HETA 94–0245–2577
Hanover Shoe Company
Franklin, West Virginia

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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Health Hazard Evaluation Report HETA 94–0245–2577

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May 1996

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SUMMARY

In June 1994, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at the Hanover Shoe Company in Franklin, West Virginia. The HHE request expressed concern over exposure to ergonomic risk factors, including repetitive motion, and reported that employees in the Making II Department were experiencing wrist, back, and shoulder pain. In response, NIOSH personnel conducted a site visit on July 27 and 28, 1994.

A questionnaire was administered to employees in the Making II Department concerning personal demographics, work history, job activities, and musculoskeletal symptoms. Forty-eight individuals were videotaped for at least three work cycles and postural data were abstracted from the videotapes for each work element within the job cycle. Review of the Occupational Safety and Health Administration (OSHA) 200 logs showed that the muscloskeletal disorders reported for 1993 included five cases of tendinitis, two cases of carpel tunnel syndrome, one case of tenosynovitis, and one case of thoracic outlet syndrome. Sixty-five out of 67 workers (97%) completed the questionnaire (2 employees were on long-term disability). Forty-nine (75%) of the employees were male and 14 (22%) were female (2 individuals (3%) did not answer the gender question). The average length of employment was 9.7 and 9.5 years for males and females, respectively. Forty (62%) of the respondents classified the physical effort necessary to perform their job as hard, very hard, or very, very hard. Fifty-five (85%) reported some body discomfort for the year prior to the site visit (82% upper extremity [UE] and 52% back). The majority of jobs had risk factors for work-related musculoskeletal disorders (WRMDs), including short work cycle times (41 [85%] were less than 30 seconds), piece work rates, and non-neutral postures of the trunk (90%), shoulder (98%), and wrist (94%). All of the jobs required pinch grips to grasp and manipulate the shoes.

The results of this investigation at the facility indicate that a potential health hazard for WRMDs exists for employees in the Making II Department. Recommendations are provided on page 8 to help reduce stress factors for WRMDs using engineering controls and process changes. Examples of engineering controls include, but are not limited to, adjustments to the height of work surfaces, seating with low back (lumbar) support, task lighting, and the use of power shears in place of scissors.

Keywords: SIC 3143 (Men's Footwear, Except Athletic), ergonomics, work-related musculoskeletal disorders, WRMDs, postural analysis, pinch grip, carpal tunnel syndrome, tendinitis.

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INTRODUCTION

In June 1994, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at the Hanover Shoe facility in Franklin, West Virginia. The HHE request expressed concern over exposure to ergonomic risk factors, including repetitive motion, and reported that employees in the Making II Department had developed symptoms such as wrist, back, and shoulder pain due to work. In response, NIOSH personnel conducted a site visit at the plant on July 27 and 28, 1994, to evaluate these employee concerns. This report discusses the details of the site visit and presents our findings and recommendations.

BACKGROUND

The Hanover Shoe Company began operation in Franklin, West Virginia, in 1966. At the time of the site visit, the company employed 704 workers on three shifts. The facility produces men's welt (sewn) and cement (glued) shoes for a variety of customers, including Bostonian, Hanover, and J.C. Penney. The Cutting Department starts with raw materials (primarily cow hides) and cuts the various pieces used to make the shoes. In the Stock Fitting Department, the manufactured components (heels, soles, insoles, heel pads, etc.) needed to complete each case lot of shoes are gathered in boxes. In the Fitting Department, the cut pieces of leather are marked and prepared. The shoe uppers are sewn together. In the Lasting Department, stiffeners (boxtoes and counters) are added to the uppers and each upper is wrapped around the last (the form inside the shoe). In the Making I Department, the sole is either sewed or cemented to the shoe upper.

In the Making II Department, lasts are removed and heels are attached by nailing. The heel area of the shoe is then trimmed and scoured. The next operation is edge trimming where shape is given to the sole edge and where the edges are slicked. Dye and ink are applied to sole edges using hand brushes. The sole edges are burnished (shined) using wax and mechanical brushes. Shoe bottoms are cleaned or sanded. Some shoe bottoms are stained and then bottom finished. Cement construction shoes have lasts pulled, heels nailed, and bottoms brushed in this department. The shoes then go to the Treeing Department where they are cleaned, shined, inspected, and packed for shipping.

This investigation centers around the Making II Department. At the time of the site visit, this department employed 67 individuals on first and second shift. These employees work in accordance with a piece rate pay system.

The company has established a medical management program for the prevention and treatment of cumulative trauma disorders (CTDs) with support from two treating physicians in the community and a consulting physician who is certified in occupational medicine. There are three basic protocols that are based on symptoms reported by the employee to the facility nurse for upper extremity problems. The protocols are based on the presence or absence of pain, inflammation/swelling, infection, or neurologic symptoms. Three protocols have also been developed for addressing back pain. Thirty-three limited-duty jobs have been identified for this facility. According to company files, limited-duty jobs in the Making II Department included inking, removing heel flange (one-handed job), edge scraping, and washing shoe bottoms.

METHODS

On July 27, 1994, NIOSH personnel met with management in an opening conference. Following this meeting, a walk-through survey of the plant was conducted. The Occupational Safety and Health Administration (OSHA) 200 logs for 1993 and January-July 1994 were reviewed for information pertinent to the health hazard evaluation. Information was gathered concerning the elements of the company's ergonomic program, including the medical management program, exercise program, and ergonomic changes that had been implemented.

Questionnaires were administered to all employees in the Making II Department that were present during the site visit. The questionnaire solicited information on personal demographics, length of employment, current job task characteristics, including lifting, bending, and pushing, estimates of forces used to perform the job, and hand tools. The questionnaire also asked workers to report injuries at work and any musculoskeletal discomfort that occurred in the past year on a four-point scale (0 = no discomfort to 3 = extremely uncomfortable). The questionnaire was administered to employees in groups of 10-12 in a conference room where the questionnaire and the purpose of the site visit were explained and the workers were allowed to complete the forms. The company paid the employees the average piece rate for the time off the work floor to complete the questionnaire. The company provided information on employee start date, job title, production data, and injury log data for each employee in the Making II Department. Copies of the questionnaire and the company-provided employee information sheet are included in Appendix A.

All jobs in the Making II Department were videotaped. Forty-eight workers were videotaped performing their usual assigned job for at least three work cycles. Postural data was abstracted from the videotapes for each element in the work cycle. Hand postures are classified as open, closed, or lateral pinch, or finger press grip. Wrist postures and postural (angular) ranges are characterized in terms of flexion (> 30 degrees), extension (> 45 degrees), ulnar deviation (angle not specified), and radial deviation (angle not specified). Ulnar deviation is defined as bending the wrist toward the little finger; radial deviation is bending the wrist toward the thumb; extension is bending the wrist up and back, and flexion is bending the wrist down toward the palm. Forearm postures are identified as pronation (palm down) or supination (palm up). Shoulder postures and postural (angular) ranges are classified as elevation (angle not specified), extension (behind midline of torso), flexion (> 45 degrees), abduction (> 45 degrees), or adduction (angle not specified). Neck flexion (>20 degrees) is also identified where present. Trunk postures and postural (angular) ranges are characterized as lateral bending (>20 degrees), mild flexion (20-44 degrees), severe flexion (> 45 degrees), and twisting (>20 degrees).

LITERATURE REVIEW

Work-related musculoskeletal disorders (WRMDs) have been found in previous studies to occur in workers whose jobs require repetitive movements, forceful exertions, and awkward body postures. The 1992 Bureau of Labor Statistics (BLS) Survey provided evidence of a twelve-fold increase in the number of new cases of repeated trauma since 1980, up from 23,200 cases to more than 280,000.[1] Men's footwear, except athletic (SIC 3143) is listed among the BLS "Industries with the highest nonfatal illness rates of disorders associated with repeated trauma, private industry, 1994."[1] The 1993 rate was 255.4 and the 1994 rate was 309.7 per 10,000 full-time workers.[1]

WRMDs can affect the tendons, tendon sheaths, muscles, and nerves. WRMDs include conditions such as tendinitis, synovitis, tenosynovitis, bursitis, ganglionic cysts, strains, DeQuervain's disease, and carpal tunnel syndrome (CTS). Studies have shown that WRMDs can be precipitated or aggravated by activities that require repeated or stereotyped movements, forceful exertions, awkward postures, or exposure to hand/arm vibration.[2,3,4] Upper extremity postures (UE) often associated with WRMDs are extension, flexion, and radial deviation of the wrist, pinching, twisting movements of the wrist and elbow, and reaching over shoulder height.[4] It is widely believed that chronic exposures to these biomechanical stressors can lead to the development of persistent musculoskeletal symptoms and eventual musculoskeletal disease.[5] Industries associated with high incidence of WRMDs, include electronic components assembly, garment manufacturing, small appliance manufacturing and assembly, meat and poultry processing, and shoe manufacturing.[6,7,8]

Despite the BLS listing as a high risk industry, there is little information in the published literature to date documenting ergonomic hazards or WRMDs in the shoe manufacturing industry. One evaluation by Drury and Wick [1984] was conducted at a shoe manufacturing facility in New England.[9,10] The study addressed injuries to the back and shoulders related to materials handling tasks and repetitive trauma to the wrists, elbows, and shoulders of employees. The investigators found that operator input was very important when developing job modifications to prevent any loss of professional skill. Five workstations were analyzed and modifications implemented to reduce postural stress or improve productivity, or both. The results for a Barring sewing operation at this facility were specifically presented.[9,11] Changes implemented were an adjustable chair with arm rests, foot rest, elevating and tipping the Barring sewing machine, and adding a work surface. These changes resulted in an increase in productivity and reductions in postural stress, awkward wrist motions, and discomfort levels.[9,11]

Another study by Wick [1987] specifically looked at design changes for adding a metal ornament to a sandal strap.[12] The workers reported symptoms of tendinitis and upper back pain. The job tasks included bending the prongs of the ornament inward and inserting the unit into a pneumatic press. The following changes were made: an adjustable chair and adjustable footrest were added; bench-mounted armrests were provided; the press was angled and raised; a small parts bin was added; and the ornaments were redesigned to match the punched holes in the sandal straps.[12] These changes reduced the postural discomfort and reduced the frequency of repetitive wrist motions and force requirements. No additional injuries were reported for two years following the implementation of the changes.[12]

Serratos-Perez and Mendiola-Anda [1993] looked at musculoskeletal disorders among male sewing machine operators in eight shoe factories in Mexico.[13] They found 47.5% of the study participants reported current musculoskeletal problems. There was a distinct difference between the types of complaints for the flat-machine and column-machine operators.

Engineering controls are the preferred method of reducing employee exposure to ergonomic stressors. The goal of engineering controls is to make the job fit the person, not the person fit the job. Administrative (personnel-based) controls should be used only as a temporary measure to control WRMD risk until engineering changes can be implemented. The shoe production industry is a very specialized industry which uses specialized equipment for dedicated operations and hand-work remains a quality trademark. "Off-the-shelf" engineering solutions to ergonomic problems in this plant will be limited, requiring the development of innovative process and equipment changes from expert knowledge of the plant's operation.

RESULTS/DISCUSSION

Questionnaire Data

Demographics

Sixty-five individuals completed the questionnaire. Two employees were absent from the facility during the site visit due to long-term disability. Forty-nine (75%) of the employees were male and 14 (22%) were female. Two individuals (3%) did not answer the gender question. The average ages for males and females were 34.5 years (yrs) (range: 17-64 yrs) and 33.4 yrs (range: 18-57 yrs), respectively. The average anthropometry (size) for the male employees was 5 feet (ft) 9 inches (in) (range: 5 ft 1 in - 6 ft 4 in) and 183 pounds (lbs). For females, the average anthropometry was 5 ft 4 in (range: 5 ft 1 in - 5 ft 9 in) and 152 lbs. Average employment for males was 9.7 yrs. (range: 1 month to 26 yrs) and 9.5 yrs (range: <1 month to 27 yrs) for females. The employees worked 40 hours each week with the exception of a utility worker and a supervisor who averaged 44 hours per week. One individual reported working one year at another shoe manufacturing facility prior to employment at this facility.

Job Categories

Due to job rotations, 22 of the employees could work at different workstations each day. Taking this into account, the jobs assignments in the Making II Department by gender are presented in Table 1. The individuals that did not have company-provided job information worked as a rough scourer (1), trimmer (1), repairs (1), and 2 were listed as being on long-term disability. The number of units produced per day was highly variable between job categories and between individuals within those job categories. From the questionnaire, employees reported producing 3 to 13 units per day (each unit consists of 12 pairs). The data provided from company records showed employees working with 3 to 222 units each day.

Self-Reported Worker Job Characteristics

Forty (62%) of the respondents classified the physical effort necessary to perform their job as hard, very hard, or very, very hard. Figure 1 shows how the respondents classified their physical effort. Fifty-five (85%) reported some body discomfort for the year prior to the site visit (not necessarily work-related). Figure 2 shows the different areas of the body where respondents showed varying degrees of discomfort in the year prior to the site visit. Sixteen individuals (25%) reported being very or extremely uncomfortable in the left neck and shoulder, 11 (17%) in the right neck and shoulder, 26 (40%) in the left hand and arm, 21 (32%) in the right hand and arm, 18 (28%) in the left leg and foot, 12 (18%) in the right leg and foot, and 21 (32%) in the back. Combining the reports for discomfort for the upper extremity (UE) (neck, shoulder, hand, and arm), 53 (82%) reported some body discomfort for the year prior to the site visit (not necessarily work-related).

Injury symptom data was evaluated from the questionnaires. Thirty-three (51%) of the questionnaire respondents reported some type of injury had occurred at the workplace within the year prior to the survey. The injuries reported by the employees by location are shown in Table 2 (some individuals reported more than one injury). The fingers and thumb were the body parts most frequently injured.

Fifty-nine employees (91%) reported using a pinch grip to perform their job tasks. Forty-nine (83%) reported using a pinch grip on a relatively constant basis (67-100% of the time); five workers (8%) used a pinch grip on a frequent basis (34-66% of the time), and two individuals (3%) reported using a pinch grip on an occasional basis (1-33% of the time). Figure 3 shows the reported effort exerted when using a pinch grip. Thirty-one employees (53%) reported using at least a hard pinch grip.

Table 3 shows the amount of time employees reported that they spend sitting, standing, walking, bending, reaching overhead, using their arms repetitively, or using repetitive leg and/or foot movements. Thirty-nine individuals (60%) reported that they are never seated while working, 45 (69%) reported standing frequently or constantly, 34 (52%) reported walking frequently or constantly, 45 (69%) reported bending at the waist frequently or constantly, 40 (62%) reported reaching overhead at least occasionally, 55 (85%) reported constantly moving their arms in a repetitive manner, and 32 (49%) reported moving their legs and/or feet in a repetitive way at least occasionally.

Sixty-two (95%) of the respondents indicated that they do some form of lifting while performing their job activities. One individual answered no to the lifting question and two did not answer the question. Workers were asked to classify the types of lift used as floor to knuckle (natural), floor to knuckle (bent leg), knee to knuckle, knuckle to shoulder, and shoulder to overhead. Table 4 shows the number of employees who reportedly do each type of lift and how often they do such a task. The employee estimated weights reportedly lifted varied greatly within and between job categories. The reported or estimated weights ranged from 0.25 lbs to 40 lbs, depending on job activities. The average weights listed by type of lift are presented in Table 5.

Twenty-four (37%) workers reported doing some type of carrying while doing their assigned job tasks, 45 (69%) reported doing pushing activities, and 46

(71%) reported doing some pulling activities. The amount of time reportedly spent doing each task is presented in Table 6. Individuals reported carrying items for an average of 22 feet (ft), pushing an average of 56 ft, and pulling an average of 25 ft (Table 7).

The employees use a variety of hand tools while preforming their job tasks. Based on workers self-report on usage, the tools used are as follows: scissors (47), pencil/pen (26), ink brush (9), knife (8), hammer (7), screwdriver (5), wrench (5), wax bar (5), pliers (4), punch (3), rag (3), sharpener (2), staple puller (2), caster (1), heel remover (1), and lace cutter (1).

OSHA 200 Logs Review

The OSHA 200 logs for 1993 and the first half of 1994 were reviewed for the Making II Department. The musculoskeletal disorders reported for 1993 included five cases of tendinitis, two cases of carpal tunnel syndrome, one case of tenosynovitis, and one case of thoracic outlet syndrome. Six lacerations of various body parts (mostly fingers) and four foreign body injuries to the eye were also reported in 1993. The OSHA 200 logs for the first half of 1994 showed one case of tendinitis, a hand infection, and an injury of a left shoulder (physician diagnosis pending) had been reported.

Injury symptom data was evaluated and compared to data from the OSHA 200 logs. One individual reported no injury on the questionnaire but company records showed that the individual had experienced a laceration. Since the questionnaire solicited information on all injuries, including minor injuries such as cuts and scrapes which are not required to be reported on the OSHA 200 logs, 13 (39%) of the questionnaire respondents' self-reported injury symptoms were recorded on the company's OSHA 200 logs.

Videotape Analysis

A postural assessment was conducted from video recordings of 48 jobs within the Making II Department. Non-neutral upper extremity postural categories were defined according to the work of Armstrong et al. [1982][14] and non-neutral back postures were defined according to the work of Keyserling et al. [1988][15].

Of the 48 jobs analyzed, 41 or 85 % have a work cycle time of less than 30 seconds. Some jobs have additional task elements outside of the actual shoe processing work, such as getting a new rack of shoes, which is not accounted for in the work cycle time noted above and which does provide the opportunity for physiological recovery from sustained and repeated exertions. Jobs on the carousel line, however, do not have this additional task element.

Nine or 19% of the jobs involve use of a foot pedal to activate machinery. Of the jobs requiring the use of a foot pedal, all of these jobs are performed in a standing position.

Non-neutral postures of the trunk (or torso) were found among 43 (90%) of the jobs, and 14 (29%) involved static loading of the muscles (i.e., the postures were sustained for at least two sequential work elements). Of the four trunk postures coded, lateral bending or bending to the side was the most prevalent exposure condition for the trunk (65%), followed by moderate forward flexion (48%), and trunk twisting (23%). No severe forward flexion of the trunk was observed. Static postural conditions of the trunk were observed to occur most often within the moderate forward flexion classification (19%). Forward neck flexion was found to occur among 41 or 85% of the jobs analyzed, and 35 (73%) involved static loading of the muscles to maintain this posture.

Non-neutral postures of the shoulder were found among almost all (98%) of the jobs. Of the five postures coded, abduction (92%) and flexion (90%) were the most prevalent exposure condition for the shoulders. Shoulder elevation was found among 44% of the jobs, extension was found among 35%, and adduction was found among 25% of the jobs. Static exertions to maintain non-neutral shoulder postures were observed among the majority of the jobs (81%). Static exertions were especially involved to maintain shoulder abduction (63%) and flexion (27%). Non-neutral postures of the forearm were found among all 48 of the jobs analyzed. Of the two non-neutral forearm postures coded, pronation (palm faced downward) was the most prevalent exposure condition for the forearm (94%), but supination of the forearm was also extensively used (83%). For most jobs (67%), both forearms were pronated at least once in the work cycle. Less than half (42%) of the jobs involved the supination of both forearms.

Non-neutral postures of the wrist were found among the majority (94%) of the jobs analyzed. Of the four wrist postures coded, ulnar deviation was the most prevalent exposure condition for the wrist (81%), followed closely by wrist extension (67%). Wrist flexion was observed to occur among 15 or 31% of the jobs and radial deviation was observed among 6 jobs (13%). Static exertions to maintain non-neutral wrist postures were not uncommon, especially with extension and ulnar deviation.

Three types of hand grips (open pinch, closed pinch, and lateral pinch) and conditions of finger pressing were coded. All jobs required the use of a pinch grip. Open pinch grips were used in the majority of jobs (98%) and this grip was static or sustained over multiple work elements in all but two instances. Closed pinch grips were observed to occur among 16 jobs (33%) and the lateral pinch was observed among 11 jobs (23%). The fingers were used for pressing in 11 jobs (23%).

Ergonomics Program

Hanover Shoe hired an ergonomic consulting firm in 1992 to evaluate some of the jobs at this facility. The consulting firm identified three jobs in the Making II Department as being likely to cause WRMDs. Each job was observed and videotaped. These jobs were edge trim, heel trim/scour, and stain heel/edge. The following recommendations were offered for these jobs by the consulting firm:

Edge Trim Recommendations

- # foot rest
- # adjustable height swivel chair

Heel Trim/Scour Recommendations

- # anti-fatigue mats
- # maintain optimal functioning condition of trimming and scouring wheels
- # train employees to minimize body movements and forces
- # work rotation with job that does not involve stressful hand, finger, and wrist motions

Stain Heel/Edge Recommendations

- # experiment with shoe on lasting tree or fixture
- # give employee option of sitting or standing
- # anti-fatigue mats
- # include in job rotation program as a job less stressful for the hand/wrist, arm/shoulder, and leg/back muscle groups.

The company has implemented some of the above changes and made additional ergonomic changes at this facility over the past few years. The following changes have been instituted plant wide: (1) A work hardening period, which varies from job to job, has been instituted for all new employees. New employees are offered at least three different jobs of less demanding production if they are not capable of meeting the production standard. (2) Antifatigue mats are provided upon request. (3) Training in lifting techniques is provided by the staff nurse. (4) Workstation adjustments are available upon request. (5) A medical case management program has been developed with the local physicians and staff nurse. (6) A voluntary exercise program has been developed with a morning session that emphasizes muscle group warm-up and flexibility and an afternoon session that stresses recovery and loosening of the muscle groups.

Specific changes have also been implemented in the different departments. The following changes/ modifications have been instituted in the Making II Department. Three automatic lasting machines had been installed to replace the manual last pulling operation. The company intends to acquire three additional automatic lasting machines which will totally replace the manual operation. The outside nailing machine has been replaced by the inside nailing machine which allows the last to be removed from the shoe prior to nailing the heel to the shoe reducing the weight handled during this operation. The nail loading mechanism has been modified by adding a microprocessor and pneumatic hydraulic loading mechanism to replace the operator activated nail loader that had to be checked for proper loading.

The trim and scour machines have been modified in the following manner to reduce the amount of force used by the operator: Carbide blades have replaced the steel blades and 40 grit sanding belts are now used instead of 50 or 60 grit sanding belts. In edge and heel inking, the last has been removed from the shoe to reduce the weight handled. A mounted post or fixture was tried but the operators had difficulties in following the contours of the shoe. A workstation rotation plan has been implemented. Some employees rotate between jobs such as edge trimming, smooth scouring, edge and heel burnishing, and buffing.

CONCLUSIONS

Shoe manufacturing has been identified by the BLS as a high risk industry for WRMDs. This investigation documents that the majority of the jobs evaluated in the Making II Department expose workers to multiple ergonomic risk factors, which have been found in previous studies to increase risk. Forty (62%) of the questionnaire respondents classified the physical effort necessary to perform their job as hard, very hard, or very, very hard. Fifty-five (85%) reported some body discomfort (not necessarily work-related) for the year prior to the site visit (82% UE and 52% back). Almost all of the 48 production jobs analyzed had risk factors for WRMDs, including short work cycle times (41 [85%] were less than 30 seconds), piece work rates, and non-neutral postures of the trunk (43-90%), shoulder (47-98%), and wrist (45-94%). All of the jobs required pinch grips to perform their job tasks. The company has instituted ergonomic changes to address some of the exposure issues such as job rotation, process changes, medical management program, and a voluntary exercise program. Ergonomic risk factors continue to exist, particularly for the upper extremities, and thus additional prevention efforts are required to reduce worker exposure.

RECOMMENDATIONS

Efforts should continue to reduce ergonomic stress in the Making II Department. Although some jobs have fewer or less severe ergonomic risk factors (e.g., inking and edge scraping), most of the jobs in this department expose employees to multiple risk factors at one or more anatomical sites. Where exposure control strategies have already been identified, and are known or suspected to be effective, a plan for their timely implementation and evaluation should be established. At the time of this HHE investigation, several recommendations provided by the ergonomic consulting firm were not yet implemented (e.g., foot rests, adjustable height swivel chair, anti-fatigue mats).

As stated earlier, engineering controls are the preferred method of reducing employees exposure to ergonomic stressors. Examples of engineering controls include, but are not limited to, adjustments to the height of work surfaces, seating with low back (lumbar) support, task lighting, and the use of power shears in place of scissors. Engineering controls such as these seek to effectively reduce or eliminate the ergonomic stress at its source, and they do not rely on worker compliance with a work policy (e.g., job rotation) or work method. Since administrative or behavior-based ergonomic control strategies may place workers at odds with production pressures or monetary incentive plans, these strategies are considered less effective.

All ergonomic control strategies (e.g., equipment changes or adjustments, etc.) should be implemented on a trial basis, to ensure that the desired effect is achieved. In some instances, suppliers are willing to provide companies with equipment or furniture for use on a trial basis without any financial obligation incurred by the company until, or unless, a purchasing decision is reached.

Ideally an ergonomic assessment, using a checklist or some other ergonomic assessment tool, should be performed before and after the job change to document how exposure to ergonomic risk factors changed. In addition, workers' evaluations of trial changes can provide valuable information about the effectiveness of a change and whether or not the change can be successfully introduced into production operations (i.e., accepted on the shop floor). A generic ergonomic job change worker evaluation form can be used for the purpose of formalizing and documenting the evaluation process. In addition, training needs associated with the introduction of equipment or process changes are more likely to be recognized and satisfied when using a formalized worker evaluation procedure, thus improving the odds for the effective control of ergonomic stressors.

Because of the specialization of equipment found in this plant, "off-the-shelf" engineering solutions are available for some, but not all exposure conditions. Some good examples of "off-the-shelf" solutions were provided to the company in the ergonomic consultants report (e.g., foot rests, adjustable height swivel chair, anti-fatigue mats). Chair design characteristics in those jobs that are performed in a seated position were found to not provide adequate cushioning to reduce contact stress, did not have low back (lumbar) support, did not have a seat pan swivel to reduce twisting of the back, and foot support was often missing. Prolonged sitting without adequate low back support makes it difficult to maintain the natural curvature of the spinal column, increasing pressure on the fibrous discs in the lower (lumbar) back and increasing the risk of back pain and injury. Improper seating can also be a source of contact stress, impairing circulation in the buttocks and legs.

Height adjustment features in seated operations are important for obtaining optimal postural conditions for the upper extremities — especially the shoulders. There are many suppliers that offer the needed chair design features, and many of these suppliers are accustomed to receiving and granting requests for "trial agreements."

Foot pedals are not recommended for standing work, except for very infrequent use.[16] Pedals that result in overstretching of the ankle joint (more than 25 degrees around the resting position of the foot) are not recommended. Workers should not have to lift their leg to reach the foot pedal. For jobs involving the use of a foot pedal, and for those jobs that have moderate or low force requirements and are performed primarily from a stationary position with little or no reaching, a sit/stand stool or lean bar should be provided. In the past five years, numerous stool design options have become commercially available. As with other types of seating, supplier agreements for the trial use of different style stools should be considered.

Anti-fatigue mats should be provided for those jobs that will continue to be performed in a standing posture. Again, it is best to evaluate several types of matting during a trial period before making a purchase. Supplier agreements for the trial use of matting may be less common than is found for seating. In addition to providing some fatigue relief benefits, mats also reduce the ambient noise in the workplace. On the rack line, it will be particularly important to ensure that the mats have a tapered edge so that the racks can be moved across matting — otherwise the matting selected should be small in size to avoid the areas of the floor where racks are likely to travel. As an alternative to matting, shoe cushioning should be provided.

For some jobs involving repetitive use of scissors, air-powered shears should be considered for use instead of the scissors to reduce manual forces (to cut and the static load to hold continuously) and mechanical stress on the thumb and fingers. The power shears should be suspended to support the weight of the tool. Power shears come in a variety of sizes with different types of cutting bits.

Task lighting should be provided for the grinding and edge trimming jobs, and considered for use in other jobs that have high visual demands. A condition of prolonged and continuous static postural loading of the shoulders was found in the edge trimming job. The height of work surfaces is known to affect manual performance and muscle fatigue, and optimal conditions have been found to be achieved when the elbows are down by the worker's side — not "winged-out" or held in too close to the body.[17] Static postural loading of the shoulders is a condition that can rapidly induce fatigue and can lead to more chronic health effects such as bursitis. Although seat height adjustment features will help to improve or optimize shoulder postures for this job, arm or elbow supports should also be considered for use in those jobs, such as edge trimming, where there is postural stress on the shoulders. A variety of arm supports are now commercially available, and some industrial seating is equipped with adjustable height arm supports that may be effective. Since the edge trimming job is performed with trim wheels located at different work heights, the feasibility of the use of arm supports may be dependent upon a simultaneous equipment change (trim wheel should be located at the same height) or a process change which would permit a batch of shoes to be trimmed on one wheel at one arm support adjustment, and then trimmed as a batch on the second wheel with a different arm support adjustment.

The recommendations provided above all involve the use of commercially available products. Other changes (equipment and process) will be needed to effectively control employee exposure to ergonomic stressors. Due to the highly specialized nature of the equipment used in this industry, plant-specific innovations will have to be developed and incorporated over time in accordance with ergonomic principles (maintain neutral work posture, reduce forceful exertions, and reduce repeating motion patterns). An example of a change not involving an "off the shelf item" would be placing a base under a piece of equipment, which could significantly improve work posture. Tilting equipment (or parts of the equipment) may also be effective in improving work posture. It is essential that employee suggestions be actively solicited and considered with respect to equipment and other job changes that may aid in reducing exposure to ergonomic stressors. The use of fixtures for some jobs should be further explored to reduce the amount of time spent handling the shoes.

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Table 1
Job Categories by Gender
Hanover Shoe Company
HETA 94-0245

Job Category	Number of Employees* (females)
Beveler	2 (0)
Bottom Sprayer	5 (1)
Bottom Stainer	3 (0)
Buffer	4 (0)
Burnisher	6 (0)
Edge/Heel Sander	6 (0)
Finisher	4 (1)
Inker	6 (6)
Inside Nailer	6 (1)
Last Puller	9 (0)
Remove Heel Fringe	5 (0)
Rough Scourer	6 (1)
Scrape & Wash	7 (2)
Smooth Scourer	6 (0)
Trimmer	15 (2)
Heeler	1 (0)
Cut Laces	4 (0)
Utility Work	1 (0)
Leader/Supervisor	1 (0)

* - Several employees rotated between jobs during a normal work day.

Table 2
Work-Related Injuries Reported on Questionnaire (For Prior Year)
Hanover Shoe Company
HETA 94-0245
(Number of Respondents = 65)

Body Part	Type of Injury and Number of Reports
Head	Smash(1)
Neck	Strain (1)
Back	Ruptured Disc (1), Strain (1), Sprain (1)
Shoulder	Pain (1), Pinched Nerve(1)
Side	Strained Muscles (1)
Fingers/ Thumb	Scrape (3), Cut (5), Muscle Cramps (1), Hairline Fractures (1), Puncture (2), Burn(1)
Hand	Cut (2), Pain (2)
Wrist	Pain (3), CTS(2), Sprain (1)
Elbow	Tendinitis (1), Tennis Elbow (1)
Arm	Cut (2), Pain (1)
Eyes	Foreign Object (1)

Table 3
Amount of Employee Reported Time Spent in Position or Performing Repetitive Motions
Hanover Shoe Company
HETA 94-0245
(Number of Respondents = 65)

Frequency of Activity	Sitting	Standing	Walking	Bending at Waist	Reaching-Overhead	Repetitive Movement Arm	Repetitive Movement Leg/Foot
Never	39	7	6	1	25	2	33
Occasional (1-33%)	3	4	17	11	21	2	8
Frequent (34-66%)	0	2	18	14	5	3	4
Constant (67-100%)	9	43	16	31	7	55	11

Table 4
Type of Lift
Hanover Shoe Company
HETA 94-0245
(Number of Respondents = 65)

Frequency of Type of Lift	Floor to Knuckle (natural)	Floor to Knuckle (bent)	Knee to Knuckle	Knuckle to Shoulder	Shoulder to Overhead
Occasional (1-33%)	18	14	9	7	9
Frequent (34-66%)	3	0	4	7	4
Constant (67-100%)	4	1	18	38	4

Table 5
Average Weight Lifted by Employees by Type of Lift
Hanover Shoe Company
HETA 94-0245
(Number of Respondents = 65)

Type of Lift	Average Weight (pounds)	Range (pounds)	Number of Reports
Floor to Knuckle (natural)	8.78	1 - 40	18
Floor to Knuckle (bent)	11.19	1 - 40	13
12 inches to Knuckle	3.56	0.44 - 40	20
Knuckle to Shoulder	3.70	0.19 - 40	42
Shoulder to Overhead	8.81	0.5 - 40	13

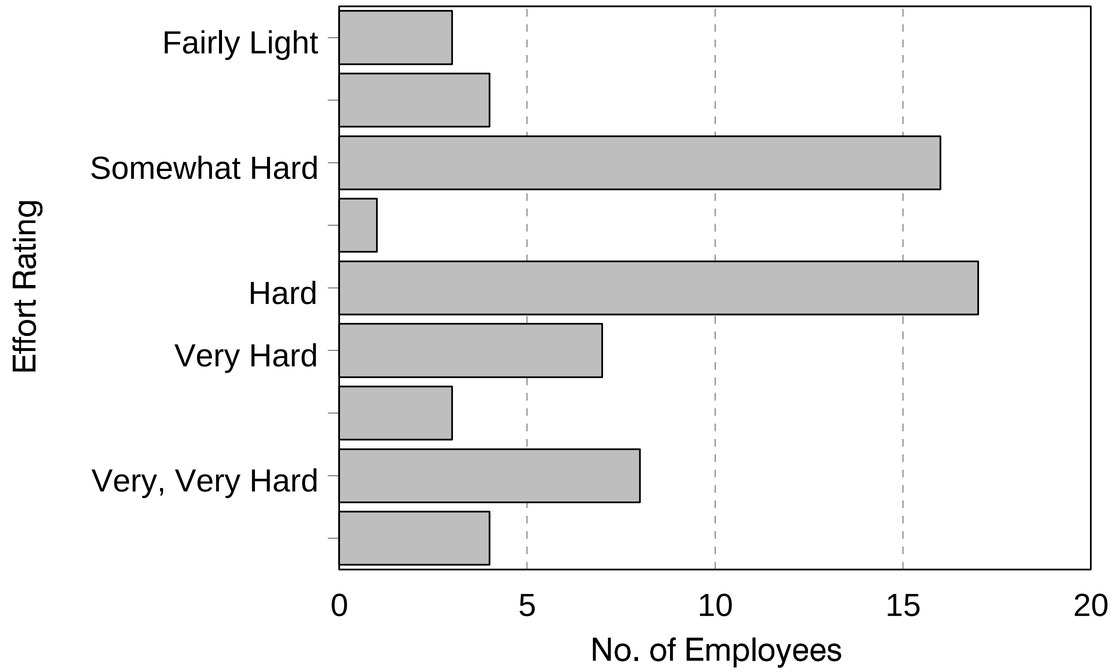
Table 6
Carrying, Lifting, and Pulling Activities
Hanover Shoe Company
HETA 94-0245
(Number of Respondents = 65)

Frequency of Activity	Carrying	Pushing	Pulling
Occasional (1-33%)	12	6	9
Frequent (34-66%)	4	11	9
Constant (67-100%)	8	28	28

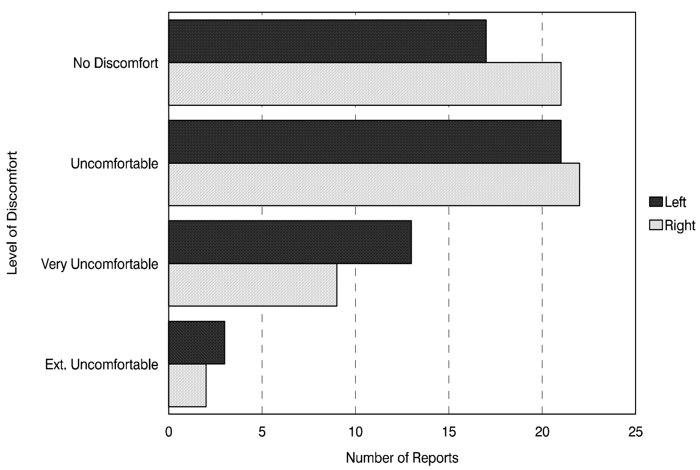
Table 7
Average Distance Moved By Task
Hanover Shoe Company
HETA 94-0245
(Number of Respondents = 65)

Type of Activity	Average Distance (feet)	Range (feet)	Number of Reports
Carrying	22	2 - 200	13
Pushing	56.23	0.5 - 200	44
Pulling	24.93	0.5 - 200	38

Figure 1 - Physical Effort to Perform Job
Hanover Shoe Co. - HETA 94-0245
No. Of Respondents = 65



Left and Right Neck/Shoulder
No. Of Respondents = 65



Left and Right Hand/Arm
No. Of Respondents = 65

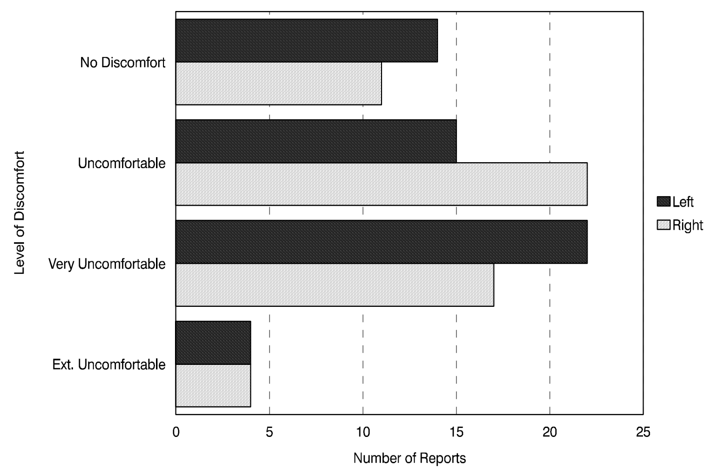
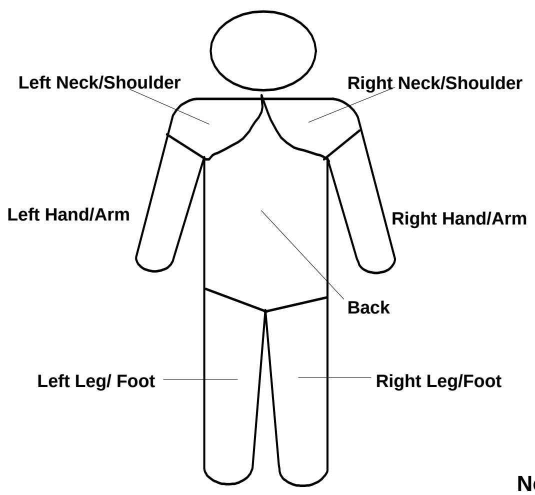
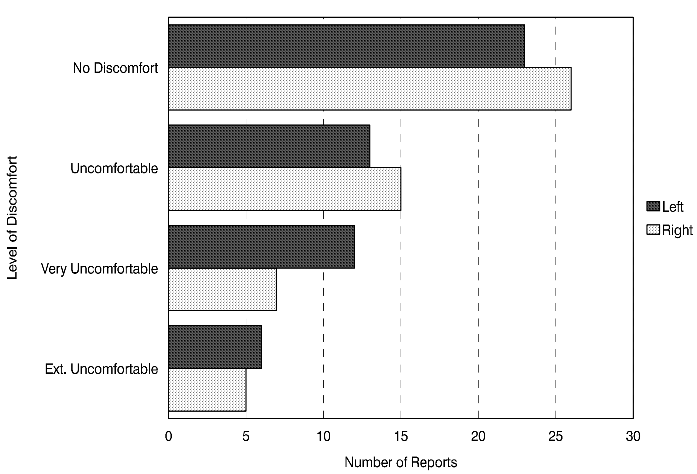


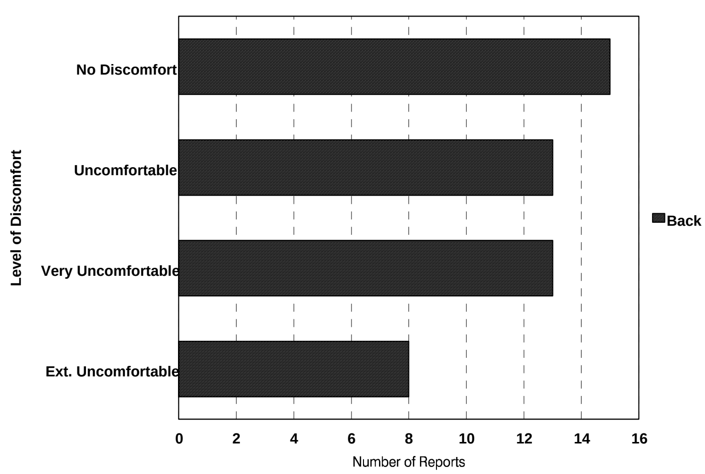
Figure 2 - Discomfort Level for Each Body Location
Hanover Shoe Company
HETA 94-0245



Left and Right Leg/Foot
No. Of Respondents = 65



Back
No. Of Respondents = 65



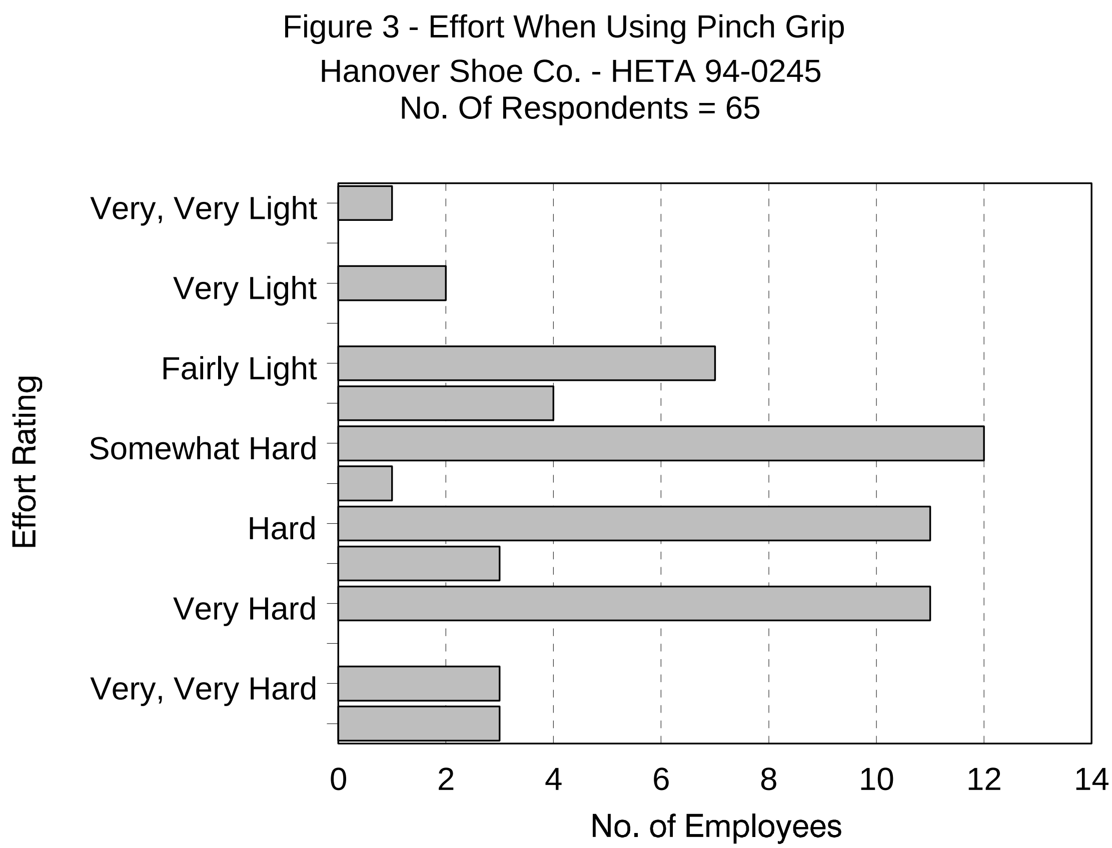


Figure 3 - Effort When Using Pinch Grip
Hanover Shoe Co. - HETA 94-0245
No. Of Respondents = 65
Effort Rating
Very, Very Light
Very Light
Fairly Light
Somewhat Hard
Hard
Very Hard
Very, Very Hard
0
2
4
6
8
10
12
14
No. of Employees

Appendix A

National Institute for Occupational Safety and Health
Hanover Shoe Company, Franklin, WV
HETA 94-0245, July 27-28, 1994

This survey is being conducted to determine the nature of your job and the amount of physical activity involved. Please answer the questions as accurately and completely as you can.

ALL OF YOUR ANSWERS WILL BE TREATED IN STRICTEST CONFIDENCE. YOUR COMPLETED SURVEY WILL BE COLLECTED AND ANALYZED BY NIOSH EMPLOYEES AND YOUR RESPONSES WILL NOT BE SEEN BY MANAGEMENT OR OTHER EMPLOYEES.

1. What is your name? ____________________ ____________________
First Last

2. What is your age: ______ yrs; height: ______ ft _____ in; weight: ________ lbs; sex: _____ male _____ female

3. When did you start working at this plant? ______ Month, 19_____ Year

4. Did you work for another shoe manufacturer previously? ___ yes ___ no

   If yes, how many years did you work at the other factory? ___ yr(s) ___ months

5. What is your job title? ____

6. How long have you worked on this job? _________ yr(s) _________ months

7. On average, how many hours do you work each week? _______ hours

8. What is the typical number of units that you produce each day? ________________ units

9. Does the number of units that you produce vary from day to day? ___ yes ___ no

   If yes, how much does it vary? ___ from 1-20 units ___ from 21-40 units ___ from 41-60 units ___ $\geq$ 61 units

10. How much of your job involves the following activities? Please check the amount of time spent on each activity.

ACTIVITY	NEVER 0% of the day	OCCASIONAL 1-33% of the day	FREQUENT 34-66% of the day	CONSTANT 67-100% of the day
Sitting	____	____	____	____
Standing	____	____	____	____
Walking	____	____	____	____
Bending (Stooping)	____	____	____	____
Reaching - Forward	____	____	____	____
Reaching - Overhead	____	____	____	____
Repetitive Arm Movement (machine controls, loading, etc.)	____	____	____	____
Repetitive Leg/Foot Movement (foot controls)	____	____	____	____

11. Does your job involve lifting? ___ yes ___ no
If yes, please check the amount of time spent lifting for each type of lift, and write in the typical weight of the objects

ACTIVITY	OCCASIONAL 1-33%	FREQUENT 34-66%	CONSTANT 67-100%	TYPICAL WEIGHT Pounds
LIFT FROM:				
Floor to Knuckle (natural lift)	____	____	____	____
Floor to Knuckle (leg lift)	____	____	____	____
12" to Knuckle	____	____	____	____
Knuckle to Shoulder	____	____	____	____
Shoulder to Overhead	____	____	____	____

12. Does your job involve carrying, pushing, or pulling? ___ yes ___ no
If yes, please check the amount of time spent carrying, pushing, or pulling, and write in the average distance moved.

ACTIVITY	OCCASIONAL 1-33%	FREQUENT 34-66%	CONSTANT 67-100%	TYPICAL DISTANCE Feet
Carrying	____	____	____	____
Pushing	____	____	____	____
Pulling	____	____	____	____

13. Does your job involve pinching? ___ yes ___ no. If yes, please check the amount of time spent using a pinch grip.

OCCASIONAL 1-33%	FREQUENT 34-66%	CONSTANT 67-100%
___	___	___

If yes, using the rating scale shown below, please circle the physical effort level demanded by the pinch grip.

20
19 - Very, very hard
18
17 - Very hard
16
15 - Hard
14
13 - Somewhat hard
12
11- Fairly light
10
9 - Very light
8
7 - Very, very light
6

14. What machines, if any, do you operate? ______________________________

15. Do you use hand tools? ___ yes ___ no. If yes, please list the type of tool; check whether the tool is operated manually or by power, and the hand postures used when handling the tool. (Check all that apply.)

HAND POSTURES

NAME OF TOOL	HAND or	POWER					
___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___

16. During the past year (July 1, 1993 to June 30, 1994), have you ever had an injury at work? ___ yes ___ no

If yes, did you report this to your employer? ___ yes ___ no

If yes, what part of your body did you injure? ____________________

If yes, what type of injury or injuries? ______________________________
____

17. During the past year, have you ever missed any workdays due to an injury at work? ___ yes ___ no

If yes, how many days did you miss? ______ day(s)

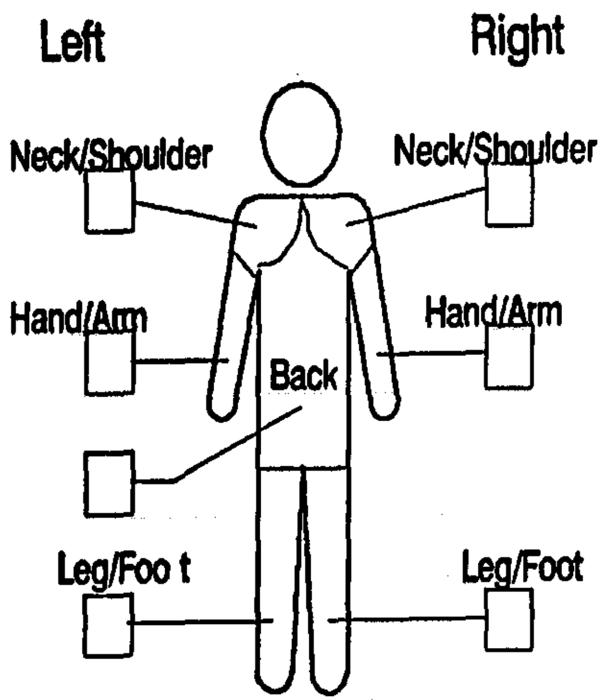
18. Using the rating scale shown below, please rate the OVERALL physical effort level demanded by your job today. Please circle the most appropriate number on the following scale.

20
19 - Very, very hard
18
17 - Very hard
16
15 - Hard
14
13 - Somewhat hard
12
11- Fairly light
10
9 - Very light
8
7 - Very, very light
6

19. **Have you had any pain or discomfort during the last year? ___ yes ___ no**

If yes, put a number in each box to indicate your level of discomfort, using the following scale.

0 - No Discomfort
1 - Uncomfortable
2 - Very Uncomfortable
3 - Extremely Uncomfortable



SAMPLE COVER SHEET

HANOVER SHOE COMPANY
HETA 94-0245

Information to be extracted from employee records:

Employee Name ________________; Employee ID ____XXXX____ (1-4)

Start Date (5-6) __XX__ mo, 19 (7-8) XX Time in Job (9-10) __XX__ yrs, (11-12) __XX__ mos

Job Title ________________________XX________ (13-14)

Production data:

Typical number of units per day (mode) (15-20) XXX.XX ____ units, based on (21) __X__ (~~days or~~ weeks) worth of data.

Range of the number of units produced per day: high value = (22-24) __XXX__ units; low value = __XXX__ (25-27) units. Based on __X__ (28) (~~days or~~ weeks) worth of data.

List of daily production: UNITS

Week of (29-34) MM/DD/YY ; a (35) Mon (36-38) ; b (39) Tues (40-42) ; c (43) Wed (44-46) ; d (47) Thurs (48-50) ; e (51) Fri (52-54)

Week of (55-60) ; (61) Mon (62-64) ; (65) Tues (66-68) ; (69) Wed (70-72) ; (73) Thurs (74-76) ; (77) Fri (78-80)

Week of (81-86) ; (87) Mon (88-90) ; (91) Tues (92-94) ; (95) Wed (96-98) ; (99) Thurs (100-102) ; (103) Fri (104-106)

Week of (107-112) ; (113) Mon (114-116) ; (117) Tues (118-120) ; (121) Wed (122-124) ; (125) Thurs (126-128) ; (129) Fri (130-132)

Week of (133-138) ; (139) Mon (140-142) ; (143) Tues (144-146) ; (147) Wed (148-150) ; (151) Thurs (152-154) ; (155) Fri (156-158)

Injury Log Data:

Employee reported an injury in the last year? (1) Y or (2) N If Yes, (159)

Body parts affected: ________________XX________ (160-161)

Type of Injuries: ________________XX________ (162-163)

Lost work time: (# DAYS) ____________XXX________ (164-166)

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Safety and health at work for all people
Through research and prevention