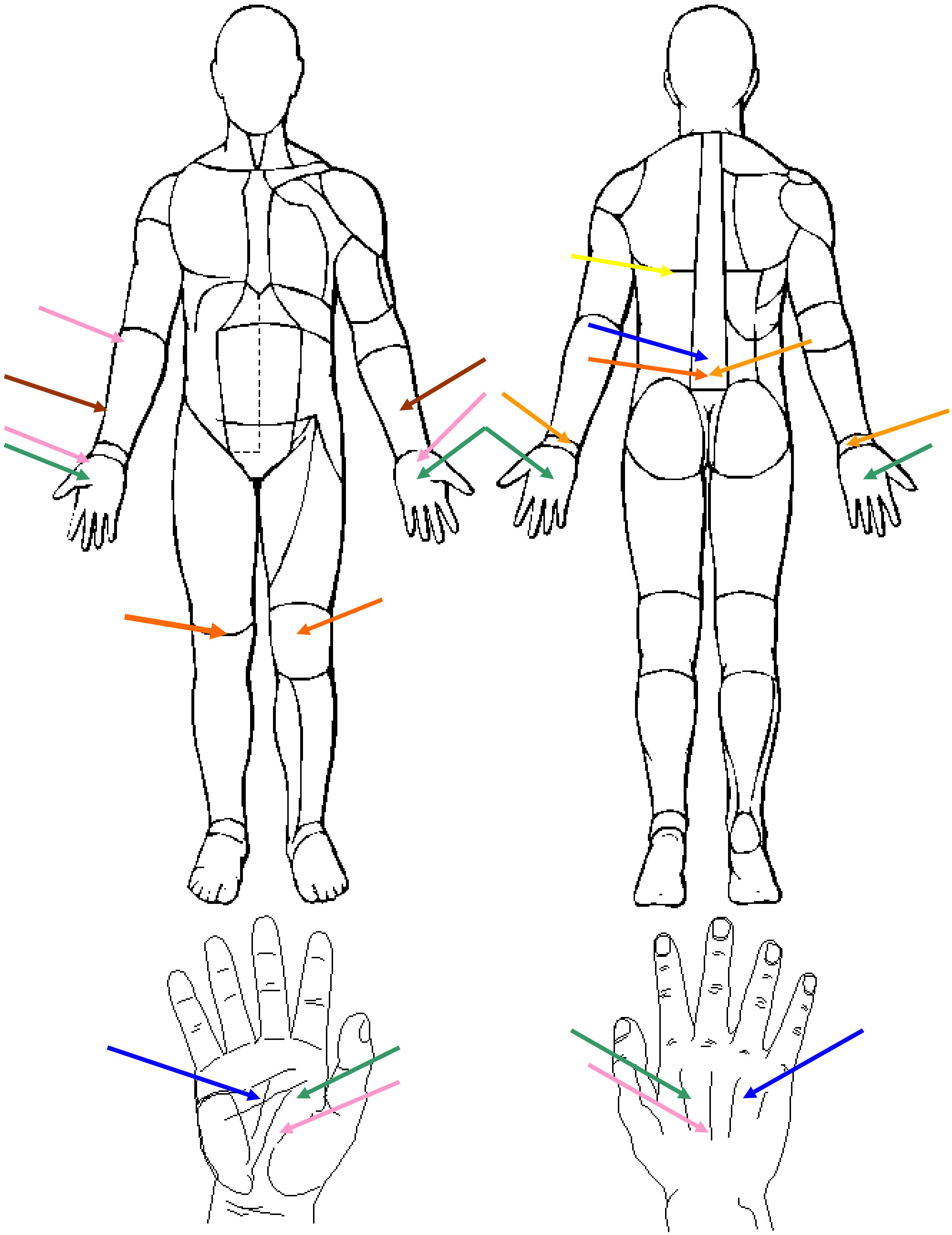
1. ***Have you had pain or discomfort during the last year?***

Employee #	Response
Employee #1	Yes
Employee #2	Yes
Employee #3	Yes
Employee #4	Yes
Employee #5	Yes
Employee #6	Yes
Employee #7	Yes

2. ***If yes, carefully shade in the area of the drawing which bothers you the MOST***

Body Parts Key

Employee #	Arrow Color
Employee #1	Blue
Employee #2	Red
Employee #3	Green
Employee #4	Orange
Employee #5	Brown
Employee #6	Pink
Employee #7	Yellow



3. Check area:

Neck	***Shoulder***	***Elbow/Forearm***	***Hand/Wrist***	***Fingers***
Upper Back	***Low Back***	***Thigh/Knee***	***Low Leg***	***Ankle/Foot***

Employee #1				
Neck	Shoulder	Elbow/Forearm	Hand/Wrist **X**	Fingers
Upper Back	Low Back **X**	Thigh/Knee	Low Leg	Ankle/Foot

Employee #2				
Neck	Shoulder	Elbow/Forearm	Hand/Wrist	Fingers
Upper Back **X**	Low Back **X**	Thigh/Knee **X**	Low Leg	Ankle/Foot

Employee #3				
Neck	Shoulder	Elbow/Forearm	Hand/Wrist **X**	Fingers **X**
Upper Back	Low Back	Thigh/Knee	Low Leg	Ankle/Foot

Employee #4				
Neck	Shoulder	Elbow/Forearm	Hand/Wrist **X**	Fingers
Upper Back	Low Back **X**	Thigh/Knee	Low Leg	Ankle/Foot

Employee #5				
Neck	Shoulder	Elbow/Forearm	Hand/Wrist **X**	Fingers
Upper Back	Low Back	Thigh/Knee	Low Leg	Ankle/Foot **X**

Employee #6				
Neck	Shoulder	Elbow/Forearm **X**	Hand/Wrist **X**	Fingers **X**
Upper Back	Low Back	Thigh/Knee	Low Leg	Ankle/Foot

Employee #7				
Neck	Shoulder	Elbow/Forearm	Hand/Wrist	Fingers
Upper Back **X**	Low Back	Thigh/Knee	Low Leg	Ankle/Foot

Total number of responses for each body segment				
Neck= **0**	Shoulder= **0**	Elbow/Forearm=**1**	Hand/Wrist= **4**	Fingers= **2**
Upper Back= **2**	Low Back= **2**	Thigh/Knee= **1**	Low Leg= **0**	Ankle/Foot= **1**

Percentage of production cooks affected in each body part				
Neck= **0%**	Shoulder= **0%**	Elbow/Forearm= **14%**	Hand/Wrist= **57%**	Fingers= **29%**
Upper Back= **29%**	Low Back= **29%**	Thigh/Knee= **14%**	Low Leg= **0%**	Ankle/Foot= **14%**

4. Please put a check by the words that best describe your problem

Aching	***Numbness (asleep)***	***Tingling***
Burning	***Pain***	***Weakness***
Cramping	***Swelling***	***Other***
Loss of Color	***Stiffness***	

Employee #1		
Aching	Numbness (asleep) **X**	Tingling
Burning	Pain	Weakness
Cramping	Swelling **X**	Other
Loss of Color	Stiffness	

Employee #2		
Aching **X**	Numbness (asleep)	Tingling
Burning	Pain	Weakness
Cramping	Swelling	Other
Loss of Color	Stiffness **X**	

Employee #3		
Aching	Numbness (asleep) **X**	Tingling **X**
Burning	Pain **X**	Weakness **X**

Cramping	Swelling	Other
Loss of Color	Stiffness	

Employee #4		
Aching **X**	Numbness (asleep) **X**	Tingling
Burning	Pain	Weakness
Cramping	Swelling	Other
Loss of Color	Stiffness	

Employee #5		
Aching	Numbness (asleep) **X**	Tingling **X**
Burning	Pain	Weakness
Cramping	Swelling	Other
Loss of Color	Stiffness	

Employee #6		
Aching	Numbness (asleep) **X**	Tingling **X**
Burning	Pain **X**	Weakness
Cramping	Swelling	Other
Loss of Color	Stiffness	

Employee #7		
Aching **X**	Numbness (asleep)	Tingling
Burning	Pain	Weakness
Cramping	Swelling	Other
Loss of Color	Stiffness	

Number of responses for each type of symptom		
Aching **3**	Numbness (asleep) **5**	Tingling **3**
Burning **0**	Pain **2**	Weakness **1**
Cramping **0**	Swelling **1**	Other **0**
Loss of Color **0**	Stiffness **1**	

Percentage of cooks affected by each type of symptom		
Aching **43%**	Numbness (asleep) **71%**	Tingling **43%**
Burning **0%**	Pain **29%**	Weakness **14%**
Cramping **0%**	Swelling **14%**	Other **0%**

Loss of Color	**0%**	Stiffness	**14%**	

5. ***When did you first notice the problem?***

Employee #	Response (Month/year)
Employee #1	Feb/1998
Employee #2	Mar/1985
Employee #3	NA/1990
Employee #4	NA/1995
Employee #5	on-going
Employee #6	Jun/2002
Employee #7	NA/2002

6. ***How long does each episode last?***

Employee #	Response (length of time)
Employee #1	1 week
Employee #2	1 day
Employee #3	years
Employee #4	1 hour
Employee #5	Ongoing
Employee #6	Whenever my hands are not kept busy
Employee #7	1 hour

7. How many separate episodes have you had in the past year?

Employee #	Response (# of episodes)
Employee #1	8-10
Employee #2	6-9
Employee #3	daily
Employee #4	No answer
Employee #5	No answer
Employee #6	Many
Employee #7	Several

8. What do you think caused the problem?

Employee #	Response
Employee #1	Poor lifting
Employee #2	Not lifting correctly
Employee #3	Hand work in food service
Employee #4	Washing dishes/Lifting frying baskets
Employee #5	Repetitive motion
Employee #6	Not enough use of muscles
Employee #7	Possibly from fall

9. Have you had the problem in the last 7 days?

Employee #	Response
Employee #1	Yes
Employee #2	Yes
Employee #3	No
Employee #4	No answer
Employee #5	Yes
Employee #6	Yes
Employee #7	Yes

10. How would you rate this problem right now? (on a scale of 1-10) 1=none 10=unbearable

Employee #	Response (1-10)
Employee #1	3
Employee #2	2
Employee #3	0
Employee #4	4
Employee #5	5
Employee #6	1
Employee #7	5

When it is the worst?

Employee #	Response (1-10)
Employee #1	8
Employee #2	8
Employee #3	7-8
Employee #4	6
Employee #5	5
Employee #6	10
Employee #7	Makes no difference

11. Have you had medical treatment for this problem?

Employee #	Response
Employee #1	Yes
Employee #2	Yes
Employee #3	Yes
Employee #4	No
Employee #5	Yes
Employee #6	No
Employee #7	Yes

12. If NO, why not?

Employee #	Response
Employee #4	Not severe enough to see doctor.
Employee #6	I have exercises that I use on my hands and also a brace to wear.

13. If yes, where did you receive treatment?

Company Medical	***Times in past year***
Personal doctor	***Times in past year***
Chiropractor	***Times in past year***
Other	***Times in past year***
Did the treatment help?	

Employee #1	Times in past year
Company Medical	0
Personal doctor	8
Chiropractor	0
Other	0
Did the Treatment help?	Yes

Employee #2	Times in past year
Company Medical	0
Personal doctor	0
Chiropractor	15

Other	0
Did the Treatment help?	Yes

Employee #3	Times in past year
Company Medical	0
Personal doctor	Surgery of summer 2002
Chiropractor	0
Other	0
Did the Treatment help?	Yes

Employee #7	Times in past year
Company Medical	0
Personal doctor	September
Chiropractor	0
Other	0
Did the Treatment help?	No

14. How much time have you lost in the last year because of this problem?

Employee #	Response
Employee #1	none
Employee #2	none
Employee #3	NA
Employee #4	none
Employee #5	none
Employee #6	none
Employee #7	1 day

15. How many days in the last year were you on restricted or light duty because of this problem?

Employee #	Response
Employee #1	none
Employee #2	none
Employee #3	NA
Employee #4	none
Employee #5	none
Employee #6	none
Employee #7	1 day

16. Please comment on what you think would improve your symptoms

Employee #	Response
Employee #1	none
Employee #2	none
Employee #3	Surgery was the only solution
Employee #4	none
Employee #5	none
Employee #6	Surgery for carpal tunnel/ use muscles
Employee #7	none

RULA Results

Three jobs were selected for review in the food service department based on an observation conducted by the researcher prior to the study. These tasks included the dishwashing area, food serving stations, and loading carriers of food for transport. Selection of tasks was based on results of the symptom surveys as well as risk factors related to repetition, awkward posture and excessive force. Results of the RULA assessments were based on the calculation of a grand score that was used to determine an action level (RULA assessments of these tasks can be referenced in Appendix A). As stated in Chapter 2, the action levels are as follows:

- **Action level 1**

  Scores of 1 or 2 indicate acceptable postures if not repeated for long periods.

- **Action level 2**

  Scores of 3 or 4 indicate a need for further investigation and possible changes.

- **Action level 3**

  Scores of 5 or 6 indicate changes are required soon.

- **Action level 4**

  A score of 7 indicates that investigation and changes are required immediately.

The final score of the dishwashing station assessment was a 7. This constituted an action level of 4, which indicated that investigation and changes were required immediately. The particular areas that contributed to the high score included the abduction of the upper arm between 45 and 90 degrees as well as extreme bending at the waist greater than 60 degrees. In terms of the serving line, a final score of 6 was calculated. This score fell into the action level category of 3, which stated that changes were required soon. Factors that contributed to this score include upper arm abduction between 45 and 90 degrees, wrist postures involving twisting and bending from the midline of the hand, and a trunk position between 20 and 60 degrees. Results of the carrier loading task included a final score of 7 which fell in the action level category of 4 that indicate an investigation and changes were required immediately. Areas related to this score include upper arm abduction between 45 and 90 degrees, a force load score between 2-10Kg, and extreme trunk bending posture greater than 60 degrees.

NIOSH Lifting Equation Results

The NIOSH Lifting Equation was used exclusively on the task of loading food carriers for transport. This job was selected for analysis on the basis of the extreme postures involved in lifting and lowering items and handling a variety of different types of containers. A number of measurements were taken in order to determine the multipliers substituted into this equation. The NIOSH Lifting Equation for determining the recommended weight limit (RWL) was as follows:

RWL=LC x HM x VM x DM x AM x FM x CM

Answer:

RWL=51(.294)(.858)(.853)(1)(.52)(.95)= 5.4 Lbs.

Abbreviation	Name	Notes	Final Values
LC	Load Constant	Always 51#	51
HM	Horizontal Multiplier	(10/H)	.294
VM	Vertical Multiplier	1-(.0075 |V-30|)	.858
DM	Distance Multiplier	.82 + (1.8/D)	.853
AM	Asymmetric Multiplier	1-(.0032A)	1
FM	Frequency Multiplier	See table in Appendix B	.52
CM	Coupling Multiplier	See table in Appendix B	.95
RWL	Recommended weight limit	Weight an employee can safely handle for 8/hrs.	5.4 lbs.

According to the results of this equation, an employee can safely handle 5.4 lbs. during an 8-hour workday at this particular job.

The RWL was then used to determine the lifting index (LI). The LI provides an estimate of physical stress associated with lifting tasks. Values of 1.0 or greater suggest problems for a fraction of the population. The results of the lifting index (LI) for this job are as follows:

LI = ***<u>(Load Weight)</u>***

(Recommended Weight Limit)

LI = <u>(30 lbs.)</u> = 5.5 (maximum amount of weight handled)

(5.4 lbs.)

LI = <u>(5 lbs.)</u> = .93 (minimum amount of weight handled)

(5.4 lbs.)

These results indicate that employees performing the task of loading food into carriers may be at risk of injury to the lower back as well as other body components.

Summary

The results of the symptom surveys, RULA and NIOSH Lifting Equation have all produced significant findings. The symptom surveys determined that 57% of production cooks experienced pain in their hands and wrists with the most common form of pain being numbness (73%). The most frequent areas of pain reported on the body parts map included the lower back, hands, and wrists. Results of the RULA analyses determined that the dishwashing station required an action level of 4, the serving stations required an action level of 3, and loading of food into carriers required an action level of 4. The calculated RWL for the NIOSH Lifting Equation was 5.4 lbs. and the lifting index was determined to be between .93 - 5.5.

Chapter 5

Conclusion and Recommendations

Introduction

This field problem involved a study of CTD injuries, ergonomic risk factors, and workstation design at XYZ High School. Within this study, a variety of information was gathered from case studies to provide a background of previous research, ergonomic risk factors, cumulative trauma injuries, instrumentation, analysis methods, and controls. The methodology outlined the study procedures, subject selection, task analysis, and instrumentation use. The results of the study found a number of significant findings in terms of activities that may be a contributing to the cause of CTD injuries at XYZ High School. This chapter will briefly review the problem statement, goals of the study, and methodology. Also, major findings, conclusions, recommendations, and controls will be presented to XYZ High School.

Restatement of the Problem

The food service department at XYZ High School has experienced a significant amount of loss related to cumulative trauma illnesses in the past year. The target group of personnel who have been experiencing these injuries are the production cooks in the Food Service Department. Injuries that have accrued thus far include elbow tendonitis, a pinched neck nerve, a torn rotator cuff, and a herniated disk. Upon visual inspection of the environment, it seemed apparent that the workstation design was unable to accommodate the range of anthropometric differences between employees. Consequently, it is highly possible that the injuries experienced by the production cooks at XYZ High School were the result of inadequate workstation design as well as poor work practices.

Restatement of the Research Objectives

The following objectives outline the goals of this study:

- Identify the prevalence of musculoskeletal discomfort that employees at XYZ High School are experiencing.

- Conduct a workstation analysis utilizing current ergonomic tools.

Methods and Procedures

A number of procedures were selected to conduct this study. First, production cooks from XYZ High School were selected to participate because a number of CTD injuries had been experienced in the Food Service Department. Symptom surveys were distributed to determine the location and types of pain experienced by the employees while performing tasks. After reviewing the symptom surveys, high-risk jobs were selected for analysis by the researcher on the basis of repetition, extreme postures, and forceful movements. Next, ergonomic instrumentation including a video camera, goniometer, and a force gauge were used to collect quantitative data for each job. Analysis methods including RULA and the NIOSH Lifting Equation were then used to determine the action level and recommended weight limit for each job selected.

Major Findings

The results of this study determined that there were a number of tasks that pose a significant threat to production cooks at XYZ High School. These tasks included:

- The dishwashing station
- Loading boxes of food into carriers for transport to outside area schools
- Food serving stations

After review of the symptom surveys, it was determined that all personnel in the department had experienced pain at one point or another while performing their jobs. Fifty-seven percent of production cooks experienced pain in their hands and wrists with the most common ailment being numbness (73%) in non-specific parts of the body. The most frequent parts of pain reported on the body parts map included the lower back, hands, and wrists. Results of the RULA analyses found that the dishwashing station required an action level of 4, the serving stations required an action level of 3, and loading of food into carriers required an action level of 4. The calculated RWL for the NIOSH Lifting Equation was 5.4 lbs. and the lifting index was determined to be between .93 - 5.5.

Conclusions

Through observations prior to the study, the researcher determined that there were a wide variety of potentially hazardous tasks performed on a semi-routine basis related to preparing different menus for each day of the week. Therefore, while employees were exposed to potentially hazardous tasks on a daily basis, it was uncommon for the same jobs to be repeated from day to day. Because of this scenario as well as time restrictions, the researcher decided to narrow the focus of the study and select the top three tasks performed routinely that posed the greatest threat to the production cooks. These tasks included the food serving stations, dishwashing area, and food carrier loading. A number of correlations can be drawn between the results of the analysis methods and survey results.

In the RULA analysis of the food serving station at the cafeteria, the calculated final score was 6. This constituted an action level of 4 that suggests immediate investigation and changes are necessary. In the analysis, three high scoring factors contributed to this action level that included a raised and abducted upper arm position, extreme forward bending and twisting of the wrist. These findings positively correlate with the results of the symptom surveys, which concluded that 57% of the cooks reported wrist pain, 29% of production cooks experienced back pain and 14% experienced pain in the arms. The factor of upper arm pain also correlated with the repetition guidelines set forth by NIOSH because the employee's arm movements exceeded the maximum recommended level of 10 per minute. During the observation and analysis, the researcher determined two variables that may have contributed to these findings. These factors included equipment design and work practices. In terms of equipment, workstations were set at a specific height and were not adjustable. This, coupled with the work practice of placing the long section of food trays away from the worker, caused excessive bending to reach food towards the back of the pan. During the analysis, the researcher noticed that the varying heights of the employees in relation to the fixed workstation height played a role in the degree of bending required.

The analysis of the dishwashing station produced a final RULA score of 7 that corresponded to an action level of 4. This station caused particular concern to the researcher due to the extreme forward and side-bending movements of the trunk required when retrieving food trays. Also, the upper arm score was relatively high due to the extent of reaching required to retrieve trays from under the rack. Results and correlations of this station were quite similar those of the food serving station in that 29% of the respondents reported back pain and 14% reported pain in their upper arms. In this area, the main cause of these results was due to workstation design that forced employees to reach under a stacking rack to retrieve lunch trays for washing. At the time of the study, the rack was not being used for any purpose besides holding a soaking bin for silverware.

The food carrier loading area was analyzed with RULA for extreme posture quantification and the NIOSH Lifting Equation for lifting hazards. In terms of RULA, the final calculated score was 7, which falls under the action level category of 4. A number of extreme postures contributed to this score including upper and lower arm movements that were associated with reaching to place food into carriers, forward bending of the trunk as a result of reaching, and a high force load related to lifting heavy boxes of fruit and pans of soup. As discussed in the previous tasks, this area also correlated with symptom survey results where 29% of the subjects experienced back pain, and 14% reporting arm pain. After analysis of this operation with the NIOSH Lifting Equation, it was determined that the recommended weight limit (RWL) was 5.4 pounds. This refers to the fact that 5.4 pounds is the load that an employee could safely handle if performing this task for an 8-hour work shift. When calculations were made for this equation, the worst-case force/load scenario was used in terms of a 30-pound box of apples. Therefore, since employees handled this weight rather infrequently, the presented RWL is very conservative in nature and should be taken subjectively. In other words, employees performing this job are capable of safely handling loads considerably heavier than 5.4 pounds because maximum loads are infrequently handled. Also, the job is not performed for an 8-hour workday. Another calculation determined by the NIOSH Lifting Equation was the lifting index (LI). The LI refers to a measure of the physical stress associated with lifting tasks. According to standards set forth by NIOSH, a LI of less than 1 suggests problems for a smaller fraction of the population. The calculated LI for lifting a 5-pound object during this task is .93 and the LI for a maximum lift of 30 pounds was 5.5. According to these values, objects that are lifted in this task between 5 and 30 pounds pose a significant risk. However, because the RWL was conservative in nature, the calculated LI in this task was also quite conservative because it was calculated by dividing the load weight by the RWL (See Chapter 4 results for equation). When comparing the results of RULA and the NIOSH Lifting Equation it can be concluded that while this task had the potential to place a considerable amount of stress on the individual, the majority of risk associated with this job fell in the category of extreme posture.

When analyzing the three routine tasks selected by the researcher as a whole, there are a number of interesting correlations that can be drawn between them (see table 1 for illustration). First, all three jobs were found to pose extreme postures to the trunk. Therefore, it is highly possible that these three jobs may be contributing to the lower back and arm pain expressed in the symptom surveys. Also, all three jobs posed a significant amount of threat in terms of extreme posture to the upper arms. This issue was also pointed out in the symptom surveys. One aspect that stood out to the researcher was the fact that only the serving line posed a considerable amount of risk to the hands and wrists. According to the survey results, the highest reported area of pain was in this vicinity (57%). Since tasks were selected for this study on the premise of routine activities, it is highly possible that the hand and wrist injuries were occurring from non-routine repetitive tasks such as daily food preparation. Unfortunately non-routine tasks were not studied in great detail within this study due to time restrictions. Therefore, recommendations for further research were suggested in these areas.

In addition to the analyses conducted, there were a number of other factors brought to attention when searching for causes of CTDs in the Food Service Department. During observations prior to the study, the researcher noticed several work practices that posed awkward postures. First, some employees had the tendency to place pans towards the back of worktables when preparing food. This scenario created a longer reach for employees resulting in excessive bending of the trunk. Also, some employees frequently placed pans with the long ends away from the body, which resulted in awkward postures. Another observation made was the uneven distribution of the workload. This was due in part to the fact that the department was two employees short because of injuries, which caused the rest of the workers to assume the workload. To make matters worse, there were a number of employees within the kitchen who had physical restrictions stemming from previous injuries. Because of this, some employees were exposed to a larger percentage of repetitive movement and lifting than others. This situation had a direct effect on the worker's ability to rotate between jobs and lessen exposure.

In summary, through observation prior to the study, interviewing employees, and results of the analysis methods, a number of conclusions can be drawn. Because of the nature of work and number of variables involved in performing the job functions of a production cook at XYZ High School, it was not possible to pin-point one particular area or task that had been causing most of the CTD injuries. Rather, it can be concluded that the injuries may have resulted from repeated micro trauma over time from performing a variety of jobs requiring awkward postures and/or repetitive movements. Factors that may have contributed to the severity of these risk factors include workstation design, work practices, and equipment. Because of the vast number of variables and non-routine nature of the production cook's daily routine, there is no single solution that will prevent all future occurrences of CTDs at XYZ High School. However, a number and combination of recommendations will be presented in an attempt to mitigate the problem as much as possible within the scope of this study.

Figure. 1

Reviewed Task	(RULA) Action Level (1-4)	Risk factors associated with job
Dishwashing (retrieving trays)	4	Workstation design
Food Serving	4	Workstation design, work practices, equipment
Carrier loading	4	Workstation design

Recommendations Related To This Study

As reported in Chapter 2, there are two types of controls that can be implemented when making improvements. These include administrative and engineering. When considering recommendations in terms of these controls, it is important to determine what is feasible. While money is often the limiting factor when implementing changes, one must observe the total cost of injuries to put things in perspective. According to a study published by Silverstein, Welp, Nelson, and Kalat (1998), the average worker's compensation costs related to carpal tunnel were $12,794, the average cost of rotator cuff injuries were $15,790, and $6,593 for epicondylitits. According to this study, it was found that the construction and food processing industries had the highest rates for the disorders listed Silverstein, et al., 1998. Therefore, it is highly possible that production cooks at XYZ High School have the potential to be at risk for developing these injuries as well as accumulating the associated direct costs. However, the only costs discussed by this study were direct. Indirect costs related to lost productivity, hiring replacement employees, training, and the morale of those who must assume the responsibilities of injured parties, can add four times to the cost of injuries. Therefore, when considering changes, it is more feasible in the long run to implement engineering controls to eliminate the problem. If job hazards are unable to be engineered out or if it is impractical for the situation, administrative controls are the next best choice. Through the analysis of the food serving line, dishwashing station, and carrier loading, the researcher has determined a number of suggestions in terms of engineering and administrative controls to be considered by XYZ High School.

In terms of the dishwashing station, a number of ideas can be considered. As far as engineering controls, the ideal situation would be to remove the stacking rack that is causing employees to perform extreme postures. Through interviewing employees, many felt that the removal of this rack would be highly beneficial in making their jobs easier. However, it is up to school personnel to determine if this rack will be used for a certain purpose or if it is an unnecessary nuisance. If a decision is made to keep the stacking rack, a number of administrative controls can be implemented. One possibility would be to block off the lower section of the rack with washing bins to force students to place trays on the rack. Another technique that could be used is to require students to push trays out from underneath the rack to eliminate excessive bending while trays are being retrieved.

There are a number of possibilities that can be considered when controlling risk factors associated with the food serving line. In terms of engineering controls, the researcher recommends placing an emphasis on the serving equipment used that will help minimize stress to the hands and wrists. According to employee interviews, use of the ice cream scoop placed an undesirable amount of stress on the thumb. Because of this, it may be worthwhile to explore alternative styles of this tool. In terms of administrative controls, management may want to consider rotating employees between jobs to reduce exposure to repetitive serving tasks. Management may also want to consider training employees on work practices relating to tray placement and proper lifting techniques.

In making recommendations for the carrier loading area, there are a number of limitations that inhibit the extent of engineering controls that can be implemented. The ideal scenario would be to place a spacer between the cart and the carrier to raise it to a level that would reduce the amount of bending. This, however, will not work in the present situation because items are stacked on top of the carriers to a point where they just clear the doorway. Another idea is to simply add more carts in order to reduce the amount of stacking required. However, there is a limited amount of space available due to the fact that shipments are delivered and stored in this area. If management was able to find additional space for more carts, spacers could then be used to raise the height of the carriers. Therefore, less material would have to be stacked on top. If engineering controls are deemed unfeasible in this situation there are a number of administrative options that can be explored. As expressed in the previous recommendations, rotating workers in and out of this job would help to lessen exposure. Also, training on proper lifting techniques may aid workers in executing lifts safely and properly.

Aside from implementing controls that are specific to the jobs analyzed, there are a number of other general recommendations that can be considered to help reduce the risk involved in the development of CTDs for production cooks. The first recommendation is to train cooks on the proper execution of work processes as well as lifting techniques. A second recommendation is informing cooks on the risk factors and symptoms of CTDs so that they can be recognized early and dealt with proactively before they become severe. A third recommendation is that XYZ High School may want to consider is implementing an exercise and/or stretching program. This would proactively attempt to maintain employee's health and reduce the loss of work time from related injuries.

In conclusion, the recommended controls listed are an attempt to mitigate CTD injuries occurring at the XYZ High School. In an ideal world, engineering controls are the best solution when mitigating these problems. However, these controls are not always feasible. It appears that due to the non-routine nature of the production cook position, management may want to consider a combination of engineering controls for certain types of equipment and administrative controls to maintain a healthy workforce, educate on lifting techniques, and train on proper work processes. It is up to the personnel at XYZ High School to determine which controls will best fit their current situation and budget.

Recommendations for Further Study

Due to the fact that this was a semester study, the researcher was limited by the amount of coverage and time that could be expended on the production cook job. In the opinion of the researcher, there are a number of areas in the kitchen as well as duties of the production cook position that could benefit from further research. In this study, routine jobs of the production cook were the major focus. According to the results of the symptom surveys, the highest percentage of cooks (57%) reported pain in their hands and wrists. Relating this figure to the tasks that were analyzed, the only job that posed a threat in this area was the food serving station. These findings lead the researcher to believe that pain related to the hands and wrists was a result of non-routine jobs that were not covered in great detail within this study. In the future, the Food Service Department would benefit from further research in the area of non-routine tasks with the major area being food preparation; more specifically, the hand and wrist movements related to preparing these foods. In terms of equipment, the researcher also recommends further study in the interaction of the hands and wrists with the tools used. Some of the equipment that caused concern to the researcher included:

- The can opener – requiring forceful movements of the upper arms, wrists, and hands
- The deep fryer – demanding awkward postures associated with the shoulder, upper arm, and wrist
- The dishwashing station – which caused repetitive motion related to rinsing trays

As stated earlier, the researcher was led to believe that the results of this study indicated that hand and wrist problems were related to non-routine tasks. The aforementioned tasks would be a good place to explore further research.

APPENDICES

APPENDIX A

MSD Symptoms Survey **Date ____/____/________**

Approximate time on this job?

1. Have you had pain or discomfort during the last year?

[ ] Yes [ ] No (if NO, Stop here)

2. If YES, carefully shade in the area of the drawing which bothers you the MOST.

(Complete a separate page for each area that bothers you)

3. Check Area: [ ]Neck [ ]Shoulder [ ]Elbow/Forearm [ ]Hand/Wrist [ ]Fingers

[ ]Upper Back [ ]Low Back [ ]Thigh/Knee [ ]Low Leg [ ]Ankle/Foot

4. Please put a check by the word(s) that best describe your problem

[ ]Aching	[ ]Numbness (asleep)	[ ]Tingling
[ ]Burning	[ ]Pain	[ ]Weakness
[ ]Cramping	[ ]Swelling	[ ]Other
[ ]Loss of Color	[ ]Stiffness	

5. When did you first notice the problem? __________(month) __________(year)

6. How long does each episode last? (Mark an X along the line)

_____/_____/______/______/______/

1 hour 1 day 1 week 1 month 6 months

7. How many separate episodes have you had in the past year? ____________________

8. What do you think caused the problem?

9. Have you had the problem in the last 7 Days? [ ]Yes [ ]No

10. How would you rate this problem (On a scale of 1-10) 1=none 10=unbearable

Right now

When it is the WORST

11. Have you had medical treatment for this problem? [ ]Yes [ ]No

12. If NO, why not? ____

13. If YES, where did you receive treatment

[ ] 1. Company Medical Times in past year ____________________

[ ] 2. Personal doctor Times in past year ____________________

[] 3. Chiropractor Times in past year ____________________

[ ]4. Other Times in past year ____________________

Did treatment help? [ ]Yes [ ]No

14. How much time have you lost in the last year because of this problem?	____ days
15. How many days in the last year were you on restricted or light duty because of this problem?	____ days
16. Please comment on what you think would improve your symptoms	

____

____

____

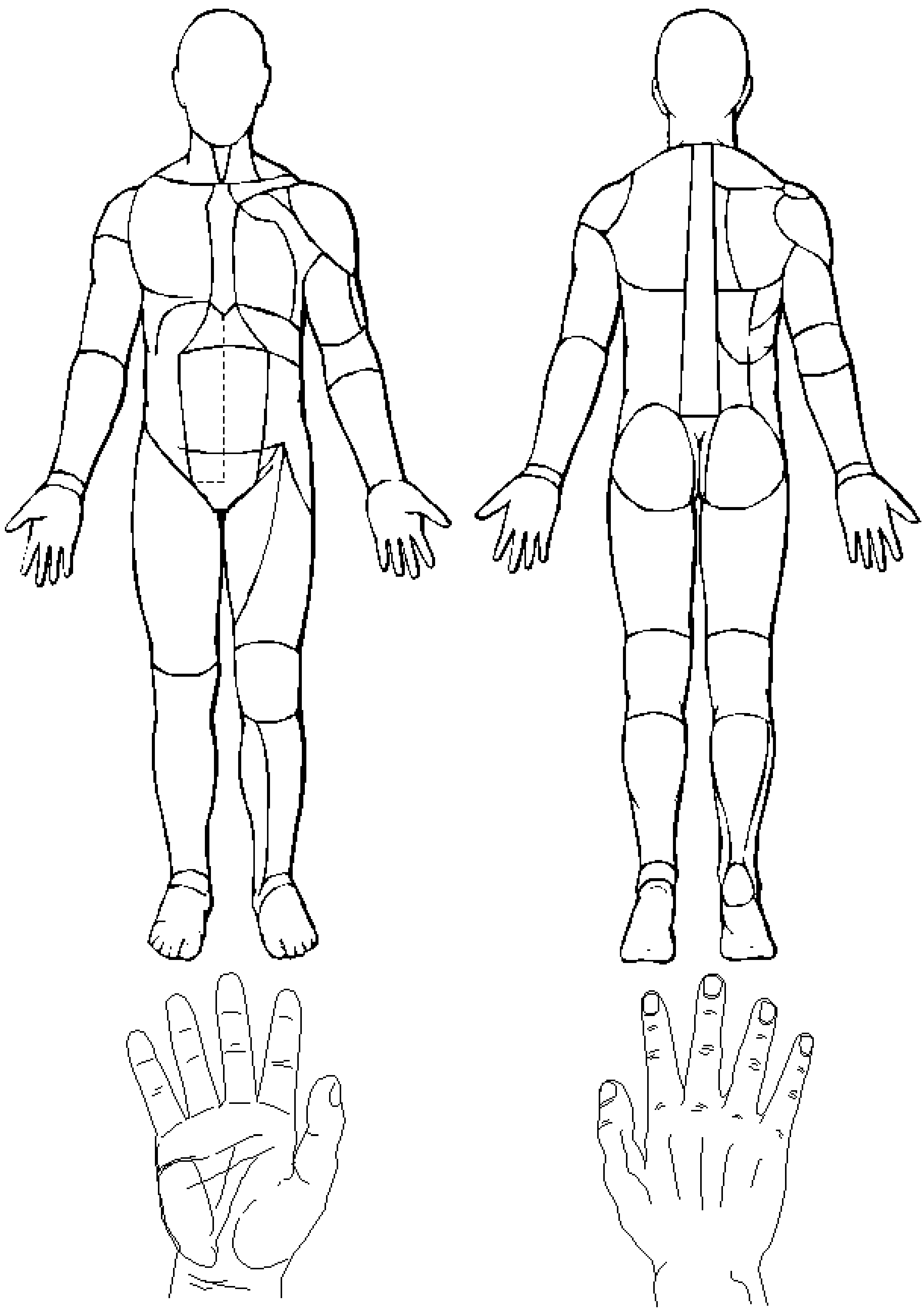
____

____

Ergonext, (2001). *MSD symptom survey,* Retrieved November 2, 2002 from http://www.ergonext.com/prevention.html

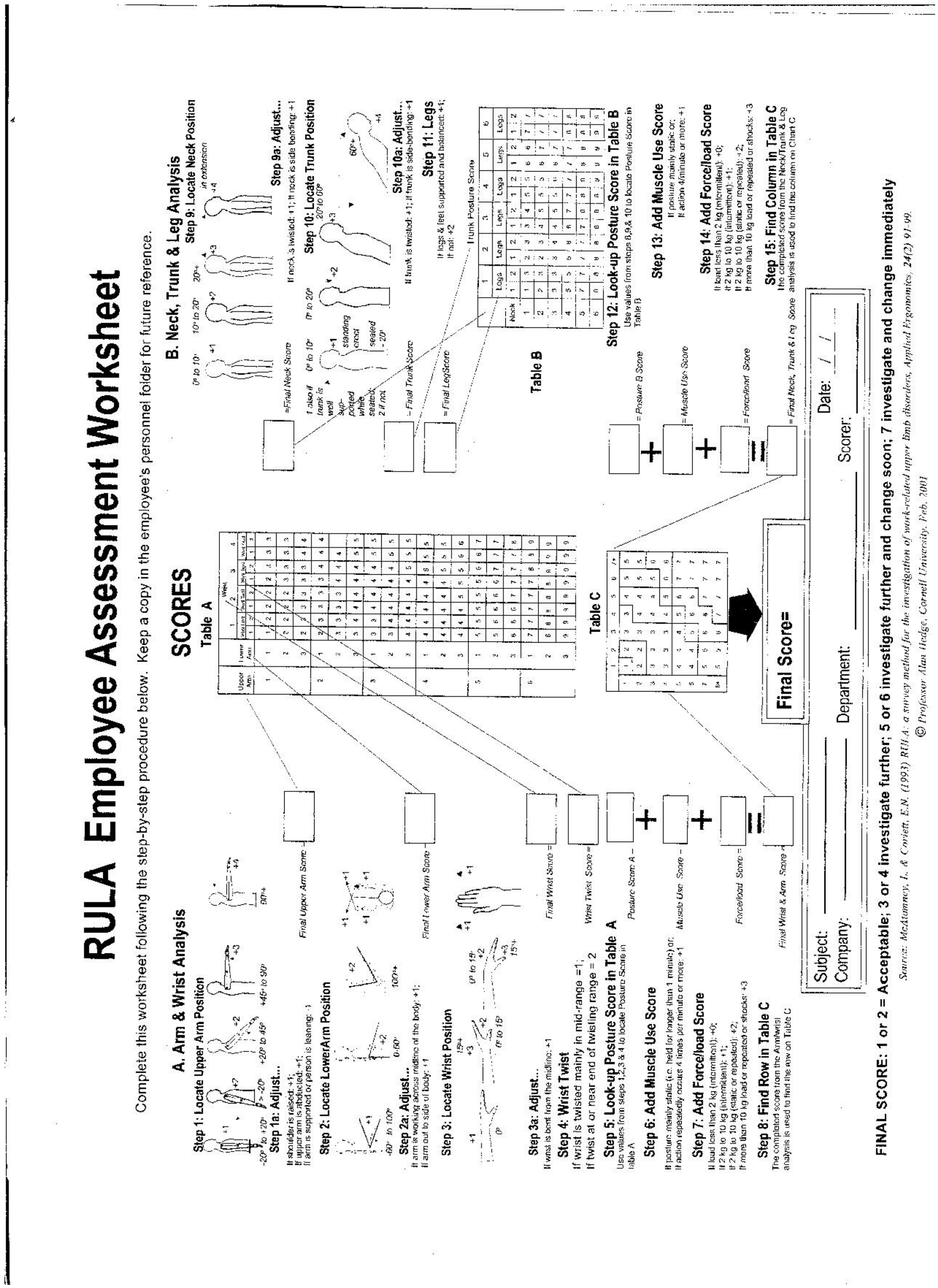
MSD Symptom Survey Locations

Please shade the exact areas of discomfort with a pencil



From: Ergonext. (2001). *MSD survey location,* Retrieved November 2, 2002 from http://www.ergonext.com/prevention.html

APPENDIX B


RULA Employee Assessment Worksheet
Complete this worksheet following the step-by-step procedure below. Keep a copy in the employee's personnel folder for future reference.
A. Arm & Wrist Analysis
Step 1: Locate Upper Arm Position
Step 1a: Adjust...
Step 2: Locate LowerArm Position
Step 2a: Adjust...
Step 3: Locate Wrist Position
Step 3a: Adjust...
Step 4: Wrist Twist
If wrist is twisted mainly in mid-range =1;
If twist at or near end of twisting range = 2
Step 5: Look-up Posture Score in Table A
Step 6: Add Muscle Use Score
Step 7: Add Force/load Score
Step 8: Find Row in Table C
SCORES
Table A
Table C
Final Score=
B. Neck, Trunk & Leg Analysis
Step 9: Locate Neck Position
Step 9a: Adjust...
Step 10: Locate Trunk Position
Step 10a: Adjust...
Step 11: Legs
Table B
Step 12: Look-up Posture Score in Table B
Step 13: Add Muscle Use Score
Step 14: Add Force/load Score
Step 15: Find Column in Table C
Subject:
Company:
Department:
Score:
Date:
FINAL SCORE: 1 or 2 = Acceptable; 3 or 4 investigate further; 5 or 6 investigate further and change soon; 7 investigate and change immediately
Source: McAtamney, L. & Corlett, E.N. (1993) RULA: a survey method for the investigation of work-related upper limb disorders, Applied Ergonomics, 24(2) 91-99.
© Professor Alan Hedge, Cornell University. Feb. 2001

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