Rob Strickland, OTR
Ergonomics Consulting

27422 SE Division Drive
Gresham, Or. 97030
503-667-3564

Ergonomic Evaluation
AccessAbility
Plywood handling device
Welding Manipulator
July 2000
By Rob Strickland, OTR

An on site ergonomic evaluation of the tasks of lifting and handling plywood sheets and of grinding small metal parts was completed on July 27, 2000. A video tape and still photos were taken during the evaluation and are available for review. A discomfort survey was completed by Gail Schmidt, (owner and the only employee at present).

Purpose/Background:

The purpose of this review is to provide an initial assessment of the musuculo-skeletal disorder (MSD) risk factors associated with these activities.

Observations:

A. Moving plywood- This task involves handling 4' X 8' sheets of ¾" plywood in the process of building access ramps. The full sheets weigh approximately 75 lbs. Approximately every 6 weeks Ms. Schmidt receives 20 sheets from the supplier who helps her carry them individually from the street (36 feet) and up two steps to lean them vertically against a wall. Periodically she cuts and prepares the sheets to fill orders for ramps she is building. This involves the following steps:

1. Load the panel saw by grasping the plywood panel and tipping it over on its edge 90 degrees to place length-wise on edge in the saw. Cut the panel to size (largest 44" X 96")

2. Lift panel from the saw to stand up on end. Carry it in this position approximately 14 feet to place it flat on a cart, which is 35" high.

3. Use a saber saw to cut notches in the corners and end of one edge of panel.

4. Lift panel from cart to stand up on end, carry approximately 8 feet to lean against a rack.

5. Paint sealant on face and three edges using a long handled roller.

6. Lift and manipulate panel to turn edge-wise 180 degrees and turn to other face for painting remaining surface and edge. Let dry over night.

7. Repeat steps 5 and 6 two additional times while applying 2 coats of paint to all edges and both surfaces. (One hour drying time in between coats of paint).

8. After drying, the panel is lifted and carried to storage on end in a rack approximately 20 feet away.

Typically, Ms. Schmidt will prepare 10 to 12 panels at a time in this fashion. She lifts, handles and carries an average of 6 sheets per week for a distance of up to 20 or 30 feet. In the process of painting them on the front, back and all sides she must lift, flip and/or roll each panel over a minimum of eight times before storing it for future use.

The primary physical demands likely to contribute to risk of musculo-skeletal injury include:

1. Forces and Loads- 45 to 75 lb. sheets of plywood exceed the recommended lifting limit established by NIOSH. The NIOSH Recommended Weight Limit for this lifting task is 37.8 pounds, roughly half of the actual weight being lifted. This bio-mechanical model predicts that 89% of the male population and only 33% of the female population are capable of safely performing this lifting task.

2. Awkward postures- The size and shape of a sheet of plywood cause trunk forward bending combined with twisting and side bending, neck rotation, shoulder flexion and abduction while reaching overhead or to the side to grasp the load.

3. Contact stress- grasping hard edges of plywood against soft tissues of hands.

This review of MSD risk factors indicates a strong need for further ergonomic evaluation with recommendations for engineering controls to reduce worker exposure to these risk factors. This assessment is substantiated by the discomfort survey completed by Ms. Schmidt which indicates significant discomfort (rated four or greater on a 0 to 10 scale) in the low back, upper back, shoulders, neck and abdominals.

Observations:

B. <u>Grinding small metal parts</u>- This task involves grinding small metal parts (column inserts) which have been welded and need to be smoothed by a grinder. The part size is roughly 4" x 1.5" x 3" with approximately 14" of lineal weld length. The parts are placed in one of two wooden fixtures clamped to a saw horse at 31.25" high. The working height of the part in the fixture is approximately 34" high. The grinder weighs 5.2 pounds and is held with both hands while moving it over the surface of the welds. Each part is manipulated with the left hand, pulling it from one fixture, rotating it 90 degrees and inserting it into the adjacent fixture, repeating the process until all four sides have been ground smooth. When manipulating the part in this fashion, she continues to hold the grinder with the right hand to maintain work efficiency.

At current production levels, Ms. Schmidt makes up approximately 100 small parts at a time, a supply which lasts about six months. This job requires approximately 24 man-hours to complete, with individual tasks allocated as follows: cutting metal materials- 40%, welding- 30%, and grinding 30%.

The primary physical demands likely to contribute to risk of musculo-skeletal injury or disorders are:

1. Repetition- movements of the upper extremities associated with holding and guiding the grinder over the small parts are continuous during this job task, for several hours at a time, up to eight hours cumulatively over a two or three day period. Frequently she must let go of the grinder with the left hand (continuing to hold it with the right hand) while reaching forward to grasp and turn the small part, replacing it in the adjacent fixture.

2. Forces and loads- moderate muscle loading occurs in the upper extremities related to the continuous grasping, holding and controlling of the grinder, compounded by the frequent need to use the left hand to manipulate (grasp, rotate and place) the small parts using the left hand. This leaves a disproportionate load for the right hand to manage the grinder and also presents a safety hazard with potential injury from loss of control with this power tool. Moderate muscle loading is also evident in the upper and lower back while maintaining a slightly forward bent trunk posture.

3. Awkward postures- mild to moderate deviations from neutral postures occur frequently in the wrists (flexion, extension, supination, pronation and radial/ulnar deviation) while holding and guiding the grinder as well as manipulating the small parts in and out of the fixtures.

4. Static postures- prolonged standing in place with a slight forward flexed posture of the back and neck.

5. Contact stress- continuous pressure from the hard handles of the grinder against the soft tissues of the palms while holding the grinder for long periods. Frequent handling of small metal parts with un-gloved hands results in mild contact stress to the fingers.

6. Vibration- moderate exposure to vibration from grinder against the metal parts for several hours at a time.

7. Cold temperatures- during winter months this may be a factor with cold being further transmitted by steel parts.

Recommendations:
Engineering controls

A. For Plywood moving- Design and build a lifting device that can grasp the plywood one sheet at a time, transport it to locations around the shop and assist in manipulating the sheet as needed to turn it over or re-position it. Ideally the device would move the sheets from initial storage, lift and lower to be placed on edge into the panel saw, lift and transport to the cart for notching, lift and move to painting area where it can be raised, lowered and rotated 180 degrees for painting, and then to hang for a period of drying before returning to a vertical storage area. The goal of the device is to eliminate all manual lifting and handling of the plywood panels while efficiently moving them throughout the shop during all processing steps. The device should be efficient, safe and simple to operate and not create additional MSD risk factors.

B. For holding and manipulating small parts- Design and build a manipulator/fixture to hold small parts securely while grinding the welds. It should be height adjustable with the effective working height of the part adjustable from 26" to 36" to accommodate the needs of most workers (approximately 5 percentile female to 95 percentile male) while using the grinder that is employed in this task. The manipulator should be able to rotate the part 90 degrees with a simple foot switch and should have a simple, quick-secure/ quick-release feature. The manipulator/fixture should be able to securely hold all small parts fabricated in the shop (currently there are four different parts) or, have separate fixtures which can be placed in the manipulator as needed to accommodate the different part types. The device should be efficient, safe and simple to operate and not create additional MSD risk factors.

Explore options for gloves to be worn with grinding task for protection against abrasion, cold and vibration. Select a well fitting glove that does not increase grip requirements while using the grinder.

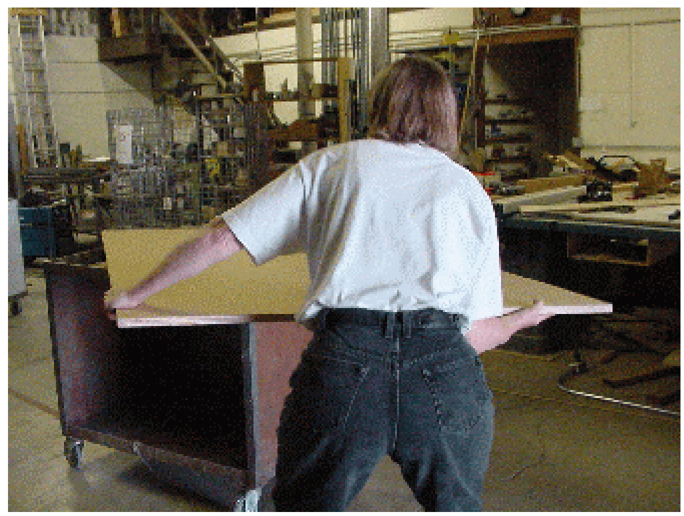
For further assistance or questions regarding this report please contact Rob Strickland, (503) 667-3564.

Respectfully,

Rob Strickland, OTR
Ergonomics Specialist

Lifting and handling plywood panels causes awkward postures and heavy forces and loads

Turning the panel from vertical to horizontal position causes bending and twisting at the trunk



Flipping the panel end for end also causes bending and twisting

Clamping device is in a fixed location creating awkward postures

Clamping fixture must be released to rotate part around during grinding

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