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Post Project Ergonomic Evaluation
Gunderson, Inc
Mobile Scissors Lift
June, 2001
By Rob Strickland, OTR

An on-site ergonomic evaluation of the tasks related to handling steel parts with the aid of the new heavy duty mobile scissors lift was completed on June 1 and June 14, 2001. Greg Miller, Manager of Health Services from Gunderson was present. A video tape and digital photos were taken during the evaluation and are available for review. Symptom surveys were completed by employees.

Purpose/Background:

The purpose of this evaluation is to provide an assessment and documentation of the improvements in the musuculo-skeletal disorder (MSD) risk factors associated with the use of the new device.

Gunderson, Inc. produces freight rail cars and Marine vessels to move cargo and as such, it is the largest steel fabricator in the State of Oregon. Gunderson employs approximately 1000 workers, most of whom work directly with metal fabrication such as cutting, bending, welding and grinding. It is estimated that approximately 20% of the employees at Gunderson could benefit from the use of a heavy-duty, mobile scissors lift as a lifting and positioning device in their job tasks.

General Description:

Metal fabrication activities take place in large, covered buildings which are open on one or more sides to the outside. Floors are old concrete, in many places marked with cracks and divots. The initial target location for the use of the scissors lift is in one of the press brake areas where parts are bent to specifications. The steel plate parts in this area vary considerably from 15 lb. to 60 lb. and are presented to the worker on pallets ranging in size from 36" square to 42" x 48". The frequency of parts handling for a given worker also varies considerably from one job to another depending on many factors such as the complexity of bending and measuring tasks.

Device Description:

1. Bishamon Scissors lift with 10,000 lb. lift capacity. The device has been customized to enable a rotating (360 degree indexing) function of the lift platform. A steel framework has been added to which wheels are attached to make it mobile. The wheels can be engaged for lift movement or, retracted- thus locking the device in place. The lift platform is 48" square and has a height adjustment range from 18" to 54" vertically. Height adjustments and indexing functions are controlled using a hand control pendant.

2. Power Pusher- A rechargeable, battery operated push device with hand controls.

3. Dollie (custom fabricated device which couples the Power Pusher to the scissors lift for transport of the lift.

Work flow process

1. Lift device is positioned next to the press brake using the "Power Pusher" (or fork lift)
2. A fork lift is used to place a pallet of parts on the lift device platform
3. Height of parts on pallet/lift platform is adjusted to appropriate operator level using hand control
4. Pallet/lift platform is rotated (if needed) to keep parts as close to operator as possible to reduce reach distance
5. Height and indexing adjustments are made periodically as needed to maintain optimum parts positioning for worker as the parts are removed from the pallet

Methodology and Assumptions used for Gunderson Evaluation

1. The original baseline evaluation report completed by Ms. Beverly Burke, RN, CIE was not available for use as a comparison to the post project ergonomic evaluation results. Therefore some baseline data was reconstructed at the time of the post project worksite visits using examples and data provided by Greg Miller and observations of employees engaged in material handling using the old method (without a scissors lift).

2. Because there is great variability in the weight of parts, frequency of lifts, positioning of parts (height and horizontal location on pallets) and employee work practices, certain lifting scenarios were selected as examples of actual lifting tasks. Then specific task variables were controlled and/or manipulated to reflect the actual change that would occur using the new lift device compared to the old method. (During the worksite visits, only two different parts were represented and observed). The lift task scenarios chosen are as follows:

Scenario 1**.** Old method, no scissors lift, parts on low level pallet
- **A.** Weight = 15 lb., frequency = 3/min, <u>at origin-</u> horizontal location (H)=18", vertical location (V)=23", <u>at destination-</u> H=12", V= 43"
- **B.** Weight = 30 lb., frequency = 2/min. Other variables remain the same as A
- **C.** Weight = 60 lb., frequency = 1/min. Other variables remain the same as B

Scenario 2**.** Old method, no scissors lift, parts on high level pallet
- **A.** Weight = 15 lb., frequency = 3/min, <u>at origin-</u> (H)=18", (V)=43", <u>at destination-</u> H=12", V= 43"
- **B.** Weight = 30 lb., frequency = 2/min. Other variables remain the same as A
- **C.** Weight = 60 lb., frequency = 1/min. Other variables remain the same as B

Scenario 3**.** New method using mobile indexing scissors lift, lifting parts from edge of pallet
- **A.** Weight = 15 lb., frequency = 3/min, <u>at origin-</u> (H)=12", (V)=43", <u>at destination-</u> H=12", V= 43"
- **B.** Weight = 30 lb., frequency = 2/min. Other variables remain the same as A
- **C.** Weight = 60 lb., frequency = 1/min. Other variables remain the same as B

Scenario 4**.** New method using mobile indexing scissors lift, reaching to center of pallet for parts
- **A.** Weight = 15 lb., frequency = 3/min, <u>at origin-</u> (H)=16", (V)=43", <u>at destination-</u> H=12", V= 43"
- **B.** Weight = 30 lb., frequency = 2/min. Other variables remain the same as A
- **C.** Weight = 60 lb., frequency = 1/min. Other variables remain the same as B

Job Hazard Analysis Tools Utilized

NIOSH Work Practices Guide for Manual Lifting- 1991 Revised Equation*

See "Applications Manual for the Revised NIOSH Lifting Equation", Waters, T.R., Putz-Anderson, V., Garg, A., National Institute for Occupational Safety and Health, January 1994 (DHHS, NIOSH Publication No. 94-110).

The NIOSH WPG revised equation is based on a combination of biomechanical, epidemiological, psychophysical, and physiological data. It establishes acceptable lifting limits based on selected task parameters and specifies recommended engineering controls. Proper application of the equation requires an appreciation of assumptions/limitations that underlie the equation and that characterize the job being evaluated.

The NIOSH equation computes the Recommended Weight Limit (RWL) which is assumed to be safe for 99% of the male population and 75% of the female population for the given task being evaluated. The lifting index (LI) is computed by dividing the actual weight being handled (numerator) by the RWL (denominator). If this resulting number is less than one (1) the task is considered safe. If the LI is greater than one it exceeds the recommended weight limit and results in increased risk of injury to employees.

NIOSH Results:

***Scenario 1*.** Old method, no scissors lift, parts on low level pallet
- **A.** Weight = 15 lb., frequency = 3/min. **RWL= 13.6 lb. LI = 1.10**
- **B.** Weight = 30 lb., frequency = 2/min. **RWL= 16.0 lb. LI = 1.88**
- **C.** Weight = 60 lb., frequency = 1/min. **RWL= 18.5 lb. LI = 3.24**

***Scenario 2*.** Old method, no scissors lift, parts on high level pallet
- **A.** Weight = 15 lb., frequency = 3/min. **RWL= 14.1 lb. LI = 1.06**
- **B.** Weight = 30 lb., frequency = 2/min. **RWL= 16.7 lb. LI = 1.80**
- **C.** Weight = 60 lb., frequency = 1/min. **RWL= 19.3 lb. LI = 3.11**

***Scenario 3*.** New method using mobile, indexing scissors lift, lifting parts from edge of pallet
- **A.** Weight = 15 lb., frequency = 3/min. **RWL= 21.0 lb. LI = .71** (54% improved from Sc.1A)
- **B.** Weight = 30 lb., frequency = 2/min. **RWL= 24.8 lb. LI = 1.21** (55% improved from Sc.1B)
- **C.** Weight = 60 lb., frequency = 1/min. **RWL= 24.6 lb. LI = 2.46** (32% improved from Sc.1B)

***Scenario 4*.** New method using mobile, indexing scissors lift, reaching to center of pallet for parts
- **A.** Weight = 15 lb., frequency = 3/min. **RWL= 15.9 lb. LI = .94**
- **B.** Weight = 30 lb., frequency = 2/min. **RWL= 18.8 lb. LI = 1.60**
- **C.** Weight = 60 lb., frequency = 1/min. **RWL= 21.7 lb. LI = 2.76**

Discussion and summary of NIOSH results:

The most favorable (lowest risk) lifting scenario is #3 (using the new mobile, indexing scissors lift while retrieving parts from the edge of the pallet). This occurs while the parts are stacked to the edge of the pallet or when the part is slid from the center of the pallet and then lifted from the edge (minimizing the horizontal reaching distance). The improvement in the RWL and lifting index while using the new lift compared to scenario #1 (old method, no scissors lift, parts on low level pallet) is 32% to 55%. This assumes that the worker uses the lift device to position the parts at the same height as the destination (brake press) and slides the parts to the edge of the pallet before lifting them.

Observations/conclusions:

The primary improvements reflected in the use of the new lift device as compared to the old method of performing the tasks are:

1. The ability of the worker to reduce the reach distance while removing steel plates from the pallet thus reducing the bio-mechanical forces on the structures of the spine and upper extremities.

2. The ability to position the lift device as needed for optimum material positioning, by using the Power Pusher and Coupling Dollie. This eliminates the need to wait for a fork lift driver to perform this task resulting in improved work efficiency.

3. Higher lift device capacity (10,000 lb. vs. the older device capacity of 4,000 lb.). This eliminates the need to break down or separate a pallet load that exceeds 4,000 lb. resulting in improved work efficiency.

4. In the case of performing this task <u>without</u> the aid of a scissors lift (which occurred when no lift device was available), the new lift device also greatly improves the task by allowing for height adjustment of the load, improving work postures and reducing biomechanical forces to the spine in addition to the improvements mentioned in 1-3 above.

The reduction in risk of musculo-skeletal injury due to the implementation of this new tool include:

1. Reduction of forces and loads from manual lifting- The actual weights being handled remain the same as before the project improvements. However, the forces and loads to the structures of the spine and upper extremities have been reduced by as much as 55% as demonstrated by the NIOSH evaluation results above.

2. Reduction in Awkward trunk postures- previously, the worker would often bend forward at the trunk while reaching downward or outward to retrieve steel plates from a stack on the pallet which was positioned at a fixed height. The worker now is able to control the height and reach distance by making adjustments to the lift device (height and indexing location) to position parts in an optimal location.

Employee Discomfort Survey Results: (Post Project)
Job Title- **Machine Operator (Plate shop)** Number of surveys completed= **2**

No discomfort was reported among the two employees using the new heavy-duty scissors lift**.**

Employee Discomfort Survey Summary

At the time of the baseline ergonomic assessment (performed by another ergonomist- Beverly Burke, RN), 4 employees completed a discomfort survey. (Results extracted from this survey dated September 15, 2000 are listed below).

Discomfort Area	Number of employees with discomfort	Percentage of the total ()	Average Rating (0-10 scale)
Head/Neck/Eyes	4	100%	3.5
Upper/Mid back	3	75%	3.7
Shoulder/Upper arm	4	100%	3.0
Elbow/Mid arm	4	100%	3.0
Forearm/Wrist	4	100%	2.8
Hand	4	100%	2.8
Upper leg/Hip	4	100%	2.0
Mid leg/Knee	4	100%	2.0
Lower leg/foot	4	100%	2.8
Low back/Pelvis	4	100%	2.8

The post project discomfort survey indicates no discomfort in relation to the use of the new device for the two employees who have been using it. Although the sample size in both surveys was quite small, there is a definite improvement in reported comfort related to the use of the new lift device. This is an indication of the reduced physical demand with the task.

Remaining physical demands and musculo-skeletal disorder (MSD) risk factors:

1. Forces and loads- Although improved from the old method (i.e. without use of the scissors lift), there remains a risk of MSD related to forces and loads. Based on the NIOSH assessment, the recommended weight limit (RWL) for handling steel plates from the scissors lift platform varies between 21 lb. and 25 lb. depending on the frequency of lifting required. This means that parts weighing more than 25 lb. (up to 60 lb.) will gradually increase the risk of MSDs for a percentage of the male population. For example, while handling 60 lb. in this fashion, the NIOSH equation predicts that 56% of the male population are capable of safely performing the task.

2. In areas where the concrete floor is uneven or broken, the Power Pusher and Dollie may have difficulty moving the scissors lift. This results in a greater physical effort to maneuver this equipment rather then the smooth operation typical on flat, smooth floors. Also, currently the dollie can attach only to one end of the lift device which limits options for positioning the lift device.

Recommendations:

1. Consider adding another attachment lip on the opposite end of the lift device to allow use of the Power Pusher and Dollie from two sides of the scissors lift.

2. Make the lift device “fork lift ready” so that transport by fork lift is safe and efficient without damage to the device (for use in areas where the floors are in poor condition or for longer distance moves in the building).

3. Lengthen the power cord to give the lift device serviceability further from a power source.

Worksite Redesign Project Completion Summary

The reduction in risk factors identified above, combined with the discomfort survey results indicate that the engineering controls instituted by the new heavy-duty, mobile scissors lift device and related processes have been very successful. The MSD risk factors have been substantially reduced and safety has been enhanced. The employees who have used the device report high satisfaction in the over-all outcome of the engineering improvements.

For further assistance or questions regarding this report please contact Rob Strickland 503-667-3564.

Respectfully,

Rob Strickland, OTR
Ergonomic Specialist

Mobile Scissors Lift

Bishamon 10,000 lb. capacity scissors lift with 360 degree indexing platform.

Worker can adjust the height and location of the load for optimal positioning

Power Pusher and custom dollie

The dollie couples the Power Pusher to the scissors lift and uses a hydraulic jack to raise the scissors lift.

Power Pusher operates with hand controls to move the dollie and scissors lift

Addendum

Ergonomics and Musculoskeletal Disorders

BACKGROUND (Adapted from Federal Register, Nov. 23,1999, Department of Labor, OSHA, Ergonomics Program; Proposed Rule)

Ergonomics is the science of fitting the workplace conditions and job demands to the capabilities of the working population. It is an applied science, incorporating engineering, anatomy, physiology, psychology, anthropology and medical sciences. Effective "fits" assure high productivity, avoidance of illness and injury risks, with increased comfort and satisfaction among the work force. A primary goal of occupational ergonomics is the prevention of work-related musculoskeletal disorders (MSDs).

What are work-related musculoskeletal disorders?

MSDs are injuries or disorders of the muscles, tendons, joints, spinal discs, nerves, ligaments or cartilage. MSDs develop as a result of repeated exposure to ergonomic risk factors. Work related MSD's are those disorders to which the work environment and the performance of work contribute significantly. Another familiar and related term is cumulative trauma disorders, (CTDs). Common examples of MSDs include carpal tunnel syndrome, tendonitis, epicondylitis, herniated spinal discs, sciatica, low back pain, trigger finger and DeQuervain's disease.

What are ergonomic risk factors?

Ergonomic risk factors are the aspects of a job or task that impose biomechanical stress on the worker. Ergonomic risk factors are the synergistic elements of MSD hazards. OSHA discusses a large body of evidence supporting the finding that exposure to ergonomic risk factors in the workplace can cause or contribute to the risk of developing an MSD. This evidence, which includes thousands of epidemiologic studies, laboratory studies, and extensive reviews of the existing scientific evidence by NIOSH and the National Academy of Science, shows that the following ergonomic risk factors are most likely to cause or contribute to and MSD:

1. Force (i.e., forceful exertions, including dynamic motions)
2. Repetition
3. Awkward postures
4. Static postures
5. Contact Stress
6. Vibration
7. Cold temperatures

These risk factors are described briefly below:

Force

Force refers to the amount of physical effort that is required to accomplish a task or motion. Tasks or motions that require application of higher force place higher mechanical loads on muscles, tendons, ligaments and joints. Tasks involving high forces may cause muscles to fatigue more quickly. High forces also may lead to irritation, inflammation, strains and tears of muscles, tendons and other tissues.

Force can be internal, such as when tension develops within the muscles, ligaments and tendons during movement. Force can also be external, as when a force is applied to the body, either voluntarily or involuntarily. Forceful exertion is often associated with the movement of heavy loads, such as lifting heavy packages, pushing a heavy cart, or moving a pallet. Hand tools that involve pinch grips require more forceful exertions than those that allow other grips such as a power grip.

Repetition

Repetition refers to performing a task or series of motions over and over again with little variation. When motions are repeated frequently (e.g., every few seconds) for prolonged periods (e.g., several hours, a work shift), fatigue and strain of the muscle and tendons can occur because there may be inadequate time for recovery. Repetition often involves the use of only a few muscles and body parts, which can become extremely fatigued while the rest of the body is little used. As task cycles in jobs get shorter (and the number of repetitions per minute increases) employees are at greater risk of injury. Where tasks cycles are short, the same muscles are in constant use and the muscles get no rest from the force required to perform the task cycle.

Awkward postures

Award postures refer to positions of the body (e.g., limbs, joints, back) that deviate significantly from the neutral position while job tasks are being performed. Neutral posture is the position of a body joint that requires the least amount of muscle activity to maintain. For example, the wrist is neutral in a handshake position, the shoulder is neutral when the elbow is near the waist, the back is neutral when standing upright.

Examples of awkward postures include: bent wrists while typing, bending over to grasp or lift an object, twisting back and torso while moving heavy objects and squatting. Awkward postures often are significant contributors to MSDs because they increase the work and the muscle force that is required.

Static postures

Static postures (or “static loading”) refer to physical exertion in which the same posture or position is held throughout the exertion. These types of exertions put increase loads or forces on the muscles and tendons, which contributes to fatigue. This occurs because not moving impedes the flow of blood that is needed to bring nutrients to the muscles and to carry away the wasted products of muscle metabolism. Examples of static postures include gripping tools that cannot be put down, holding the arms out or up to perform tasks, or standing in one place for prolonged periods.

Vibration

Vibration is the oscillatory motion of a physical body. Localized vibration, such as vibration of the hand and arm, occurs when a specific part of the body comes into contact with vibration objects such as powered hand tools (e.g., chain saw, electric drill, chipping hammer) or equipment (e.g., wood planer, punch press, packaging machine). Whole-body vibration occurs when standing or sitting in vibrating environments (e.g., driving a truck over bumpy roads) or when using heavy vibrating equipment that requires whole-body involvement (e.g., jackhammers).

Contact stress

Contact stress results from occasional, repeated or continuous contact between sensitive body tissue and a hard or sharp object. Contact stress commonly affects the soft tissue on the fingers, palms, forearms, thighs, shins and feet. This contact may create pressure over a single area of the body (e.g., wrist, forearm) that can inhibit blood flow, tendon and muscle movement and nerve function. Examples of contact stress include resting wrists on the sharp edge of a desk or workstation while performing tasks, pressing of tool handles into the palms, especially when they cannot be put down, tasks that require hand hammering, and sitting down without adequate space for the knees.

Cold temperatures

Cold temperatures refer to exposure to excessive cold while performing work tasks. Cold temperatures can reduce the dexterity and sensitivity of the hand. Cold temperatures, for example, cause the worker to apply more grip force to hold hand tools and objects. Also, prolonged contact with cold surfaces (e.g., handling cold meat) can impair dexterity and induce numbness. Cold is a problem when it is present with other risk factors and is especially problematic when it is present with vibration exposure.

Exposure to one ergonomic risk factor may be enough to cause or contribute to an MSD. For example, a job task may require exertion of so much physical force that, even though the task does not involve additional risk factors such as awkward postures or repetition, an MSD is likely to occur. However, most often ergonomic risk factors act in combination to create a hazard. Evidence shows that of these risk factors, the combination of force, repetition and awkward postures, especially when occurring at high levels are most often associated with the occurrence of MSDs. Jobs that have multiple risk factors have a greater likelihood of causing or contributing to MSDs, depending on the duration, frequency and magnitude of employee exposure to each risk factor or to a combination of them. Thus, it is important that ergonomic risk factors be considered in light of their combined effect in causing or contributing to an MSD.

Solving Ergonomic Problems

As stated above, a primary goal of ergonomics is the prevention of work-related musculoskeletal disorders (MSDs). Ideally, this is accomplished while simultaneously enhancing the productivity and job satisfaction of the employee work group. This is accomplished by identifying the ergonomic risk factors and systematically eliminating or reducing employee exposure to them. There are three approaches to this process described briefly below:

Engineering controls:

Engineering controls are physical changes to a job that eliminate or materially reduce the presence of MSD hazards. They are the primary and preferred method of improving job tasks to reduce exposure to MSD risk factors. Examples of engineering controls for MSD hazards include changing, modifying or redesigning the following:

1. Workstations
2. Tools
3. Facilities
4. Equipment
5. Materials
6. Processes

Work practice controls:

Work practice controls involve changes in the way an employee does the job. They are defined as changes in the way an employee performs the physical work activities of a job that reduce exposure to MSD hazards. Work practice controls involve procedures and methods for performing work safely. Examples of this type of control are training workers to: use good body mechanics and lifting techniques, to vary the tasks they perform throughout the day to minimize muscle fatigue and to use a new or modified tool properly. In the context of ergonomic programs, work practice controls are essential, both because they reduce ergonomic stressors in their own right and because they are critical if engineering controls are to work effectively.

Administrative controls:

Administrative controls are management-controlled work practices and policies designed to reduce exposures to MSD hazard by changing the way work is assigned or scheduled. Administrative controls reduce the frequency, magnitude, and/or duration of exposure and thus reduce the cumulative dose to any one worker. Examples of this type of control are employee rotation, job enlargement, and employer-authorized changes in the pace of work. Administrative controls should be used with caution and only after careful consideration of all reasonable engineering controls.

Ergonomic assessment tools:

•NIOSH Guide to Manual Lifting
•Postural assessments
•Risk factor check lists
•Task frequency and duration
•Force/weight measurements
•Dimension measurements
•Anthropometry data comparisons
•Energy demand
•Body mechanics assessment
•Environmental factors