Easy Ergonomics

A Practical Approach for Improving the Workplace

Department of Industrial Relations
Cal/OSHA Consultation Service
Education and Training Unit

About the Cover

▲ *Simple wooden A-frame makes work more comfortable and efficient*

▲ *In-line tool used on a horizontal surface makes the wrist and arm more comfortable*

▲ *Team lifting reduces the workload*

▲ *Lift-assist device eliminates manual handling*

▲ *Scissors lift provides a portable, height-adjustable workstation*

▲ *Parts storage is tilted for easy access and convenience*

Publishing Information

Easy Ergonomics, A Practical Approach for Improving the Workplace was developed by the Education and Training Unit, Cal/OSHA Consultation Service, California Department of Industrial Relations. The document was prepared for publication by the staff of the Publications Division/CDE Press, California Department of Education. It was distributed under the provisions of the Library Distribution Act and *Government Code* Section 11096.

Published 1999 by the California Department of Industrial Relations

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About This Booklet

► This booklet offers a simple, hands-on approach to workplace ergonomics that can work regardless of the size of your organization. It is designed for owners, supervisors, and employees as they work toward improving their workplace.

► The booklet is divided into four sections:

I. **How Ergonomics Can Help.** Introduces you to ergonomics, describes the benefits of taking a proactive approach, and illustrates some practical workplace improvements made by employers and employees in California.

II. **Ergonomics and Your Workplace.** Gives a description of factors that may contribute to problems in work tasks. Also provides a simple method to help you address ergonomics issues in your workplace.

III. **Improving Your Workplace.** Shows examples of ergonomic improvements. Offers suggestions to help set priorities, make informed choices, and determine whether your improvements are working effectively.

IV. **Resources.** Includes a problem-solving exercise. Presents basic information on musculoskeletal disorders, suggestions for getting help from a health care provider, and ergonomics references for further reading (including case studies and Internet web sites).

Note: This booklet *does not* cover ergonomics for the office environment (e.g., the use of video display terminals) or for construction or field agriculture. For a reference on office ergonomics, contact Cal/OSHA Consultation Service (1-800-963-9424) and ask for a copy of:

► *Four-Step Ergonomics Program for Employers with Video Display Terminal (VDT) Operators.* State of California, Department of Industrial Relations, Division of Occupational Safety and Health, Education and Training Unit, 1997.

For an additional reference on health issues related to the use of computers in the workplace, see the Resources section, page 79.

► The information in this booklet is intended to provide general guidance. There may be instances in which workplace issues are more complex than those presented here. You may need the advice of an ergonomics consultant or other outside experts.

► The content is intended to provide current information about workplace ergonomics. The field of ergonomics is dynamic, and new information is constantly being developed. Cal/OSHA will periodically update this publication to reflect changes.

NO ONE IS REQUIRED TO USE THE INFORMATION IN THIS BOOKLET. THIS BOOKLET IS **NOT** INTENDED TO PROVIDE EMPLOYERS WITH INFORMATION ON HOW TO COMPLY WITH CAL/OSHA REGULATIONS.

Contents

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Section I

How Ergonomics Can Help

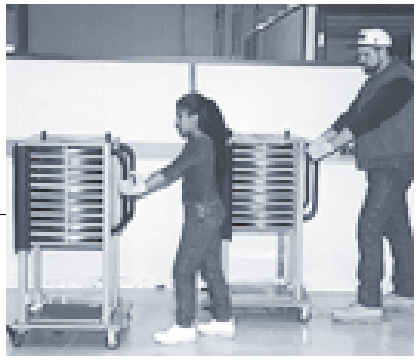
How Ergonomics Can Help

If work is performed in awkward postures or with excessive effort, fatigue and discomfort may be the result. Under these conditions muscles, tendons, ligaments, nerves, and blood vessels can be damaged. Injuries of this type are known as musculoskeletal disorders, or MSDs. MSDs can increase the cost of doing business both directly and indirectly. Direct costs may include medical services and higher workers' compensation premiums. Indirect costs from increased employee turnover, absenteeism, and retraining may also occur. Productivity, product quality, and employee morale may also suffer. Estimates indicate that the indirect costs associated with MSDs may be four to ten times higher than the direct costs.[1]

► You may ask, "What can our organization do to reduce or prevent costly MSDs and avoid the other problems mentioned above?" One answer is to use ***ergonomics*** in your workplace. Ergonomics is the study of how to improve the ***fit*** between the physical demands of the workplace and the employees who perform the work. That means considering the variability in human capabilities when selecting, designing, or modifying equipment, tools, work tasks, and the work environment. Employees' abilities to perform physical tasks may vary because of differences in age, physical condition, strength, gender, stature, and other factors.

[1] See Dan MacLeod, *The Ergonomics Edge: Improving Safety, Quality, and Productivity.* New York: Van Nostrand Reinhold, 1994

Differences in stature can mean the job is awkward for one employee but comfortable for the other .



Consider the differences in employees when improving the fit between the work and the employees who perform it.

► Improving the ***fit*** often involves a process of trial and error until a more effective and appropriate improvement is found. More often than not, maximizing the fit reduces injuries, increases productivity, saves money, and improves product quality and job satisfaction.

A Proactive Approach to Problem Solving

► You don't have to wait for a problem to find you before you address it. Being proactive helps you "get a jump" on solving problems. Taking a proactive approach in your workplace can be as simple as taking a look around, talking to employees, and asking questions such as these:

- Do employees have ideas about how to improve products and make their jobs less physically demanding and more efficient?
- Are employees working in comfortable postures—that is, with no significant fatigue and discomfort?

Remember, it is always best to:

- Take action as soon as you become aware of early warning signs (employee fatigue or discomfort, reports of problems, or high levels of absenteeism, etc.).
- Minimize factors that may contribute to musculoskeletal disorders at the ***design*** stage of the work process, if possible.

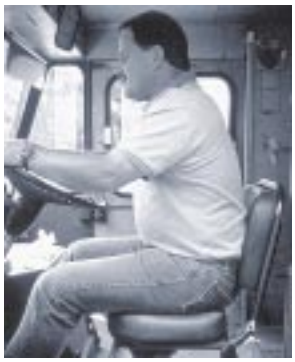
- Be proactive.
- Promote a healthy workplace.
- Save money.

► Early action is particularly important when addressing MSDs because they tend to be treatable and less expensive in the early stages but irreversible and very expensive later. For example, medical costs and workers' compensation claims for ***one*** serious back injury case can run up to or even exceed $85,000.

Employees discuss potential workplace improvements.

A pallet elevated by an employee makes moving the product easier.

► The following pictures illustrate some practical ways proactive employers and employees in California have improved their workplaces.

BEFORE	AFTER
	
Microscope workstation—leads to uncomfortable work posture with bending	*Height-adjustable computer monitor stand under the microscope allows comfortable, upright work posture for shorter and taller employees*
	
Seat too small with poor back support—leads to poor back and neck posture	*Larger, more comfortable adjustable seat with improved back support*
	
A physically demanding task in an awkward posture with a heavy tool	*A pull chain makes opening the valve easier*

Maximizing the *fit* reduces injuries, increases productivity, saves money, and improves product quality and job satisfaction.

BEFORE	AFTER
	
Lifting and carrying—leads to forceful exertions, awkward posture, and blocked vision	*Scissors lift replaces lifting and carrying with sliding and rolling*
	
Manual lifting of drums leads to forceful exertions	*Lift gate eliminates manual lifting and increases productivity—allows loading several drums at once*
	
Short handle on tool leads to bending and squatting—uncomfortable working posture	*Extended handle on tool allows upright, comfortable posture*

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Section II

Ergonomics and Your Workplace

Ergonomics and Your Workplace

Jobs are made up of tasks. Tasks are the things employees must do to accomplish their jobs. Put simply, ***tasks are the parts of a job.*** Some jobs may contain only a single task, but many jobs are made up of multiple tasks. Below are some examples:

Job	Tasks
Cabinet shop worker	Retrieving wood, feeding saw, stacking cut wood
Custodial worker	Emptying trash, dusting, vacuuming
Jewelry manufacturer	Waxing, cutting, finishing
Metal fabricator	Shaping bar stock, cutting, threading
Supermarket clerk	Stocking shelves, checking out groceries
Warehouse worker	Filling containers, shrink-wrapping, loading trucks

► Most work tasks involve movement and physical exertion. But how do you know—

- When repeated movements, forceful exertions, and other aspects of work tasks may lead to fatigue, symptoms of MSDs, and injuries?
- Why workplace problems are occurring (i.e., the reasons or root causes)?

► In short, how do you find out which work tasks may be causing problems and what to do about them? One possible way to help answer these questions is to become aware of workplace "contributing factors."

Workplace Contributing Factors

► Contributing factors are aspects of work tasks which can lead to fatigue, musculoskeletal disorder (MSD) symptoms and injuries, or other types of problems. These factors may be present in one or more of the tasks employees must perform to accomplish their jobs. The contributing factors you and your employees should be aware of include:

- Awkward postures
- Repetitive motions
- Forceful exertions
- Pressure points (e.g., local contact stress)
- Vibration

► There are also environmental factors associated with the workplace which can cause problems. Extreme high temperatures can increase the rate at which the body will fatigue. Alternatively, exposure of the hands and feet to cold temperatures can decrease blood flow, muscle strength, and manual dexterity. These conditions can also cause excessive grip force to be applied to tool handles or objects. Another problem may be caused by tools or equipment that exhaust cold or hot air directly onto the operator. In addition, the lighting in a workplace may be too dark or too bright for the work task. This may result in employees assuming awkward postures to accomplish work tasks and a loss of product quality.

Don't forget to consider the duration of work tasks.

► You should also be aware of the amount of time in a workday that employees spend performing physically demanding or repetitive tasks (i.e., the duration of tasks). Both the total time per work shift and the length of uninterrupted periods of work can be significant in contributing to problems. As repetitive motions, forceful exertions, and other contributing factors increase in work tasks, so does the recovery time (i.e., the length and frequency of muscle relaxation breaks) needed to help reduce fatigue and prevent injury.

► Finally, remember that it is important to uncover ***why*** (i.e., the reasons or root causes) the contributing factors are occurring in work tasks. The ***why*** is important because it allows you to fully understand the nature of the problem and eventually to come up with effective improvement options.

► The employee pictured here is bending and reaching to retrieve a part. The contributing factor is awkward posture (i.e., bending and reaching). The employee is bending and reaching because there is limited access. But why is the access limited? If you look closely, you will see that access is limited because a pallet was left on the shelf. The part the employee needs to retrieve was pushed behind the box on the pallet. Therefore, the real ***why*** for the awkward posture is improper storage of a pallet loaded with boxes.

Awkward Postures

Contributing factors:

- ► Awkward postures
- Repetitive motions
- Forceful exertions
- Pressure points
- Vibration

► Posture affects which muscle groups are active during physical activity. Awkward postures can make work tasks more physically demanding, by increasing the exertion required from smaller muscle groups, and preventing the stronger, larger muscle groups from working at maximum efficiencies. The increased exertion from the weaker, smaller muscle groups impairs blood flow and increases the rate of fatigue.

► Awkward postures typically include ***repeated or prolonged*** reaching, twisting, bending, working overhead, kneeling, squatting, and holding fixed positions or pinch grips. They may affect various areas of the body such as the hands, wrists, arms, shoulders, neck, back, and knees. The effects of awkward postures are worse if work tasks also involve repetitive motions or forceful exertions. Awkward postures may be caused by using poorly designed or arranged workstations, tools, and equipment and poor work practices.

Awkward postures include repeated or prolonged:

- Reaching
- Twisting
- Bending
- Working overhead
- Kneeling
- Squatting
- Holding of fixed positions
- Pinch grips

Work too low—bending, reaching, and twisting

Work too far away—extended reach

Lack of access or clearance—bending and awkward upper body posture

Awkward postures
(Continued)



Work too high—extended reach

Using a pistol grip tool on a horizontal surface—awkward upper body posture and bent wrists

Using a hand tool—bent wrist

Using a hand tool—grip span too wide

Awkward postures may be caused by:

- Poorly designed or arranged workstations, tools, and equipment
- Poor work practices



Pinch grips

Visual Effort

► Sometimes employees assume awkward postures or experience eye strain and fatigue because it is hard for them to see their work. For example, when the lighting is bad, the work is too far away, or materials are blocking the field of vision, employees may have to bend, reach, twist, or hold fixed positions. Similarly, handling or assembling very small parts and materials or performing extremely precise tasks may contribute to eye strain and awkward postures.

Visual effort from precision task—fixed posture with bent neck

Visual effort—bent and twisted upper body posture

Repetitive Motions

Contributing factors:

- Awkward postures
- ► Repetitive motions
- Forceful exertions
- Pressure points
- Vibration

► In repetitive work the same types of motions are performed over and over again using the same muscles, tendons, or joints. The amount of repetition can be affected by the pace of work, the recovery time provided (i.e., number and length of muscle relaxation breaks), and the amount of variety in work tasks. The pace of work may be controlled by the employee performing the task, machines, other employees, or administrative procedures. Examples of jobs involving machine-controlled pace include working on assembly, packaging, or quality-control lines. Work tasks linked to performance or incentives are examples of administratively controlled pace.

Repetitive work tasks

Machine controlled pacing

► The risk of injury is greater when repetitious jobs involve awkward posture or forceful exertions. Injuries may also develop when highly repetitive jobs are combined with low-force exertions, such as in light assembly tasks involving the hands, wrists, elbows, and shoulders. For example, having to grip a cutting or trimming tool throughout the entire work task without being able to set it down momentarily to rest the hand.

Contributing factors:
- Awkward postures
- Repetitive motions
- ► Forceful exertions
- Pressure points
- Vibration

Forceful Exertions

► Force is the amount of muscular effort expended to perform work. Exerting large amounts of force can result in fatigue and physical damage to the body. The amount of force exerted when moving or handling materials, tools, or objects depends on a combination of factors, including the:

- Load shape, weight, dimensions, and bulkiness
- Grip type, position, and friction characteristics
- Amount of effort required to start and stop the load when moving it (i.e., how physically demanding it is to accelerate or decelerate the load)
- Length of time ***continuous force*** is applied by the muscles (e.g., the amount of time the load or object is held, carried, or handled without a muscle relaxation break)
- Number of times the load is handled per hour or work shift
- Amount of associated vibration
- Body posture used
- Resistance associated with moving the load (e.g., over rough flooring or with poorly maintained equipment)
- Duration of the task over the work shift
- Environmental temperature
- Amount of rotational force (e.g., torque from tools or equipment)

Tasks requiring forceful exertions

Load too heavy

Heavy, bulky loads with no handles

Tasks made more physically demanding by awkward postures

Bending and reaching—work too far away

Heavy load with no handles—pinch grip

Heavy hand tool—extended reach

Heavy load with no handles—twisted upper body posture

Reaching up—work too high

Contributing factors:
- Awkward postures
- Repetitive motions
- Forceful exertions
- ► Pressure points
- Vibration

Pressure Points (local contact stress)

► Pressure points result from the body pressing against hard or sharp surfaces. Certain areas of the body are more susceptible because nerves, tendons, and blood vessels are close to the skin and underlying bones. These areas include the sides of the fingers, palms, wrists and forearms, elbows, and the knees.

Pressure points include:
- Sides of the fingers
- Palms
- Wrists
- Forearms
- Elbows
- Knees

Resting the forearms or wrists against sharp edges on a work piece or table

Kneeling on hard surfaces

Tool handles digging into the palm and fingers

Contributing factors:
- Awkward postures
- Repetitive motions
- Forceful exertions
- Pressure points
- ► Vibration

Vibration

► Vibration exposure is of concern when it is continuous or of very high intensity. Using vibrating tools such as sanders, grinders, chippers, routers, impact guns, drills, chain saws, and circular saws can cause exposure to hand-arm vibration. Tools that are not properly maintained or are inappropriate for the task may increase the amount of hand-arm vibration. These exposures may result in fatigue, pain, numbness, tingling, increased sensitivity to cold, and decreased sensitivity to touch in the fingers, hands, and arms.

Hand-arm vibration–vibrating sander

Hand-arm vibration–pneumatic chisle

Whole-body vibration

► Whole-body vibration commonly results from sitting or standing on work surfaces that vibrate. Examples of such surfaces include vibrating vehicles, equipment, and platforms. Whole-body vibration may be associated with general discomfort and lower back pain.

Final Thoughts on Contributing Factors

► As you and your employees become aware of contributing factors in your work tasks, keep in mind that it is still not known precisely:

- How many repetitions are too many.
- What degree of awkward posture is harmful.
- What duration of a task is too long.
- How much force is too much.
- What the effects are on individuals from combinations of these factors.

► Contributing factors are similar to speed limits. No one knows exactly at what speed people will get into accidents. We do know, however, that after a certain point, the faster you drive the more likely you are to have an accident and the more severe that accident is likely to be. Similarly, with workplace contributing factors we do not know exactly how much is "too much." ***Therefore, contributing factors should be minimized in work tasks as much as possible to prevent fatigue, pain, and disability.*** Finally, remember that activities outside the workplace can also contribute to the development or aggravation of MSDs.

Activities Outside the Workplace

► Our bodies do not stop functioning when we go home from work. Home and recreational activities may also contain factors that contribute to MSDs or make them worse. These activities may be different from those at work, but the types of effects they have on the body (e.g., awkward postures, forceful exertions, or repetitive motions) may be the same. Activities that may contribute to MSDs include:

- Knitting
- Crocheting
- Playing musical instruments
- Playing recreational sports
- Using home computers
- Doing other work involving hard physical labor

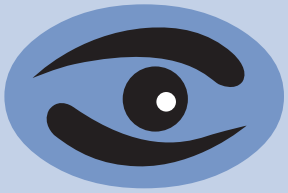
Personal Factors

► Keep in mind that personal factors, such as level of physical fitness, weight, diet, habits, and lifestyle, may also affect the development of MSDs. Also, various medical conditions may predispose individuals to MSDs or make the disorders worse. Examples include:

- Arthritis
- Bone and muscle conditions
- Contraceptive use
- Diabetes mellitus
- Pregnancy
- Previous trauma
- Thyroid problems

► In addition, psychosocial factors may have an impact on MSDs. These factors include:

- Level of stress
- Level of job security and satisfaction
- Amount of autonomy on the job (e.g., degree of control over the arrangement of work areas or the pace of work)



Develop Your "Ergo Eye"

You and your employees may feel you want some practice at identifying contributing factors before you go into your workplace to address potential problems. If you would like some practice, review Section III, "Improving Your Workplace," then try the Problem-Solving Exercise in the Resources section (pp. 56–71).

Ergonomics Job Analysis Methods

► There are many different types of ergonomics job analysis methods. These methods consist of various techniques for taking a systematic look at jobs and work tasks. They help you decide which jobs and specific tasks may contribute to problems. Once you know where problems may exist, it is easier to come up with ideas for making improvements.

► Some methods are relatively simple, and others require detailed analysis and sophisticated equipment. Checklists are generally a simpler, less comprehensive type of ergonomics job analysis method. More comprehensive methods break jobs down into specific movements (e.g., reach, grasp, place) or use other complicated techniques.

► Ergonomics job analysis methods also vary according to what types of work activities they address. Some focus on workstation design. Others are more specific to certain types of work (e.g., manual materials handling or the office environment) or focus on the work environment (e.g., lighting, cold exposures). See the Resources section (pp. 76–82) for references on methods that are more comprehensive than the checklist provided here.

Ergonomics Awareness Checklist

► The purpose of this checklist is to increase your ***basic awareness*** of potential problems associated with jobs and their tasks. This awareness can help provide clues on how to make effective improvements. Be sure to read through the following information completely (including "A Note of Caution") before trying to use the "Ergonomics Awareness Checklist" in your workplace.

Using the "Ergonomics Awareness Checklist"—As Easy as 1, 2, 3

The "Ergonomics Awareness Checklist" was designed to be easy to use. Just follow three simple steps:

1. Look for clues.
2. Prioritize the tasks in each job.
3. Observe the work.

1 ***Look for clues.*** Try to find out which *jobs* may be causing problems. You can do this by looking around your workplace, talking to employees, and becoming aware of early warning signs, such as:

- Employee fatigue or discomfort
- Employees restricting their movements or range of motion because of fatigue or discomfort (e.g., a stiff neck, sore shoulder, or backache)
- Employees modifying tools, equipment, or workstations on their own
- High absenteeism or employee turnover rates
- Poor product or service quality
- High error rates or waste of materials
- Customer complaints
- Production bottlenecks
- Employee reports of problems

► You can also review your written records (e.g., OSHA Log 200, past employee reports, and workers' compensation information).

Examples of employee-modified workstations—"footrests" (i.e., boxes) help relieve back strain and pressure on the back of the knees

Examples of employee-modified tools or equipment—"padded" handles (i.e., tape added) reduce pressure points on the palms and fingers

► Based on the clues you found, list the *jobs* you want to look at on a separate piece of paper.

2 ***Prioritize the tasks in each job.*** For each job you noted in step 1, use the work sheets on this page to list and prioritize the tasks in that job. Make additional copies for each job you plan to look at.

Job title: _____

The **tasks** in this job are:

_____

_____

_____

_____

_____

► Now, for ***each task*** you have noted for this job, ask the employee(s) performing the work the following questions:

How hard is this task?	Score	How often is this task done?	Score
Very easy	1	Seasonally (a few times a year)	1
Easy	2	Occasionally (a few times a shift or week)	2
Somewhat hard	3	Frequently (up to 4 hours per shift)	3
Hard	4	Constantly (more than 4 hours per shift)	4
Very hard	5	Extended hours (more than 8 hours per shift)	5

► Next, give ***each task*** listed a score and multiply the two scores together to get a total for the task.

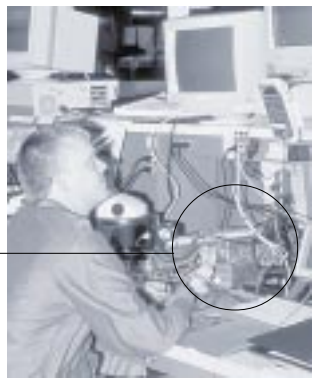
Tasks	Score for "how hard"	x	Score for "how often"	=	Total score for the task

Make copies as needed.

3 ***Observe the work.*** The Ergonomics Awareness Checklist provided on page 25 is designed for use while observing employees performing their work. ***Observe only one job at a time, using one complete copy of the checklist for each job.*** Use additional sheets if there are more than five tasks in any one job. Make copies of the checklist for as many jobs as you plan to observe.

► ***Look at each task in the job separately.*** Begin with those tasks assigned the highest total score. Any tasks that are "very hard" (i.e., score of 5) should automatically be looked at because they might contribute to fatigue and injury even if they are performed very rarely (e.g., on a seasonal basis). For each task, list the contributing factors you observe and the *reasons* for them.

Example



In this photo the employee is experiencing neck strain from bending his neck backward. Why is the employee bending his neck backward? You can see that the monitor he is looking at is too high. But why is the monitor too high? A close look at the situation provides the answer. You will notice that equipment is located below the shelf holding the monitor; therefore, the shelf cannot be lowered. The real ***why*** for the visual effort and awkward neck posture is a lack of workspace for equipment at this workstation.

Note: If you look closely, you will also see a pressure point from resting the right elbow on the work surface.

► Talking to the employees who actually perform the work can often provide valuable information about why tasks are hard and how they may be improved. Also, remember it is important to carefully observe all of the tasks in a given job because each of them may contain contributing factors. Musculoskeletal disorders can be associated with a combination of contributing factors in multiple tasks.

► When you have finished looking at your work tasks, save the checklist results. These results can be useful when considering ergonomic improvements and evaluating the effectiveness of changes you decide to make.

A Note of Caution

► The "Ergonomics Awareness Checklist" may not be the best method for addressing your particular workplace problem. You may need more sophisticated methods for addressing your workplace MSDs. If you feel uncomfortable using the checklist, or if problems seem complicated, severe, or widespread, you probably need additional help. You may contact the following sources:

- Cal/OSHA Consultation Service
- Ergonomics consultants or other outside experts
- Ergonomics equipment vendors
- Peers in your industry
- Trade associations/industry groups
- Unions or employee organizations

► For more help, see the Resources section (pp. 55–82). Finally, remember that the "Ergonomics Awareness Checklist" was not designed to be used for jobs at computer workstations.

Notes

Ergonomics Awareness Checklist

Job Title: _____ Job Location: _____

Name of Employee: _____

Name of Observer: _____ Date: _____

Contributing Factor Descriptions

- ***Awkward postures–***Repeated or prolonged reaching, twisting, bending, working overhead, kneeling, squatting, holding fixed position, or pinch grips
- ***Repetition–***Performing the same types of motions over and over again using the same muscles, tendons, or joints
- ***Forceful exertion–***The amount of muscular effort expended to perform work
- ***Pressure points*** *(local contact stress)*–The body pressing against hard or sharp surfaces
- ***Vibration–***Continuous or high-intensity hand–arm or whole-body vibration
- ***Other factors–***Extreme high or low temperatures; lighting too dark or too bright

► For each task list the contributing factor(s) you observe and the reasons for them.

Contributing Factors (CF)	*Reason for CF*	*Comments*
Task 1 _____		**Total score** _____
Task 2 _____		**Total score** _____

Make copies as needed.

Ergonomics Awareness Checklist *(Continued)*

Contributing Factors (CF)	*Reason for CF*	*Comments*
Task 3 _____		**Total score** _____
Task 4 _____		**Total score** _____
Task 5 _____		**Total score** _____

Make copies as needed.

Section III

Improving Your Workplace

Improving Your Workplace

With your "Ergonomics Awareness Checklist" results in hand, you may decide to improve your workplace. Before you begin, look at the following basic information designed to help you and your employees answer some relevant questions:

- What are ergonomic improvements?
- Which tasks should we try to improve first?
- How do we make informed choices about ergonomic improvements?
- How do we know if our improvements are working?

What Are Ergonomic Improvements?

► Ergonomic improvements are changes made to improve the "fit" between a job and the capabilities of the employees performing it. They are commonly grouped into three categories:

- Engineering improvements
- Administrative improvements
- Safety gear

Engineering improvements include rearranging, modifying, redesigning, or replacing:

- Tools,
- Equipment,
- Workstations,
- Packaging,
- Parts, or
- Products.

Engineering Improvements

► Engineering improvements include rearranging, modifying, redesigning, or replacing tools, equipment, workstations, packaging, parts, or products. These improvements can be very effective because they may reduce or eliminate the underlying reasons for contributing factors. The best time to select engineering improvements is when new facilities, processes, or work procedures are being planned. For examples of engineering improvements, look at the following pictures (pp. 29–39) and the references in the Resources section (pp. 76–82).

Improvement Options for Workstations

Raise or lower the work surface or the employee—reduces bending, reaching, and awkward postures.

Raise the work surface

Adjustable work surface

Scissors lift

Adjustable work platforms

A rule of thumb

A rule of thumb is to try to keep your hands at about elbow height when working. Suggested heights (in inches) above the floor ***for the hands*** while working are as follows:

Seated Work

- Light assembly tasks, *24–28*
- Writing and reading, *26–31*
- Fine visual work, *31–44*

Standing Work

- Heavy work, *28–37*
- Light assembly, *34–38*
- Precision work, *38–46*

Improvement Options for Workstations

Use cut-out work surfaces—allows employees to get closer to their work, reducing visual effort and awkward postures.

Seated work

Standing work

Reposition the work—reduces bending and reaching.

Pop-up table

A-frame

Reconfigure the workstation—sliding and rolling replaces lifting and carrying.

Roller conveyor and roller ball tables

Roller ball tables

Improvement Options for Workstations

Use adjustable equipment—allows comfortable, upright working posture.

Microscope adjusts horizontally and vertically.

Work surface, chair, and shelves all adjust easily.

Provide close, convenient storage for frequently used materials, parts, or tools—reduces reaching and awkward postures.

A rule of thumb

A rule of thumb for maximum reach distances for frequently used items is as follows:

Seated Work

- 15 inches from the employee
- 10 inches above the work surface

Standing Work

- 14 inches from the employee for two-handed tasks
- 18 inches from the employee for one-handed tasks

Note: Reach distances for standing work apply to tasks (other than lifting) performed within the "general safety zone" between the hips and shoulders. For lifting tasks see pages 41 and 42.

Improvement Options for Workstations

Provide comfort.

Foot rests reduce pressure behind the knees and reduce strain on the lower back.

Padding reduces pressure points on the forearm and knees.

Good task lighting reduces eyestrain and makes work tasks easier.

Be innovative.

Slippery coatings on work surfaces (ultra-high molecular weight polyethylene) reduce the force necessary to slide materials or products. Note clamps for holding material or parts in place when needed.

Improvement Options for Movement of Materials

Lifting

Lifting aids reduce force, repetition, and awkward postures in lifting or handling tasks

Vacuum-assist devices

Manipulators

Powered mechanical lift

Workstation crane for heavy loads

Mobile scissors lift

Automatic feed systems reduce lifting and materials handling

Improvement Options for Movement of Materials

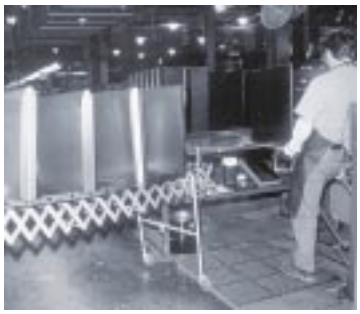
Transporting

Mechanical aids reduce force, repetition, and awkward postures in transporting materials and products around the workplace.

Adjustable carts and carriers

Height-adjustable cart for heavy loads

Powered conveyors



Portable roller conveyor—eliminates carrying of products between workstations

Roller conveyors on a cart and scissors lift—replaces lifting and carrying with rolling and sliding

Transporting *(Continued)*





Powered transport for longer distances

Improvement Options for Storage and Retrieval of Materials

Provide adequate, well-lit storage with easy access for employees—reduces repetitive reaching, bending, twisting, and forceful exertions.


Mobile, lightweight storage carts with adjustable trays

Tilted container with step for easier access

Lift adjusted to waist height for easy loading of containers onto a gravity flow rack

Storage of Materials
(Continued)

Increase the efficient use of storage space by grouping stored items by container size or shape.

Larger containers

Small containers

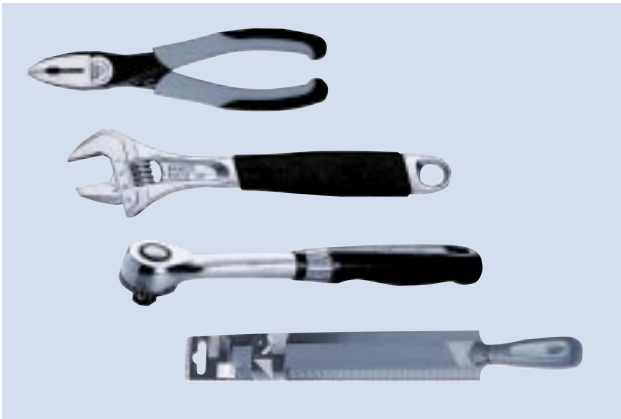
Rolls

Improvement Options for Tools

Good design and proper maintenance can help reduce pressure points on the hands, awkward postures (e.g., bent wrists), forceful exertions, and other contributing factors.

► Handles

- Rounded, soft, and padded—no sharp edges or deep grooves (reduces pressure points on fingers and hands)
- At least 1 to 2.5 inches in diameter (allows a power grip) and 5 inches long (do not dig into palms)
- High-friction surfaces or moldable substances may be added to handles to improve the grip



Tools–Handles *(Continued)*

Well-balanced tool (sprayer) with a swivel connector for hoses

Pliers or cutting-type tools—a maximum grip span of 2 to 3 inches and an adjustable spring return to reduce fatigue and provide a better fit to the hand.

Two handles help to improve control

► Triggers

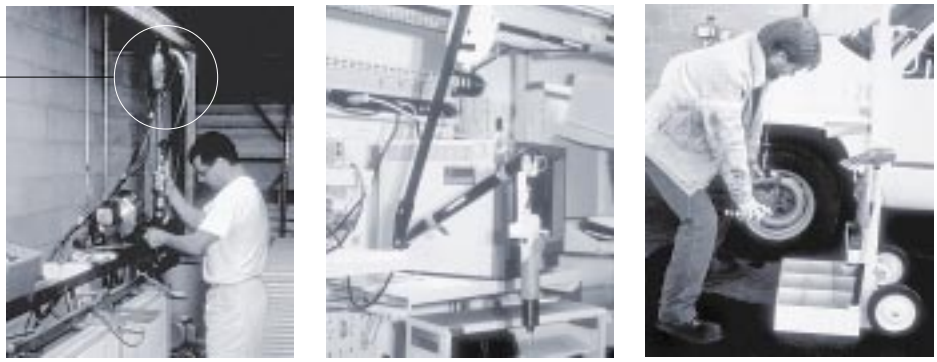
Triggerless tools—contact switches replace triggers

Triggerless infra-red scanner

Multifinger trigger

Trigger bar with low activation forces

Fixtures



Reduce forceful exertions by supporting the weight of the tool

Other Ideas

Look for tools with the appropriate design, such as:

- The right orientation for the work (e.g., horizontal versus vertical surfaces)
- Reduced weight, impact, and vibration
- Padding or other useful additions to the handles (e.g., extensions)
- The cold or hot air exhausted away from the operator
- Torque shock controls (torque arms, reaction bars, etc.)

In-line tool—can be used with a straight wrist on horizontal *surfaces*

Pistol-grip tool—can be used with a straight wrist on vertical *surfaces*

A dead-blow type hammer (composed of a nylon or plastic covering filled with metal shot)—reduces impact and contact stress from metal-on-metal hammering

Tools—Other Ideas
(Continued)

Disk added to handle—reduces grip force needed to hold and use the roller

Extended handle reduces bending and reaching to move parts

Padded handles—reduce pinch grip and pressure points on the fingers

► Storage

Foam tool pad on adjustable tray—employees cut out the foam and arrange their own tools. Reduces reaching for frequently used tools and eases pressure points on the hands and fingers

Vibration Reduction

Ways to reduce hand-arm and whole-body vibration

- Routine maintenance
- Vibration-dampening wraps on handles
- Isolating the tool from the operator
- Properly fitting vibration-dampening gloves
- Good design of an alternate or low-vibration tool
- Suspending or supporting tools (e.g., by a fixture)
- Providing vibration isolators (e.g., springs or pads) for seated work tasks
- Providing cushioned floor mats for standing work tasks
- Mounting equipment and work platforms on vibration-dampening pads or springs
- Altering the speed or motion of tools and equipment

Administrative Improvements

► Administrative improvements include changing work practices or the way work is organized. They may not address the reasons for the contributing factors or other problems. Administrative improvements usually require continual management and employee feedback to ensure that the new practices and policies are effective.

Administrative Improvement Options

- Providing variety in jobs
- Adjusting work schedules and work pace
- Providing recovery time (i.e., muscle relaxation time)
- Modifying work practices
- Ensuring regular housekeeping and maintenance of work spaces, tools, and equipment
- Encouraging exercise

Providing variety in jobs

► There are a couple of ways to increase variety in jobs. *Job rotation* means rotating employees through different jobs. *Job enlargement* means increasing the variety by combining two or more jobs or adding tasks to a particular job. To be effective, both of these improvements rely on rotating through or combining jobs and tasks which differ in the:

- Muscles or body parts used
- Working postures
- Amount of repetition
- Pace of work
- Amount of physical exertion required
- Visual and mental demands
- Environmental conditions

Adjusting work schedules and work pace

► Try to limit the amount of time any employee has to spend performing a "problem job." If you have new employees or employees returning from long absences, introduce them to a normal work pace and workload gradually, like an athlete in spring training.

Providing recovery time

► Recovery periods (i.e., muscle relaxation breaks) can help prevent the accumulation of fatigue and injury to muscles and their associated structures. Try to break up work ***with frequent, short recovery periods***. Even recovery periods as short as a few seconds on a regular basis are helpful. For example, providing a fixture for a tool can allow the hands to relax momentarily between uses.

Modifying work practices

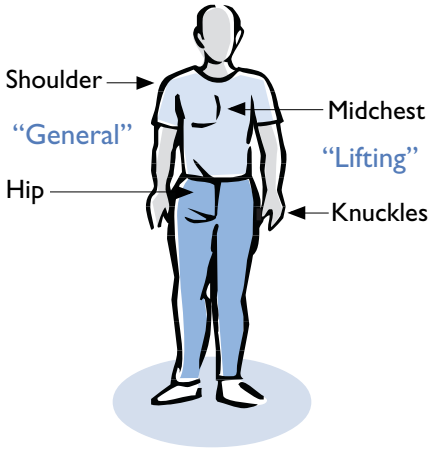
► Pay close attention to how the work is being performed. Our bodies are stronger, more efficient, and less injury prone when we work in ***midrange*** postures. Maintaining midrange working postures simply means sitting or standing upright and not bending the joints into extreme positions. This can be done by trying to keep the neck, back, arms, and wrists within a range of neutral positions. Employees should be encouraged to be comfortable, to change positions, and to stretch when working.

Encourage a midrange, comfortable posture by ensuring that:

- Materials, tools, and equipment for all work activities (excluding lifting tasks) are kept in the "general safety zone" (between the hips and shoulders and close to the body).
- Lifting tasks are performed within the "lifting safety zone" (between the knuckles and midchest and close to the body).

Maintaining comfortable, midrange working postures

SAFETY ZONES



Improving work practices for manual lifting, carrying, pushing, and pulling

Ask yourself:

- *Does the load need to be moved at all?*

If **YES:**

- Can it be done mechanically or rolled or slid instead of lifted?

If it is necessary to handle the load manually:

- Use good lifting techniques.
- Get help.
- Know your personal limits.
- Maintain equipment.
- Warm up and stretch.

Maintain an upright posture by avoiding bending or twisting at the waist. If you must bend, bend the hips and knees, not the waist.

Keep the load or container close to the body (not more than a few inches away when lifting or carrying) and within the "lifting safety zone" (between the knuckles and midchest).

Use teams or get help for bulky materials and difficult work tasks; know your personal limits

Replace lifting with pushing or pulling when possible

Exercise, warm up, and stretch regularly

► Other work practice improvements for work tasks involving manual handling include encouraging employees to:

- Minimize carry, push, or pull distances.
- Try to carry roughly equal amounts of weight in each hand.
- Turn or pivot the entire body instead of twisting at the waist.
- Avoid jerking by using smooth, even motions.
- Use their legs to do the work, not the upper body or back.
- Plan by making sure paths are clear, even-surfaced, and free of obstructions.
- Organize their work to provide gradual increases in exertion or pace.
- Make sure their shoes have the appropriate soles for the surfaces in the workplace.

► Tags can be used to identify loads that may be unstable and heavy. Before moving or handling loads you have tagged, consider:

- Testing for stability
- Reconfiguring or repackaging
- Using mechanical or other alternate means to move or handle them

Load tag

Ensuring regular housekeeping and maintenance of workspaces, tools, and equipment

► Regular housekeeping to eliminate clutter can reduce reaching, bending, or twisting when handling materials, tools, or objects. Floor surfaces kept dry and free of obstructions help eliminate slipping and tripping hazards.

► Regular maintenance of tools and equipment can help reduce or prevent problems in work tasks. For example, keeping cutting or drilling tools sharpened and in good condition can reduce the amount of force and repetition required when using the tools. Fixing broken handles or replacing worn padding can help reduce vibration and awkward postures when performing work tasks. Making sure that carts and other equipment are in good working condition can reduce the amount of force required to move materials.

Encouraging exercise

► Long-term, sensible exercise has many benefits, which may include better health and reduced injuries. Individuals in good physical condition are generally more productive and less injury prone. Regular exercise can increase an individual's energy level, alertness, and coordination. The range of motion of joints and the circulation may also improve with regular exercise. Remember to encourage your employees to warm up, perform gentle stretching (e.g., without bouncing), and increase their physical exertion gradually. New, returning, or injured employees should gradually increase their physical activity.

Safety Gear

► Safety gear, or personal protective equipment (PPE), includes gloves, knee and elbow pads, footwear, and other items that employees wear.

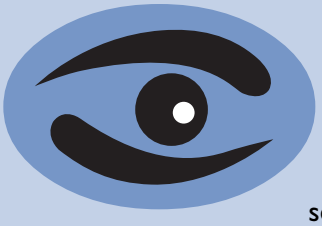
- Gloves can protect hands from cold or injury. However, gloves may decrease manual dexterity and make it harder to grip if they do not fit correctly.
- Proper footwear and antifatigue soles can prevent employees from slipping and prevent fatigue from long hours of standing on hard surfaces.
- Knee and elbow pads can protect the body from pressure points when pressing against hard or sharp surfaces.

Back Belts

► Back belts are not typically considered to be personal protective equipment. They may help maintain the proper curvature of the spine during lifting or physical exertion and may also provide comfort and confidence while performing work tasks. Rigid or nonelastic back belts may serve as an awareness tool by helping to remind employees to reduce bending and twisting when lifting or handling materials.

► Whether back belts are effective in preventing injuries remains an open question (see "Workplace Use of Back Belts, Review and Recommendations," by NIOSH Back Belts Working Group, May 1994). Some studies have suggested that back belts, when accompanied by other improvements, may reduce low back injuries (see "Reduction of Acute Low Back Injuries by Use of Back Supports," by Kraus et al., *International Journal of Occupational and Environmental Health,* Vol. 2, October-December 1996).

A Note of Caution: Safety gear and back belts are not a substitute for other kinds of ergonomic improvement options. Splints are not safety gear and should be used only under a physician's direction as part of an injured employee's treatment for a diagnosed MSD.



Develop Your "Ergo Eye"

You and your employees may feel you want some practice at selecting ergonomic improvements before you go into your workplace to address potential problems. If you would like some practice, try the Problem-Solving Exercise in the Resources section (pp. 56–71).

A Word About Training

► For improvements to be effective, employees need to be trained thoroughly and given opportunities for hands-on practice with any new tools, equipment, or work procedures. The goals for training should include a mix of the knowledge and the skills needed to work safely. Employees should always be informed of any workplace changes.

► Remember that you have gathered a lot of good information in looking at your work tasks and in considering improvements. Share this information and the materials in this booklet with your employees. Inform employees about the:

- Factors that may contribute to the development of MSDs and ways of identifying these factors (Section II)
- Types of improvement options and the process of implementing them in your workplace (Section III)
- Nature of musculoskeletal disorders (Resources section)

► Give some thought to how employees are trained. The most effective approaches for adult learners are interactive and involve combining:

- Multiple types of visual aids (e.g., pictures, charts, graphs, and videos of actual jobs or tasks at your workplace)
- Hands-on exercises with new tools, equipment, or procedures
- Case studies that focus on problem solving in similar operations
- Small group discussions, brainstorming, and problem-solving sessions

► Try to provide ample opportunity for questions and answers, and limit the use of traditional lectures or printed materials. Consider language and literacy issues among your employees when you train them. Finally, remember that videos may be used as a training aid but they are not sufficient if used alone. Can you imagine how effective it would be to try to teach someone to drive or play baseball by just showing them a video?

Which Tasks Should We Improve First?

► You may want to choose some specific improvement options to try in your workplace. Setting your priorities will help you sort out which tasks you want to work on first.

To determine which tasks you want to address first, consider the following:

- Frequency and severity of complaints, symptoms, and injuries
- Contributing factors or other problems you have identified in a particular task
- Ideas your employees have for improvements
- Difficulty of implementing various improvements
- Your time frame for making improvements
- Potential effects on productivity, efficiency, and product or service quality
- Technical and financial resources at your disposal

Improvement Priority List

► Taking into account the relevant and important factors in your workplace, use the space provided below to ***prioritize the tasks within each job you plan to improve.*** Make additional copies for each job you want to address.

Job Title: _____

Task	*Priority*	*Comment(s)*

Make copies as needed.

How Do We Make Informed Choices About Ergonomic Improvements?

Effective brainstorming includes:

- Involving everyone affected by the problem
- Listening to all ideas without criticism or judgment
- Encouraging creativity and new ideas—the more ideas the better

► Look at your "Ergonomics Awareness Checklist" (or other methods you used) and the suggestions noted below. These may help you when considering improvement options for your workplace.

1. *Use in-house human resources.* Brainstorming or holding discussions with engineers, maintenance personnel, managers, and production employees are great ways to generate ideas. Involving everybody can help produce good ideas and increase everyone's acceptance of any changes.

2. *Review original design specifications.* You may find that the job, equipment, tools, raw materials, or other aspects of the work have changed in unexpected ways. A return to the original specifications or conditions may help improve the situation.

3. *Look through equipment catalogs.* Focus on those dealing with the types of problems you are addressing.

4. *Talk to equipment vendors.* They may be able to share ideas from operations similar to yours. It may be useful to develop a partnership with a vendor to resolve the problem.

5. *Contact trade associations or labor unions.* These groups may serve as focal points for efforts to initiate changes within an industry.

6. *Contact others in your industry.* They may have already addressed some of the same types of problems or analyzed similar operations. They may have identified improvement options that could also apply to your problem. You could save a lot of time, money, and effort by taking advantage of tested improvement options in similar operations.

7. *Consult an expert in ergonomics.* An expert can provide insights into available improvements, their cost, and their potential value. Remember, the expert can provide third party credibility and may have experience regarding your particular problem job(s).

8. *Review this booklet.* See the information on improvement options throughout this section (pp. 27–53). Also look in the Resources section for ergonomics references and web sites (pp. 76–82).

Ergonomic Improvements for Your Workplace

► Next, for ***each task*** listed on your "Improvement Priority List" (p. 47), use the space provided below to write down several potential ergonomic improvements. Make additional copies for each task you plan to improve. Start with those tasks you have given the highest priority. For each task, focus on listing improvements you think will most effectively address the ***reasons for the contributing factor(s) and other problems you have identified.*** Remember, a single ergonomic improvement may reduce or eliminate multiple contributing factors. Always ask your employees which improvements they think will work best.

Job Title: _____

Task: _____ Priority: _____

Potential Improvements for This Task

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

► Once you have listed potential improvements for each task, ***evaluate each one separately*** by asking yourself the questions listed below. Then mark or highlight the specific improvement(s) you have selected to try out in your workplace.

Improvement Criteria

Will this improvement:

- Reduce or eliminate most or all of the identified contributing factors and the ***reasons for those factors?***
- Add contributing factors that have not been previously identified?
- Reduce or eliminate any other problems identified and the ***reasons for them?***
- Increase or decrease productivity and efficiency?
- Be feasible from an engineering standpoint?
- Handle the required volume of work (e.g., throughput requirements) for the operation, job, or task?
- Be affordable for this organization (e.g., is there a less expensive alternative that could be equally as effective)?
- Increase or decrease the pace or volume of the work?
- Be accepted by employees?
- Positively affect employee morale?
- Be able to be fully implemented in a reasonable amount of time?
- Affect the rate of pay or a collective bargaining agreement?
- Require an excessive amount of training to implement properly (e.g., is there a simpler alternative)?
- Require training this organization can provide (either in-house or through outside experts)?

Make copies as needed.

► Now that you have selected specific improvements, it is time to try them in your workplace. Consider setting up a ***trial period*** to test new tools, equipment, or work procedures. You may want to use one or more of the following arrangements:

- Mock-up of an improved workstation
- Single modified workstation first (put in full-scale changes to multiple workstations later)
- Off-line workstation or training line
- Extra workstation inserted on a full-speed production line
- Practice or demonstration periods

How Do We Know if Our Improvements Are Working?

► During the trial period, improvement(s) you have selected should be looked at to determine how effective they are. Do not make final decisions on their effectiveness until enough time has passed for people to adjust to the changes. Employees should have a "break-in period" in which they have a chance to practice using the new work-station, tool, piece of equipment or work method. Providing this adjustment period may help you avoid rejecting an otherwise good ergonomic improvement. Some modifications may require employees to use new muscle groups or different parts of the body, and some employees may initially feel fatigued, tired, or sore. Remember to check periodically with your employees to see how they feel the improvements are working.

► Keep in mind the process of improving the workplace is not exact. Expect to try out improvements, see how they are working, and either tinker with them or discard them in favor of alternatives.

► After an appropriate adjustment period, ***evaluate each improvement separately*** by considering the following list of questions.

Has this improvement:

- Had enough time to work (e.g., are employees used to the changes)?
- Reduced or eliminated fatigue, discomfort, symptoms, and/or injuries?
- Reduced or eliminated most or all of the contributing factors and the reasons for them?

- Reduced or eliminated other identified problems and the reasons for them?
- Added any new contributing factors or other problems?
- Worked from a financial standpoint?
- Had a positive effect on productivity and efficiency?
- Matched the production requirements of the job?
- Had a positive effect on product and service quality?
- Been accepted by employees (e.g., has it had a positive effect on employee morale)?
- Been fully implemented in a reasonable amount of time?
- Had a positive effect on absenteeism and turnover rates for jobs where changes were made?
- Been supported with the training needed to make it effective?

Note: A good way to determine whether you have reduced or eliminated contributing factors or other problems associated with a specific task is to go back and take another look at the task, using the "Ergonomics Awareness Checklist."

Additional Thoughts on Ergonomics

- You may hear people say that a job has been "fixed" or that "ergonomic solutions" have been found. This implies that a given job cannot be further improved. Ergonomics in the workplace should be thought of in a relative sense. Therefore, "improvement" from an ergonomics standpoint depends on what you are comparing it to.

- For example, at a tool repair shop, an employee is required to take apart, repair, and reassemble small power tools. To complete these tasks, the employee loosens and tightens fasteners by using a manual screwdriver. He works on a horizontal surface. After a period of time, the employee notices the tool he uses digs into the palm of his hand and it hurts. He also notices that by the end of the day his right arm and wrist begin to ache.

- The employee convinces his supervisor he could do this job more efficiently and with less discomfort if he were to use a power drill with a screwdriver tip. The supervisor agrees and an extra power drill is found in the maintenance shop. Changing to a power tool allows the employee to become much more efficient. However, by the end of the workday, the employee notices that his arm and wrist are tired from using this new pistol-grip tool on the horizontal surface.

- The employee remembers seeing an example of a powered, in-line screwdriver in a magazine. He shows the picture of the tool to his supervisor. He tells the supervisor that this new tool should allow him to work even more efficiently and comfortably than the power drill. The supervisor agrees to let him try out the new tool and contacts a vendor. With the new in-line tool, the employee's productivity increases and he notices that at the end of the work shift his right arm and wrist are not tired. Use of the new in-line tool on the horizontal work surface has turned out to be a better ***fit*** between the employee and his job demands. The new tool has helped reduce awkward posture, repetition, and pressure points in the employee's work tasks. Most important, this successful experience has motivated the employee to continue to look for ways to improve his work tasks.

► The example presented on the previous page illustrates the process of making improvements a little at a time compared with identifying a "fix" or a "solution." The point is that ergonomics can provide a process to help you continue to improve your workplace. This may mean looking at work tasks, selecting improvements and trying them out, looking again to see if they are working, making needed modifications, and so on. Some people refer to this process as ***continuous improvement.***

► A final thought. Some employers and employees have found that one effective way to improve their workplace is to put an ergonomics program in place. Ergonomics programs can create a structure for looking at jobs, providing training, and trying out improvements. If you are interested in an ergonomics program for your workplace, see the references in the Resources section, page 78.

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Section IV

Resources

1. Problem-Solving Exercise
2. Musculoskeletal Disorder Basics
3. Getting Help from a Health Care Provider
4. References
   - Articles
     —Workplace Contributing Factors and Ergonomics Job Analysis Methods
     —Workplace Improvement Options
     —Ergonomics Programs
   - Books and Manuals
   - Case Studies
   - Web Sites
5. Other Educational Resources from Cal/OSHA
6. Questionnaire: We Want to Hear from You

I. Problem-Solving Exercise

Develop Your "Ergo Eye"

You and your employees may want to build your awareness and observational skills by trying the following exercise. It was designed to give you practice at identifying contributing factors and ergonomic improvement options. First review the information in Section II (pp. 7–26). Then, for each task pictured below, try to identify the contributing factors and the reasons for them. Remember, tasks are the things employees do to accomplish their jobs. Some jobs contain a single task but many jobs are made up of multiple tasks. Each task an employee performs may contain contributing factors.

► After you have identified contributing factors for each of the tasks, list some ergonomic improvements that you feel would address these factors. For ideas, brainstorm with your employees or look back through Section III (pp. 27–53). Remember, there is no one right answer. Keep an open mind and don't limit your choices when doing this exercise. To assist you we have done job #1 for you. Review this information first and then try doing the rest of the exercise.

1 Job # 1. Lapping Plate Handler

► This job involves loading lapping plates on a cart (task #1) and transporting them to a resurfacing area (task #2). Carts must hold 10 plates because the plates are processed in groups of 10. Each employee loads and transports 40 to 60 carts per day. The carts weigh 150 pounds.

Task #1—Loading Lapping Plates on the Cart

Contributing Factors

The top of the cart is 38 inches high. However, the poor design of the cart and the need to hold 10 plates means that some of the 25-pound plates that employees must handle are as low as 9 inches from the floor. This results in forceful exertions and bending at the waist (or a deep squat) when handling the lapping plates on the lower shelves. Employees have reported leg and back discomfort from performing this task.

Potential Ergonomic Improvements

Before *After*

The cart must still be able to carry 10 lapping plates. It must be stable and have adequate space between shelves for the fingers and hands to grasp the plates. The design could be improved by raising the overall height of the cart and getting rid of the shelves lower than 24 inches from the floor. In addition, narrowing the thickness of each shelf and reducing the space between shelves would help improve the design of the cart. In the example shown, the top of the cart is raised from 38 to 45 inches. The shelf thickness is reduced from 1 $^{1}/_{4}$ inches to $^{1}/_{2}$ inch, and the space between shelves is reduced from 2 inches to 1 $^{1}/_{2}$ inches.

This reconfigured cart will reduce bending, squatting, and forceful exertions when loading and unloading lapping plates.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*
Awkward posture • Bent back or full leg squat	**Poor cart design** • Bottom shelves too low	• 9 inches from floor	**Reconfigure cart** • Raise overall height from 38 to 45 inches • Reset lowest shelf at 24 inches above floor • Narrow each shelf from 1 1/4 inches to 1/2 inch • Reduce space between shelves from 2 inches to 1 1/2 inches • Keep10 shelves
Forceful exertion • Back and legs	• Up to 25 lb load handled in awkward posture	• Awkward posture makes lifting the lapping plates more physically demanding	• (Same as above)

Task #2 — Transporting the Plates to the Resurfacing Area

Contributing Factors

The resurfacing area is 100 feet away. When pushing the old-style cart to this area, the fixed-height, horizontal handle can cause the wrists to be bent backwards and taller employees to bend at the waist. Employees have noticed that the casters on the cart are worn. In addition, in some places in the facility, the floor is cracked and rough and the aisles are crowded. These conditions cause large amounts of force to be exerted when transporting and maneuvering the heavy, loaded cart (total weight of 400 pounds: 150 pounds for the cart and 10 plates at 25 pounds each). Employees have reported wrist, shoulder, and back discomfort while pushing and turning the cart.

Potential Ergonomic Improvements

This task cannot easily be improved by reducing the distance pushed. However, the fixed-height, horizontal handle could be replaced by two vertical handles. Individuals of different statures would then have options for placing their hands at comfortable heights without bending their wrists back. Improving the handles, along with raising the overall cart height to 45 inches, helps employees maintain an upright posture without bending at the waist. Replacing worn casters and patching and smoothing out the floor would also reduce the workload when transporting and maneuvering the cart.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*
Awkward posture	**Poor cart design**		**Reconfigure cart**
• Bent wrists	• Horizontal, fixed-height handle	• Limits options for wrist position and hand height when pushing cart	• Change to two vertical handles
• Bending at waist	• Cart too low	• Taller employees must bend at the waist	• Raise cart height from 38 to 45 inches
Forceful exertion			
• Wrists or shoulders or back	• Worn casters	• Increases required force	• Replace casters
	Facility condition/layout		**Facility improvements**
	• Cracked, uneven floor	• Increases required force	• Patch and smooth floors
• Sustained pushing	• Distance cart has to be pushed	• Location of resurfacing area is determined by existing plumbing and waste-disposal systems	• Cannot change location
	• Crowded aisles near resurfacing area	• Causes excess maneuvering and turning of heavy, loaded cart	• Clean and rearrange aisle

► Now look at the following pages and try to do jobs 2 through 5 on your own. The tasks in each job are described for you. Can you identify contributing factors, the reasons for them, and some ergonomic improvements? After you have completed each job, look on the subsequent pages for some answers. Remember, there is not one "right" answer! You may have many good ideas that are not listed.

2 Job # 2. Chair Casing and Handling

► A furniture manufacturing job on an assembly line involves lifting office chairs from a conveyor and placing them in shipping cases (task #1). After strapping, the cases are transferred from a conveyor onto flat carts (task #2) for transport to the shipping area. Approximately 200 chairs are handled each shift by each employee. Employees have reported low back and shoulder discomfort for both tasks. Also, this point in the process has often been a production bottleneck causing shutdowns of the assembly line.

Task #1—Placing Chairs in Shipping Cases

The chairs are 35 inches tall, weigh 40 pounds each and are bulky. Their weight is not evenly distributed. The shipping case is 36 inches high and weighs 5 pounds. Chairs must be carried a short distance. Before being set in the case, the chairs must be lifted above the case and turned as they are lowered so they will fit in. The height of the hands when lifting and carrying the chairs ranges from 55 to 75 inches above the floor. The pace of handling the chairs is controlled by the speed of the assembly line.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*

Task #2—Pulling Strapped Cases to a Transfer Cart

The loaded shipping cases weigh 45 pounds each (i.e., chair plus case). Employees pull (by the strapping) two loaded cases at a time onto carts to keep up with the assembly line. Carts have non-locking casters so they shift around when the loaded cases are pulled onto them.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*

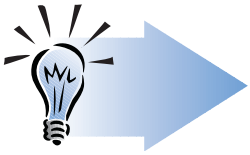
2 Job # 2—Answers

Task #1—Placing Chairs in Shipping Cases

Improvements should address awkward postures and forceful exertions. These include lifting and carrying chairs above shoulder height and twisting to lower them into the cases. These factors could be addressed by placing cases over chairs or sliding side-opening cases onto chairs while they are still on the assembly line. These options would eliminate the need to lift and carry chairs and place them in cases. The lighter weight of cases (only 5 pounds) would greatly reduce the force on the back and shoulders. Positioning cases and employees directly in front of the chairs would eliminate twisting. If shorter employees find the case lift or slide too high, they could stand on a floor platform. Alternatively, a lift assist device (see task #2) could be used to place cases over the chairs or move the chairs into cases. Employees could be rotated through the chair casing job every few hours to reduce repetitive motions.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*
Awkward posture			
• Lifting and carrying above shoulders	• Chair height - 35 inches Case height - 36 inches	• Height of hands from 55 to 75 inches above floor	• Place case over chair while still on the line, or use side-opening case, or use lift assist device
• Twisting back	• Chairs turned to fit in case		• Same as above and position employees directly in front of chairs on the line
Forceful exertion			
• Back and shoulders	• Chairs bulky and uneven weight distribution	• Awkward posture increases exertion by smaller muscle groups • Plastic around chairs makes them hard to grasp	• (Same as above)
Repetitive motions			
• Back and shoulders	• Pace controlled by assembly line	• Employee must keep up or risk shutting down the assembly line	• Rotate employees or use lift assist device

Before



After

Task #2—Pulling Strapped Cases to a Transfer Cart

Improvements should reduce or eliminate the extended reaching and pulling and the forceful exertions. A vacuum lift assist could effectively address these factors by moving the cases with very little operator effort. An added benefit could be increased productivity. The same lift assist device could be used for task #1.

► If a lift assist device is not feasible, improvements could be made by increasing the stability of the cart and modifying the work practices. Cart stability could be improved by installing locking casters, angle iron, or tracks on the floor or by using chocks for the casters. Then employees standing on a height adjustable platform on the opposite side of the conveyor could use both hands to push the cases onto the stable cart. Pushing against the flat cardboard shipping cases instead of pulling by the strapping would eliminate the pressure points on the fingers. A roller-ball table added to the end of the conveyor would reduce forceful exertions and make the cases easier to push. Slipping and falling hazards could also be reduced by these measures. A less desirable option is continuing to allow employees to pull the cases. They could stand on the stable cart, get closer to the cases, and pull with both feet positioned at equal heights. Whichever set of improvement options is selected, employees could be rotated every few hours to reduce repetitive motions.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*
Awkward posture			
• Back bent and extended reach	• Reaching across shifting cart • Casters do not lock	• Employee cannot stand on cart to pull cases • Legs at different heights	• Lift assist device or push instead of pull and improve cart stability (i.e., locking casters or chocks)
Forceful exertion			
• Back and shoulders	• Pulling two cases in an awkward posture	• Slipping and falling hazard if strap breaks or cart moves	• (Same as above)
• Legs	• Employee must steady cart while pulling cases	• (Same hazard as above)	• (Same as above)
Pressure points			
• Fingers	• Pulling cases using strapping		• (Same as above)
Repetitive motions			
• Back and shoulders	• Pace controlled by assembly line	• Employee must keep up or risk shutting down line	• Rotate employees or use lift assist device

Before

After

3 Job # 3. Filing Cabinet Handler

► In a single-task job, assembled filing cabinets are lifted and carried from a conveyor and placed on a cart for transfer to the finishing department. Approximately two hundred cabinets are handled per employee in an 8-hour shift. Employees have reported back, leg, arm and shoulder discomfort. Some employees with a history of back or shoulder problems have not been able to keep up the pace and have been moved to other jobs.

Moving Filing Cabinets from a Conveyor to a Cart

The conveyor is 28 inches high. The transfer cart sits parallel to the conveyor. Work space is limited and moving the cart closer to the conveyor would block the aisles. The cabinets are open on top and do not have useable handholds on the sides. They are bulky (24 inches high, 15 inches wide, 26 inches deep, 40 pounds each). Employees cannot get their arms around the cabinets when handling them, so they grip them inside the top edges (putting their hands at least 52 inches above the floor). Employees are required to wear leather work gloves. Because of the cabinets' height, weight, bulkiness and lack of handholds, employees swing and twist as they move them from the conveyor to the cart. They do this to try to take advantage of momentum to make the task easier. Cabinets are stacked on the cart two deep, so employees must either reach across the cart to place the back cabinets or carry them around the cart.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*

3 Job # 3—Answers

Moving Filing Cabinets from a Roller Conveyor to a Cart

Improvements should address the awkward postures (e.g., lifting and carrying at or above shoulder height, twisting the back), poor grasping points and the forceful exertions from repeated handling. A lift assist manipulator would make moving the cabinets much less physically demanding and more efficient. It could also reduce the chances of the product being damaged or dropped while being moved.

► If a manipulator is not feasible the task could still be improved by using a roller-ball table or team lifting. The roller-ball table should be installed at the end of the conveyor with its surface slightly higher than the transfer carts. Cabinets on their individual skids could be pushed or slid onto carts located at the end of the conveyor. The wheels on the carts must be locked or stabilized to keep the carts from moving. The grip on the cabinets could be improved with hand tool assists such as hooks, straps, suction cups or magnets which could be attached to the cabinets or their skids. Alternatively, team lifting could be used to transfer the cabinets. With two employees the high lifting and forceful exertions could be reduced by grasping the cabinets from the bottom (at the front and back or on each side) and moving them as a team. Finally, if a higher-volume assembly line production process is required, it would be best to move the assembled product to the finishing department by conveyor rather than transporting it by cart.

► Rotating employees through the task on a regular basis could help reduce repetitive motions from the pace of the assembly line.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*
Awkward posture			
• Lifting and carrying at or above shoulder height	• Conveyer 28 inches high • Cabinet 24 inches high • No good handholds so cabinet gripped on top	• Height of hands at least 52 inches above floor • Cannot get arms around cabinet to lift	• Lift assist manipulator or roller-ball table at end of conveyor (replaces lifting with sliding) or team lift
• Elbows out from body	• (Same as above)	• (Same as above)	• (Same as above)
• Twisting back	• Cart parallel to conveyor and swing lift used	• Moving cart closer would block aisle	• (Same as above)
Forceful exertion			
• Back and upper body	• Cabinets heavy, bulky, and no good hand holds		• (Same as above)
• Hands and fingers	• Pinch grip at top of cabinet	• Gloves decrease pressure points but also can decrease grip strength	• Same as above and improve grip with hooks or straps or magnets
Repetitive motions			
• Back, upper body, and hands	• Pace controlled by assembly line	• Employee must keep up or risk shutting down line	• Rotate employees or use lift assist manipulator

4 Job # 4. Maintenance Mechanic

Low Work on a Conveyor

A maintenance task underneath a 27-inch-high conveyor system requires mechanics to work lying down on the floor. They may spend several hours a day performing this type of work around the facility. Mechanics have been observed using cardboard to insulate themselves from the cold, hard floor surface. Their work usually involves using hand tools to loosen and tighten fasteners and adjust controls. They must reach up and extend their arms and shoulders to perform the work. At times fasteners become "frozen" and are difficult to turn and loosen. In addition, some of the fasteners and controls are small and painted the same color as the conveyor. It is dark under the conveyors. These factors often cause the mechanics to elevate their heads and necks to get closer to the work to see what they are doing. Sometimes they support their heads and necks with a hand to reduce fatigue. When they do this they are left with only one hand to use tools. Mechanics have reported neck, shoulder, forearm and hand discomfort.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*

4 Job # 4—Answers

Low Work on a Conveyor

The maintenance task can be improved by reducing the awkward postures and the amount of exertion required. Creepers or variable height positioners with easily adjustable head- and neckrests would be effective improvements. Padding on the floor in varying thicknesses could also be used. These options would raise the mechanic off the floor, relax the shoulders, reduce reaching, and support the neck in a comfortable position. The mechanic would no longer need to occasionally use one hand to hold up his head. This would free up both hands to perform the work, which would lessen the force exerted when repetitively turning fasteners or adjusting controls. Also, portable lighting should be provided to make the work easier to see.

► Selecting appropriate, well-designed alternative hand tools (e.g., power tools, bent or padded handles, ratchets) is another option to help reduce force and repetition. Tools must be small enough to get into tight spaces, but the handles must be long enough to take advantage of leverage. There should not be too many tools for mechanics to comfortably carry around to the various tasks. Other ideas include making the fasteners and controls more visible by replacing them with larger ones or painting them a distinctive color. Where feasible, access to frequently maintained fasteners and controls could be improved by moving them to the top or sides of the conveyor. Improved access would help reduce awkward postures and the force required to use hand tools. An adjustable-height stool with locking casters and a backrest should be provided for maintenance work on the top or sides of the conveyor. These or other combinations of improvements, which make the maintenance easier and faster, should lead to increases in productivity in the production process.

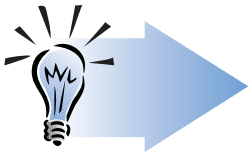
Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*
Awkward fixed posture			
• Arms and shoulders extended	• Need to reach work with proper tool orientation	• Conveyor design requires access from below	• Raise mechanic with creeper or positioner with adjustable head and neck support and locking wheels, or use pads • Retrofit conveyor, moving frequently maintained fasteners and controls to side or top
• Back on cold, hard surface	• Cramped work space—must lie on floor	• 27 inches from floor to bottom of conveyor • Conveyor design requires access from below	• (Same as above)
• Neck bent—need to see work (visual effort)	• Poor lighting • Fasteners and controls hard to see • Mechanic lying on floor		• Same as above and use portable lights and larger or different colored fasteners and controls

Job #4—Answers *(Continued)*

Low Work on a Conveyor

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*
Repetition • Hands, arms, and shoulders	• Use of hand tools	• Varies, based on tool used and type, size, and condition of fastener or control	• Use powered hand tools or better tool designs to reduce repetitive torquing and turning of tools
Forceful exertion • Hands, arms, and shoulders	• Use of hand tools—arms fully extended and occasionally only one hand used • "Frozen" fasteners or controls and awkward hand-wrist postures	• Other hand supporting head and neck	• Reduce reach distances using creeper or positioner or pads • Retrofit conveyor moving frequently maintained fasteners and controls to side or top • Use powered hand tools or better tool designs to reduce force and alleviate awkward wrist and hand postures (e.g., bent-handled tools or ratchets)

Before



After

5 Job # 5. Motherboard Inspection and Repair

► A manufacturing job involves inspection and minor repair of computer motherboards from an assembly-line conveyor. Employees handle 30 to 45 boards per hour for eight hours during their shift. The conveyor is 36 inches high and the worktable is 6 inches lower. A new motherboard arrives every one to two minutes. This leaves little time for the employee to catch up if an individual board needs special attention. Over the course of the last month, the assembly line has been stopped several times per shift. Employees have reported back, hand, wrist, and elbow discomfort from performing this job.

Motherboard Inspection and Repair

The assembly-line conveyor is at a right angle (i.e., 90 degrees) to the worktable where the inspection and repair work is performed. Employees twist and reach up to 24 inches to retrieve the motherboards from the conveyor.

◄ Then they hold and manipulate the boards to inspect them for defects or missing parts. If necessary, minor repairs are made with a small manual nut driver. Finally, employees again twist 90 degrees and reach over to the conveyor to return the motherboards.

Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*

5 Job # 5—Answers

Motherboard Inspection and Repair

Improvements should address the repeated twisting and reaching when the motherboards are retrieved from and returned to the conveyor. Reorienting the worktable 90 degrees so its surface is parallel to the conveyor eliminates the repetitive twisting. Providing a cutout in the newly oriented worktable reduces reach distances and the overall movement required to perform the job. The worktable surface should be the same height as the conveyor and located as close as possible to the assembly line. Employees could then simply slide the boards a few inches onto the worktable for the inspection and any needed repairs. To help reduce reaches for employees of different stature, a height-adjustable chair could be provided.

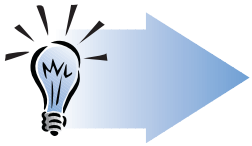
A light-weight, adjustable fixture holds the motherboard during inspection or repair.

Other factors to address include the repetitive hand and finger movements required to manipulate the motherboards during their inspection and repair on the worktable. A light-weight, adjustable fixture could be added to the workstation. The fixture would eliminate the need to hold the motherboards and could be used to adjust the position of the boards during the inspections. That would free both hands to repair defects or perform other work on those boards needing special attention. The fixture would also raise the boards closer to the employees, making the work easier to see. A light-weight, powered hand tool could be used to further reduce repetitive hand and finger movements when making minor repairs to the boards.

► The combination of improvements mentioned above should reduce the effort and time needed to inspect and repair individual boards as they come down the conveyor. The improvements could help reduce the number of times the assembly line needs to be stopped. In addition, rotating employees through the job every few hours could reduce repetitive shoulder, arm, hand, and finger movements.

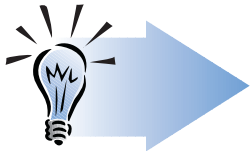
Contributing Factors (CF)	*Reasons for CF*	*Comments*	*Ergonomic Improvements*
Awkward posture			
• Twisting back and upper body	• Worktable oriented 90 degrees from conveyor		• Reorient worktable parallel to conveyor
• Extended reach—hands, arms and shoulders	• Distance from conveyor to worktable (retrieving and returning mother-boards)	• Long reach, even for bigger individuals	• Locate worktable at edge of conveyor and use cut-out worktable (also equalize height of work surface and conveyor)
			• Provide height-adjustable chair
Repetition			
• Twisting and extended reach	• (Same as above)		• (Same as above)
	• Pace controlled by assembly line	• Frequent twisting (two twists per board)	• Rotate employees every few hours
• Hand and finger manipulations to inspect and occasionally repair boards	• Employees hold and manipulate boards by hand		• Provide adjustable fixture
	• Manual nut driver used for occasional minor repairs		• Use powered hand tool
	• Pace controlled by assembly line		• Rotate employees every few hours

Before



After

Before



After

2. Musculoskeletal Disorder Basics

The following information summarizes musculoskeletal disorder (MSD) characteristics, symptoms, and terminology.

Characteristics

MSDs may:

- Occur from a single event (such as a strain or sprain from a lift, slip, or fall) or result from the buildup of tissue damage from many small injuries or microtraumas.
- Take weeks, months, or years to develop.
- Produce no symptoms or exhibit no findings on medical tests in their early stages (medical tests may be positive only in later stages when irreversible injury has occurred).
- Be associated with contributing factors present in work tasks and in home or recreational activities.
- Differ in symptoms and severity from individual to individual even though their work tasks or other activities are similar.

Symptoms

Symptoms associated with MSDs may include:

- *Pain* from movement, from pressure, or from exposure to cold or vibration.
- *Change in skin color* from exposure to cold or vibration.
- *Numbness or tingling* in an arm, leg, or finger, especially in the fingertips at night.
- *Decreased range of motion* in the joints.
- *Decreased grip strength.*
- *Swelling* of a joint or part of the arm, hand, finger, or leg.
- *Fatigue,* or difficulty in sustaining performance, particularly of small muscle groups

Common Terms for MSDs

► Many MSD conditions are grouped under the terms *cumulative* or *repeated traumas, repetitive motion injuries,* or *repetitive strain syndrome.* (On your OSHA Log 200, you may see cases of muscle strains, ligament sprains, back, wrist, or shoulder pain.) Other terms, such as those noted below, may be found on the Cal/OSHA Log 200 or on the Employer's and Doctor's First Reports of Occupational Injury and Illness.

Medical Terms

► The general term *musculoskeletal disorder* is not a medical diagnosis. Musculoskeletal disorders primarily affect muscles, tendons, ligaments, nerves, and small blood vessels. Examples of specific types of disorders include:

myalgia—muscle pain

chronic myofascial pain syndrome—chronic pain in the muscles

tendinitis—inflammation of a tendon (e.g., shoulder tendinitis, tennis elbow, de Quervains disease)

tenosynovitis—inflammation of a tendon and its sheath (e.g., in the wrists, hands, or fingers)

carpal tunnel syndrome—swelling and entrapment of the median nerve in the wrist

thoracic outlet syndrome—squeezing of the nerves and blood vessels between the neck and shoulder

hand-arm vibration syndrome—damage to blood vessels and nerves in the hands and arms

degenerated, bulging, or ruptured (herniated) disks in the neck or back—disks that wear or dry out, bulge, lose elasticity, or rupture, causing pain and pressure on other structures of the neck or back

sciatica—bulging or ruptured disks in the lower back causing lower back pain that also extends to the legs and feet

degenerative or *osteoarthritis*—wear and tear on the spine, joints, vertebrae, and disks, associated with long-term physical loads on spinal structures

3. Getting Help from a Health Care Provider

When dealing with a potentially complicated or severe MSD, you may decide that you want help from a health care provider (HCP). Alternatively, the employee may have seen an HCP on his or her own. Sometimes, company policies or workers' compensation carriers require that an HCP get involved. However the situation has evolved, the more you know about what a good HCP can do to help you, the better off you and your employees will be.

What Can a Good Health Care Provider Do to Help?

► A good health care provider can be a partner to you and your employees by helping to confirm if an MSD is present and whether it may be connected to the individuals' work tasks. Also, if the HCP is knowledgeable about the employees' work tasks and other activities, he or she can help come up with effective improvement options.

What Can You and Your Employees Do?

► Try to choose an HCP who is familiar with work-related MSDs. Make sure to supply the HCP with detailed information describing the work activities of the individual being evaluated. Ask the HCP to review this information as a part of the medical evaluation. Potential problems can be addressed most effectively when the HCP is familiar with your workplace and employees' work tasks. When interacting with a health care provider, ask for his or her opinion on the following types of questions:

- Is an MSD really present?
- What is the nature of the physical problem?
- If present, which specific work task(s) is the MSD connected to ?
- What kind of specific work-related improvements may help?

► Throughout the situation, stay in communication with the HCP. Do not hesitate to ask questions or get more information if you feel you need it. Follow up with the health care provider and let him or her know whether the improvement options you are trying are working effectively. If you think further workplace modifications may be needed, consult with the HCP before making any more changes.

The Penny Wise, Pound Foolish Syndrome

► Finally, remember that it is better for several employees to be evaluated and found free of injury than for a single employee not to be evaluated and later develop an irreversible MSD. Why? Just look at the numbers. Medical examinations can cost as little as $100. However, medical costs and workers' compensation claims for serious MSDs may run anywhere from $15,000 to $85,000 or more. Talk about this potential with your insurance carrier. You may find they are willing to encourage preventive evaluations because of their long-term value. ***Early intervention is an opportunity to use health care resources to the benefit of both you and your employees.***

4. References

The following references provide further information on contributing factors, ergonomics job analysis methods, workplace improvement options, and ergonomics programs. These references include selected articles, books and manuals, case studies, and Web sites (which also provide sources for products and vendor information).

Note: The references are listed alphabetically by title, rather than by author, to help readers find information on issues of particular concern.

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Case 10. "Musculoskeletal Injuries in a Packaging/Warehousing Operation," Chapter 4, pp. 131–134.

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Case 18. "Reorganization of an Electrical Components Assembly Line," Chapter 4, pp. 162–164.

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Case 36. "Maximizing Gains from Mechanized Handling," Chapter 6, p. 214.

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Case Study 1. "Canister Washing"

Case Study 2. "Metal Tube Cutting"

Case Study 3. "Palletizing Boxes"

Case Study 4. "Warehouse Carrying"

Case Study 13. "Door Assembly Operation"

Case Study 17. "Moving Storage Drums"

Case Study 18. "Beverage Delivery"

Case Study 20. "Hand Truck Delivery"

Case Study 23. "Manufacturing Steel Furniture"

Case Study 26. "Recycle Warehouse Operation"

Case Study 30. "Shoe Manufacturing Procedures"

Case Study 31. "Unloading and Scanning Groceries"

Case Study 38. "Low-Force Activation Buttons"

Case Study 39. "Knob Twist Fixture"

Case Study 41. "Manufacturing Industrial Equipment"

Case Study 42. "Manual Delivery"

Case Study 43. "Box Building and Closing"

Case Study 49. “School Custodians”

Case Study 51. “Motor and Equipment Assembly”

Case Study 52. “Quality Control Inspection”

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Web Sites

American Industrial Hygiene Association, Occupational Health Resources <**users.aol.com/nohc96/pnsaiha.html**> contains useful technical links, etc.

Board of Certification for Professional Ergonomists <**www.bcpe.org**> contains a list of certified professional ergonomists, definitions, requirements for certification, areas of expertise for ergonomists, etc.

California Department of Industrial Relations (Cal/OSHA) <**www.dir.ca.gov**> contains bulletins, an organization chart, regulations, etc.

Conveyor Equipment Manufacturers Association <**www.cemanet.org**>

CTD News <**www.ctdnews.com**> contains a summary of current publications, information on cumulative trauma disorders, technical links, etc.

Ergo Web Inc. <**www.ergoweb.com**> contains information on vendors, case studies, literature, publications, product information, etc.

Ergonomic Resources <**www.lib.utexas.edu/Pubs/etf**> contains online ergonomic resources in ten highlighted categories.

Ergoworld <**www.interface-analysis.com/ergoworld**> contains information on office and industrial ergonomics, injury prevention and treatment, products, consultants, organizations, university programs, etc.

Human Factors and Ergonomics Society <**www.hfes.org**> contains information on membership services, professional activities, news bulletin, technical links, news groups, etc.

Industrial Distribution Association <**www.ida-assoc.org**>

Industrial Truck Association <**www.indtrk.org**>

Institute of Industrial Engineers <**www.iienet.org**>

Institute of Logistics Supply, Chain Center <**www. institute-of-logistics.org.uk**>

Material Handling Equipment Distributors Association <**www.mheda.org**>

Material Handling Industry of America <**www.mhia.org**> contains product and vendor information, literature, publications, case studies, and world wide resources, including web sites.

National Electrical Manufacturers Association <**www.nema.org**>

National Institute for Occupational Safety and Health (NIOSH) <**www.cdc.gov/niosh/ergopage.html**> contains technical links, statistics, publications, regulations, case studies, etc.

National Wooden Pallet & Container Association <**www.nwpca.com**>

Society of Manufacturing Engineers <**www.sme.org**>

United States Department of Labor, Additional Resources <**www.osha-slc.gov/SLTC/ergonomics/index.html**> contains links to the following web sites:

- Center for Industrial Ergonomics at University of Louisville
- Center to Protect Worker's Rights (CPWR)
- CUErgo–Cornell University Web
- North Carolina Ergonomics Resources Center
- Ohio State University Institute for Ergonomics
- University of Michigan Center for Ergonomics
- University of Virginia Ergonomics Training and Resources

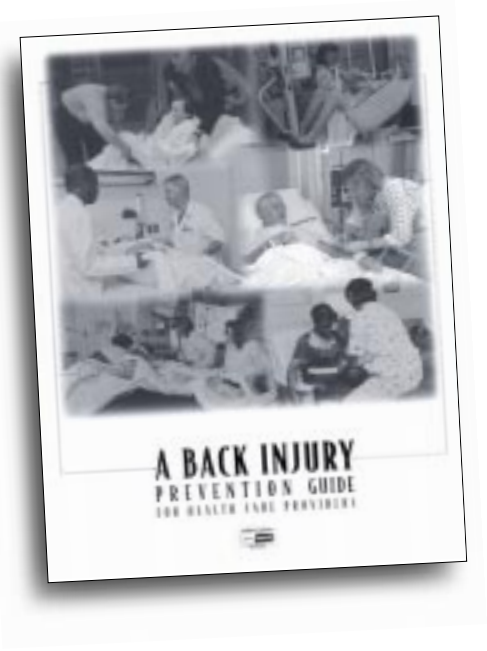
United States Department of Labor, Federal OSHA <**www.osha.gov**> contains technical links, statistics, publications, regulations, case studies, etc.

University of California at San Francisco and University of California at Berkeley Ergonomics Program <**www.me.berkeley.edu\ergo**> contains information on musculoskeletal disorders, design ergonomics, case studies, references, product and vendor information, technical links, etc.

Warehousing Education and Research Council <**www.werc.org**>

5. Other Educational Resources from Cal/OSHA

► Cal/OSHA Consultation Service has a series of recent publications designed to assist employers and employees in California. To receive one or more of these publications, just call: 1–800–963–9424.

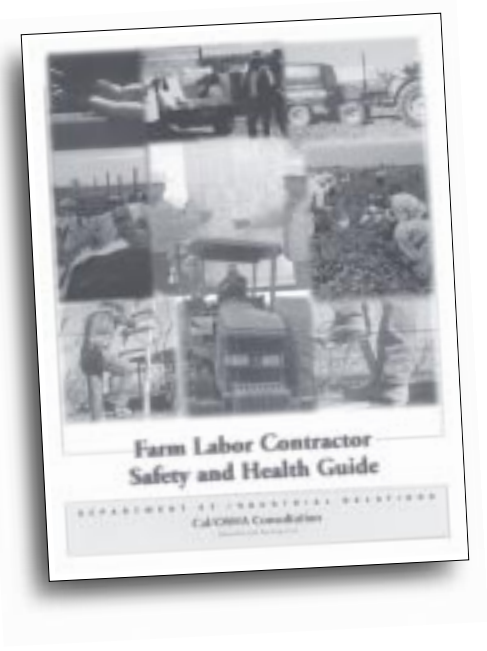


A Back Injury Prevention Guide for Health Care Providers

This booklet is designed to provide general guidance for employers and employees about how to prevent back injury as a result of lifting and moving patients and residents. It may be useful in settings such as hospitals, nursing homes, assisted-living facilities, board and care homes, and during the provision of home health care. Some of the benefits of back injury prevention include decreased injuries and costs, as well as increased efficiency and employee morale. The practical suggestions in this guide are focused on orderlies, attendants, nurses, nursing assistants and others who actually lift and move patients and residents. The information was developed with the help of individuals and institutions in the health care field that have found effective ways to prevent back injuries.

This guide discusses how to:

- Understand the scope of the back injury problem.
- Analyze the workplace to find work activities, equipment and related factors which may contribute to the development of back injuries.
- Identify and implement improvement options.
- Evaluate the results.



Farm Labor Contractor Safety and Health Guide

This document was developed with the help of farm labor contractors (FLCs) and agricultural safety and health professionals to provide general guidance for employers and employees about preventing work-related injuries and illnesses. *The biggest challenge is to give this vital information to all your supervisors and workers and to ensure that they clearly understand the job hazards before starting a new crop or task.* Information described in this guide also applies to growers who directly hire their own crews. Each section, including the checklists and fact sheets, can be used individually. Fact sheets and checklists may be reproduced as handouts and distributed during employee training.

This guide has six sections that address farm labor contractors' main concerns:

- Section 1. Background Information
- Section 2. The Required Injury and Illness Prevention Program (IIPP)
- Section 3. Worker Training
- Section 4. Employers' Obligations Under the Law—The Cal/OSHA Program
- Section 5. Fact Sheets and Checklists
- Section 6. Other Available Assistance

Other Educational Resources from Cal/OSHA *(Continued)*

Confined Space Guide

This *Confined Space Guide* has been developed to explain the hazards of confined space work and to assist employers in establishing and maintaining an effective confined space program. By implementing such a program, both employers and employees will be able to:

- Recognize, evaluate, and control confined space hazards.
- Save lives and protect employees from job-related injuries and illnesses.
- Promote safe and effective work practices.
- Reduce preventable workers' compensation losses.
- Comply with the law.

Managing Stress Arising from Work

The focus of this brochure is *harmful* stress that arises from work situations, as opposed to stress that is generated by an employee's personal life.

Harmful workplace stress has been associated with:

- Jobs that demand a lot from the employees while allowing them little control over how the job is performed
- Work environments that are unsafe and/or uncomfortable
- Organizational practices that exclude employee participation or input.

This brochure offers suggestions for reducing the potentially harmful effects of work-related stress on employers and employees.

6. Questionnaire:

We Want to Hear from You

► Cal/OSHA values and welcomes your comments about our booklet. We want to provide the best service possible to employers and employees in California. Please fax this form to our Education and Training Unit at (916) 574-2532 or mail your comments to:

Education and Training Unit
Cal/OSHA Consultation Service
2211 Park Towne Circle, #4
Sacramento, CA 95825

Question	*Yes*	*No*	*Comments*
1. Are the descriptions of workplace contributing factors helpful?	○	○	
2. Is the Ergonomics Awareness Checklist easy to use?	○	○	
3. Does the Ergonomics Awareness Checklist help you to identify contributing factors and their causes in your workplace?	○	○	
4. Does the subsection titled "What Are Ergonomics Improvements?" (pp. 28–45) provide you with useful ideas for improvement options that may be effective in your workplace?	○	○	
5. Do the subsections titled "Which Tasks Should We Improve First?" and "How Do We Make Informed Choices?" (pp. 47–50) help you to implement improvements?	○	○	
6. Is the Resources section useful?	○	○	
7. Did you try the problem-solving exercise in the Resources section before attempting to evaluate and improve your workplace?	○	○	
8. Did completing the problem-solving exercise help you to evaluate and improve your workplace?	○	○	

Additional Comments

1. Please describe briefly what your organization plans to do or has done as a result of using this booklet (e.g., designate individuals to identify and evaluate potential problem work tasks, select and implement improvements).

2. Are any parts of the booklet unclear or confusing? What changes would make these sections better? (Please list the page numbers and the topics.)

3. Are there important issues ***not*** addressed or that should be dealt with more fully?

4. What information could be added to ***help persuade*** the decision makers in your organization to evaluate problems and implement appropriate improvements?

5. Do you have any other comments? (When referring to specific text or sections, please indicate page numbers.)

6. Do you have an ergonomics success story to share with us? (If so, please provide your name and phone number.)

WE THANK YOU FOR YOUR IMPORTANT PARTICIPATION!

Acknowledgments

Writers and Editors

Mario Feletto, MS, MPH, Cal/OSHA Consultation Service Education and Training Unit, Sacramento, California

Jim Lopes, MSPH, CIH, Cal/OSHA Consultation Service Northern/Central Valley Region, Fresno, California

The authors thank the following persons and organizations for their support and assistance in the research and development of this document:

Technical Review

Suzanne H. Rodgers, PhD, Consultant in Ergonomics, Rochester, New York

Ira Janowitz, PT, CPE, Ergonomics Consultant, University of California, San Francisco/Berkeley Ergonomics Program, Richmond, California

Editorial Review

John Howard, Chief, Division of Occupational Safety and Health, California Department of Industrial Relations, San Francisco, California

Dave Bare, Program Manager, Cal/OSHA Consultation Service, San Francisco, California

Michael Alvarez, Manager, Education and Training Unit, Cal/OSHA Consultation Service, Sacramento, California

Caesar B. Adams, PhD, Writing Consultant, Davis, California

Development of Exercises and the Ergonomics Awareness Checklist

Suzanne H. Rodgers
Jim Lopes
Mario Feletto

Contributors

Walter Graze, CIH, CSP, Senior Industrial Hygienist, Asbestos Contractors Registration Unit, California Department of Industrial Relations, San Francisco, California

Kate Stewart, MS, CPE, Stewart and Associates, Seattle, Washington

Layout and Design

Paul Lee, Senior Graphic Artist, CDE Press, California Department of Education, Sacramento, California

Cooperators for Onsite Development and Research

Packard Bell/NEC, Sacramento, California

Paul G. Kelley, Corporate Director of Environmental Health and Safety
Mike Bristow, Safety Manager/Security

Hewlett Packard, Rohnert Park, California

Michael Parker, PE, Ergonomics Engineer, Microwave Instruments Division
Dan Hulbert, Physical Distribution Safety Coordinator, Microwave Instruments Division

IBM, San Jose, California

John Mazzella, Advisory Engineer, Ergonomics, Safety and Health Services
Arnie Kestler, Safety and Health Staff

Steelcase Incorporated, Tustin, California

Glenn Azevedo, MS, CSP, Safety Engineer and Ergonomics
Pete Zande, CSP, Manager, Safety and Health

Westminster Ceramics Incorporated, Bakersfield, California

Wes Stanley, Environmental and Safety Officer

Butterfield Brewing Company, Fresno, California

Jeff Wolpert, Owner

Organizations That Supplied Photographs

- Packard Bell/NEC, Sacramento, California
- Hewlett Packard, Rohnert Park, California
- IBM, San Jose, California
- Steelcase Incorporated, Tustin, California
- Westminster Ceramics Incorporated, Bakersfield, California
- Butterfield Brewing Company, Fresno, California
- Sandvik Saws and Tools Company, Sandvik, Sweden
- Veterans Administration Hospital, Livermore, California
- The Union Sanitary District, Fremont-Union City, California
- Lawrence Berkeley Laboratory, Berkeley, California
- Arnold Lee's Service, Fresno, California
- Textube Corporation, Greer, South Carolina

Photographers

Emi Manning, University of California, Davis
Jim Lopes, Cal/OSHA Consultation Service
Bernadine Osburn, Cal/OSHA Consultation Service

Preparation of Draft Document

Bernadine Osburn, Cal/OSHA Consultation Service, Education and Training Unit, Sacramento, California

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Note: The titles and locations of the persons included in this list were current at the time this document was developed.

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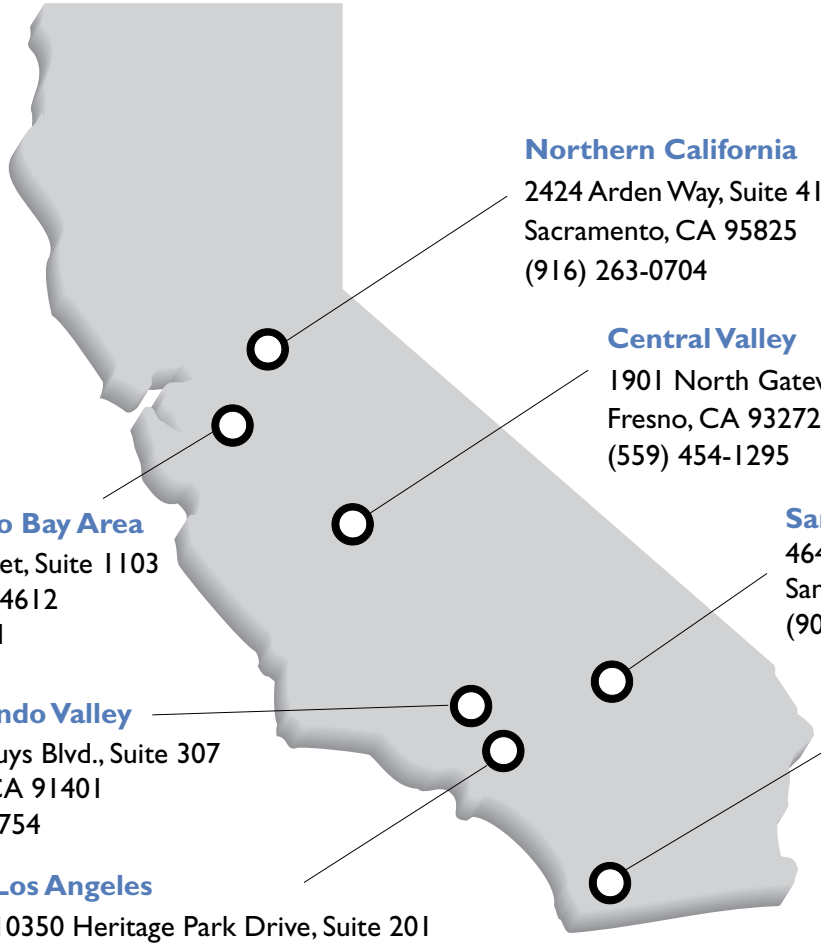

Northern California
2424 Arden Way, Suite 410
Sacramento, CA 95825
(916) 263-0704

Central Valley
1901 North Gateway Blvd., Suite 102
Fresno, CA 93272
(559) 454-1295

San Francisco Bay Area
1515 Clay Street, Suite 1103
Oakland, CA 94612
(510) 622-2891

San Bernardino/Orange
464 West 4th Street, Suite 339
San Bernardino, CA 92401
(909) 383-4567

San Fernando Valley
6150 Van Nuys Blvd., Suite 307
Van Nuys, CA 91401
(818) 901-5754

San Diego
7575 Metropolitan Drive
Suite 204
San Diego, CA 92123
(619) 767-2060

Los Angeles
10350 Heritage Park Drive, Suite 201
Santa Fe Springs, CA 90670
(562) 944-9366

- **Voluntary Protection Program**
  San Francisco, CA 94142
  (415) 703-5272

- **Education Unit**
  Sacramento, CA 95825
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