Ergonomics in Action

A Guide to Best Practices for the Food-Processing Industry

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

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This booklet is intended to provide employers with information to help reduce workplace injuries. Although the information may also be an aid to employers in making compliance decisions, this booklet is not intended to be a guide on how to comply with Cal/OSHA regulations.

The display or use of particular products in this booklet is for illustrative purposes only and does not constitute an endorsement by the Department of Industrial Relations.

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About This Booklet

Ergonomics in Action: A Guide to Best Practices for the Food-Processing Industry is written to give management, "front-line" supervisors, and facility/maintenance personnel general guidance on how to reduce work-related musculoskeletal disorders.

The booklet uses a "best-practices" approach with examples that illustrate how actual food-processing facilities have reduced work-related musculoskeletal disorders. It includes ideas for making practical ergonomic improvements. Companies can reduce or eliminate the *contributing factors* (e.g., physical, environmental, individual, and work organization factors) that lead to the development of musculoskeletal disorders.

The ergonomic improvement options contained in this booklet are general so that they can be used in a wide variety of food-processing industries. For example, in many applications, a palletizer, or a scissors lift, can be used to maintain the height of material at waist level while loading the pallet.

For easy reference, this booklet is divided into four main sections:

1. Challenges Facing the Food-Processing Industry. The first section describes the many challenges facing the food-processing industry and the impact that work-related musculoskeletal disorders can have on business and workers' health.

2. Taking Action. The second section provides background on the three categories of job improvements: engineering improvements, administrative improvements, and personal protective equipment. This section explains the many contributing factors that can lead to the development of work-related musculoskeletal disorders and suggests ways to reduce or eliminate these contributing factors. Examples of different job improvements to reduce these disorders are presented.

3. A "Best Practices" Approach. The third section describes a process to help identify jobs that can lead to musculoskeletal disorders. The process entails selecting tasks for ergonomic improvements and finding ways to make these improvements.

4. Resources. The last section includes references on reducing work-related musculoskeletal disorders, and information on how to obtain other educational resources from Cal/OSHA. Three easy step-by-step work sheets are provided to help employers make ergonomic improvements at their work site.

Note:

The information in this booklet is intended to provide general guidance. The severity of safety and health hazards at the workplace will vary depending on the complexity of the work environment; the nature of the hazards; the physical characteristics of the facility; and the unique processes at a particular food-processing industry. This booklet does not address all the potential safety and health hazards that may exist at a work site. A full safety and health evaluation and the services of a trained safety and health professional may be needed to assist in performing a job hazard analysis and help implement hazard control measures.

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.

Using Ergonomics to Improve the Workplace

Food-processing workers may experience fatigue and discomfort when performing highly repetitive tasks, working in repeated and sustained or awkward postures, performing heavy physical work, and using forceful exertion. Continued work under these conditions may result in chronic injuries to muscles, tendons, ligaments, nerves, and blood vessels. Injuries of this type are known as work-related *musculoskeletal disorders.* Musculoskeletal disorders can increase the cost of doing business. The costs may include medical services, workers' compensation premiums, employee turnover, absenteeism, and retraining. Productivity, product quality, and employee morale may also suffer.

One way to reduce work-related musculoskeletal disorders and to minimize the other problems mentioned above is to use ergonomics in your workplace. *Ergonomics* is the study of how to improve the fit between the tasks of the job and the employees who perform the work. Ergonomics requires a consideration of the variability in workers' physical and mental capabilities when one selects, designs, or modifies their tools, equipment, or workstations. Employees' abilities to perform tasks may vary because of differences in age, physical condition, strength, gender, stature, and other individual factors.

Everyone benefits from ergonomics. By fitting the work tasks to the capabilities of most workers, employers can:

- Reduce or eliminate the contributing factors that can lead to musculoskeletal disorders.
- Decrease injuries, illnesses, and workers' compensation costs.
- Decrease absenteeism and turnover.
- Improve workers' health outcomes.
- Increase employee morale and productivity.
- Make it easier for workers to do high-quality work.

1. Challenges Facing the Food-Processing Industry

Common Work-Related Injuries and Illnesses

The Toll on Workers' Health and Livelihood

The Increased Cost of Doing Business

1. Challenges Facing the Food-Processing Industry

This section describes the effects of work-related injuries and illnesses that are occurring in the food-processing industry. Every year food-processing workers are injured from exposures to contributing factors for musculoskeletal disorders and other workplace hazards. This type of work environment can take its toll on workers' health. Work-related musculoskeletal disorders can also have a financial impact on a company.

Common Work-Related Injuries and Illnesses

Data from the California Department of Labor Statistics and Research reveal that workers in food-processing plants have a higher likelihood of being hurt on the job than workers in many other industries. Food-processing is among the industries with the highest lost-workday incidence (LWDI) rates. In 2000, workers in the food-processing industry suffered a LWDI rate of 6.5, almost double the LWDI rate of 3.3 for all industries as a whole. (Incidence rates represent the number of injuries and illnesses per 100 full-time workers.)

The Bureau of Labor Statistics indicates a wide variety of injuries in the food-processing industry, including cuts, bruises, burns, fractures, and amputations. One of the most common types of injuries in the food-processing industry are *musculoskeletal disorders.* Musculoskeletal disorders are usually not the result of a particular event, such as a fall; they are the development of damage to muscles, nerves, tendons, ligaments, joints, cartilage, or spinal discs over time. Musculoskeletal disorders may:

- Result from *microtraumas,* which are the buildup of tissue damage from many small injuries.
- 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 damage has occurred.
- Vary in symptoms and severity from person to person.

Symptoms associated with musculoskeletal disorders may include:

- *Pain* from movement, pressure, or exposure to cold or vibration
- *Change* in skin color from exposure to cold or vibration
- *Numbness or tingling* in the legs, arms, hands, or fingers
- *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 keeping up with performance requirements

Examples of musculoskeletal disorders include:

Tendinitis—inflammation of a tendon

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

Sciatica—bulging or ruptured discs in the lower back, causing lower back pain that also extends to the legs and feet

Production workers perform manual handling tasks, such as sorting, packaging, boxing, and lifting food products. Production jobs in food processing involve repetitive, physically demanding work that has been shown to be associated with the development of musculoskeletal disorders. Food-processing workers are also highly susceptible to sprains and strains to the hands, wrists, and elbows. Production workers often stand for long periods and may be required to lift and move heavy objects—actions that can cause lower back injuries.

Sorting

Packaging

Boxing

Lifting

The Toll on Workers' Health and Livelihood

It is difficult to fully understand the loss a worker experiences as a result of a workplace injury or illness. Not only is there a monetary loss, but there is an emotional loss as well. Workers who sustain a catastrophic injury or illness experience the grieving process, much like those who experience the loss of a loved one. The injured worker grieves the loss of physical capacity as a result of the injury. Even a minor injury can take a toll on a worker. As the result of injury, workers may experience:

- Physical and emotional pain and suffering
- Loss of earning capacity
- Permanent physical effects on their health
  Reduction of earnings while recuperating from the injury
- Financial hardships that are borne by their families
- Loss of job skills
- Retraining to gain new skills or to recover lost skills
- Loss of social contacts when away from the workplace

The Increased Cost of Doing Business

The costs of designing, manufacturing, distributing, marketing, and merchandising are usually all factored into the price of a product. However, many companies forget to consider the cost of an occupational injury or illness. Work-related injuries and illnesses are costly to a company. Costs to employers include:

- Medical expenses
- Vocational rehabilitation
- Increased workers' compensation insurance premiums
- Wages paid to injured employees who are not producing
- Damaged or spoiled material
- Replacement of damaged tools or equipment
- Time required for administrative and clerical personnel to investigate the injury, process the forms, and settle claims
- Recruiting and training new employees to replace injured workers, either temporarily or permanently
- Reduced production by new or substitute employees
- Reduced product quality
- Effect on employee morale
- Effects of the injury on the company's image and public relations

The food-processing industry is facing many challenges to compete in today's global market. With the accelerated pace of change in technology, international trade, market price, product competition, customer demands and expectations, many companies are forced to change the way they do business. They may downsize their workforce and adopt flexible staffing practices (e.g., job outsourcing, subcontract labor, and temporary workers). Other ways that companies have changed to meet demands are to use high-performance work systems (e.g., self-managed work teams, flexible and lean production, and just-in-time manufacturing).

Fierce competition has also led some food-processing plants to invest in technology that results in less waste and higher productivity. Factory automation is being applied to various functions, including inventory control, product movement, packaging, and inspection.

Market forces and new manufacturing practices may affect workers' safety and health. Employees may face an increased chance of working in hazardous conditions, intensified work demands, reduced job security, and loss of control over the way they perform their jobs. For example, fewer employees on the production line may mean an increase in workloads for remaining front-line personnel. On the other hand, new technical advances and computer-controlled equipment might be used to reduce monotonous, repetitive manual tasks so workers can have more variety in their job assignments.

Despite all the challenges facing the food-processing industry, many plants have successfully reduced work-related musculoskeletal disorders by using a combination of innovative approaches. These approaches include:

- Redesigning work tasks and equipment
- Rotating employees between heavier and lighter tasks
- Allowing shorter, more frequent rest breaks to give the body time to recover during heavy work
- Developing training programs on safe work practices

2. Taking Action

Considering Types of Improvements

Addressing the Contributing Factors

Improving Tools, Equipment, and Workstations

2. Taking Action

This section outlines the improvements employers can make to reduce work-related musculoskeletal disorders. With any proposed workplace change, getting employees involved in the planning process is the cornerstone for success. Employee participation can increase "buy-in" and acceptance of new ways of performing a job.

Considering Types of Improvements

Different job improvements made by employers can reduce work-related musculoskeletal disorders. Job improvements are changes made to improve the "fit" between job tasks, tools used, and the capabilities of the employee. They are commonly grouped into three categories:

- Engineering improvements
- Administration improvements
- Personal protective equipment

Engineering and administrative improvements attempt to reduce or eliminate the chances of employee exposure to contributing factors that are associated with musculoskeletal disorders. Personal protective equipment does not eliminate the contributing factor itself; it merely acts as a barrier between the worker and the contributing factor.

Engineering Improvements

Engineering improvements are often the most successful and cost-effective ways to reduce the contributing factors associated with musculoskeletal disorders. In many instances, employees make engineering improvements whenever they modify their workstations to make them more comfortable or more efficient.

General engineering improvements to improve the fit between the worker and the work may include:

- Using tools or equipment instead of physical effort
- Providing better designed tools or equipment for the job

- Modifying or redesigning the workstation
- Rearranging or changing the orientation of the workstation to the worker
- Reducing the weight or size of the packaged product

Specific examples of engineering improvements include:

- Adjustable seating and workstations
- Footrests
- Arm supports
- Assist devices for material handling
- Anti-fatigue mats

Anti-fatigue mat reduces fatigue.

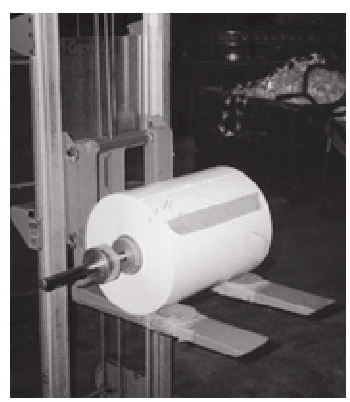
Adjustable chairs will allow workers to find the best seat height for them and their tasks.

For employees who sit for long periods of time, footrests reduce the pressure behind the knees.

For employees who stand for long periods of time, foot rails reduce strain on the lower back.

This pallet truck runs throughout the plant on a track.

A powered pallet truck is used to transport materials.



A lift truck used to move heavy objects.

Administrative Improvements

Administrative improvements are changes to work practices or the way work is organized. They usually require management personnel to modify or change organizational practices or to institute new procedures. Administrative improvements require continual feedback from management and employees to ensure that the new practices or procedures are effective. Administrative improvements may be used alone, used in conjunction with engineering improvements, or used when engineering improvements have been exhausted.

Some examples of administrative improvements include:

Job rotation. Rotate individual jobs among employees within the same skill level. This practice helps to reduce overexertion and limits the amount of time an individual employee is exposed to contributing factors that can lead to musculoskeletal disorders.

Employee exchange takes place within the same job.

Employee exchange within the same job. For jobs that require coworkers to face each other and reach left or right (such as when moving a product from one location to another), the employees should exchange positions periodically during the shift. Each employee will have an opportunity to alternate his or her reach and to share the work between the left and right arms. (A reach to the left becomes a reach to the right after workers exchange positions.) This technique prevents overexertion of one arm or hand.

Job enlargement. For jobs that consist of only one or two tasks that expose employees to contributing factors, enlarge the job by assigning additional tasks during the day that do not expose employees to contributing factors. With job enlargement, exposure to contributing factors arising from any one job is reduced over the course of the day.

Recovery time. Recovery time is the time needed for muscles to recover from the physical intensity of the work performed and can be provided by a *working rest break* or *non-working rest break.* As the physical intensity or repetition rate of the work increases, the length of time the work can be performed decreases, and the recovery time needed increases. Try to break up work *with frequent, short recovery times.* Even recovery times as short as a few seconds on a regular basis are helpful.

- **Recovery time using working rest breaks—***Working rest breaks* provide an interruption in the work activities that involve *risk factors* such as high repetition, forceful exertions, or prolonged static postures. See pages 13-24 for more details on risk factors. A working rest break does not necessarily require the employee to stop working but simply to perform other tasks that decrease the chances of fatigue.[1]

- **Recovery time using nonworking rest breaks—***Non-working rest breaks* are brief periods when an employee stops working to recover from physical exertion and relax the muscles. More frequent, shorter non-working rest breaks are better in terms of providing recovery time than less frequent, longer non-working rest breaks.[2]

Work practice training. Train all employees on the symptoms and contributing factors associated with musculoskeletal disorders. Educate them on the benefits of ergonomics in the workplace. Also train employees on safe work practices and encourage the buddy system by having new employees learn the best practices from experienced employees. Train employees to use specific tools and equipment safely and properly and retrain employees when necessary. Give them an opportunity to learn new skills whenever new processes, procedures, tools, or equipment are introduced in the workplace.

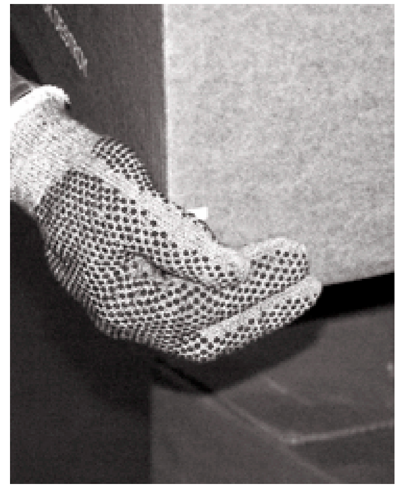
Organizational practices. A combination of improvements may be made at the organizational level: better production planning, preventive maintenance, worker input, and worker control over their pattern of work.

Personal Protective Equipment

Personal protective equipment is used as a barrier between the contributing factors and the worker. Personal protective equipment should be the last resort used to reduce employees' exposure to contributing factors and not serve as a substitute for other feasible improvement options. Nevertheless, it is important to provide this type of protection to employees when appropriate. Obtain the active involvement of employees in the selection, care, and maintenance of personal protective equipment. Find out from the employees whether the personal protective equipment will interfere with effective workplace performance. Make sure the personal protective equipment is properly fitted, worn, and maintained.

Personal protective equipment may include a combination of gloves, safety shoes or boots, and other appropriate protective equipment. Before providing personal protective equipment to employees, be sure that they are properly trained in its use.

Gloves can protect the hands from injury. Different types of gloves are made of materials designed to protect hands from chemicals, biological agents, cuts or abrasions, vibration, or temperature extremes. Check with the manufacturer to know what the gloves are designed for. If gloves are too large, they may make it harder to grip; if they are too small, they may impair circulation to the hands. Provide gloves in different sizes to ensure that each employee can select a pair that fits properly. When employees must grip on a low-friction surface, provide gloves that enhance the grip, such as those with rubber dots or strips. Remember that some employees may have an allergic reaction to gloves made of latex or natural rubber.



Gloves with rubber dots enhance the grip.

Rubber boots help to reduce slipping on wet floors.

Safety shoes and boots can help prevent employees from slipping on wet floors. Several shoe manufacturers have developed rubber-type soles that are specifically designed for working in a wet environment. Shoes with anti-fatigue soles and insoles can also reduce fatigue after long hours of standing on hard surfaces. Other safety shoes and boots (steel toe) are designed to protect the feet from blunt injury.

Addressing the Contributing Factors

This section explains the many factors that can contribute to the development of musculoskeletal disorders. It describes the actions that employers can take to reduce or eliminate specific contributing factors.

The major contributing factors for musculoskeletal disorders are:

- Physical factors (physical demands of the job and risk factors)
- Environmental factors (hot/cold temperatures and high/low lighting)
- Individual factors (e.g., age, gender, stature)
- Work organization factors (e.g., fast work pace, low staffing levels, shift work)

When several contributing factors are present at a workplace, it may be hard to know the exact cause of musculoskeletal disorders. When employees are exposed to a combination of these contributing factors, the chances of having musculoskeletal disorders increase. Therefore, identifying all the contributing factors present in a workplace is essential to reduce musculoskeletal disorders.

Physical Factors

The physical factors present in a workplace include the physical demands of the job and certain risk factors. To reduce musculoskeletal disorders, it is important to understand the relationship between the physical demands of the job and the risk factors that may be present in the workplace.

Physical demands of the job. The physical demands of the job are simply the activities that employees perform every day to accomplish their tasks. They include activities such as:

Lifting	Reaching	Handling
Climbing	Crouching	Fingering
Crawling	Pushing	Grasping
Pulling	Walking	Sitting
Standing	Kneeling	Squatting

Risk factors. The physical demands of a job performed over time, in combination with the risk factors listed below, can lead to fatigue, discomfort, and musculoskeletal disorders. These risk factors are:

Repetitive motion	Sustained static posture	Contact pressure
Awkward posture	Forceful exertion	Vibration

For example, *lifting* is a physical demand that, by itself, is not a risk factor for musculoskeletal disorders. Lifting (a physical demand), when it is repeatedly performed in an *awkward posture,* such as *twisting* (a risk factor), may lead to a back injury (a musculoskeletal disorder). This type of injury is commonly seen in the food-processing industry when workers repeatedly *lift* and *twist* while loading products from the conveyor into a box.

No one knows how often or how long the exposure must be repeated before one experiences a musculoskeletal disorder.

Repetitive Motion. In repetitive work the same types of motions are performed over and over again using the same muscles, tendons, or joints. The repetition rate may be affected by the pace of work and the amount of variety of job tasks.

The repetition rate may be affected by the:

- Pace of work
- Amount and variety of job tasks

The pace of work may be controlled by the employee performing the task, by machines, by other employees, or by administrative policies and procedures. Employees on a food-processing line typically have no control over the work pace. Examples of jobs involving machine-controlled pace include working on food inspection or quality-control lines, sorting, packaging, or boxing assembly lines.

Product placement on an assembly line involves repetitive motions.

Boxing items off an assembly line involves repetitive motions.

The pace of stacking is machine controlled.

The pace of packaging is machine controlled.

The chance of injury is greater when repetitive jobs involve awkward posture or forceful exertions. Injuries may also develop when repetitive work is combined with low-force exertions. The job of loading cans on a production line, for example, involves repetitive hand, wrist, elbow, and shoulder movements. Another example of a repetitive job and forceful exertion is when workers have to grip and squeeze a food product dispenser throughout an entire work cycle without setting the dispenser down to rest the hand.

Repetitive gripping with forceful exertions exposes the worker to injury.

To reduce the strain on muscles, tendons, or joints posed by repetitive tasks, some employers in the food-processing industry provide greater variety in job tasks. Adding variety will interrupt the repetition of work tasks that require the same or similar movements. Variety can be accomplished with *job rotation* or *job enlargement*. The new tasks should not require the same or similar movements. To be effective, both administrative controls rely on rotating through tasks or adding other tasks that differ in the:

- Muscles or body parts used
- Working postures
- Repetition rate
- Work pace
- Amount of physical exertion required
- Visual and mental demands
- Environmental conditions

Squeezing liquid food product dispenser involves repetitive gripping with forceful exertions.

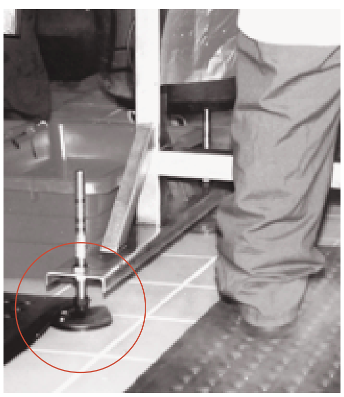
Liquid food dispenser is operated by a foot pedal.

Liquid food dispenser is operated by a hand lever.

A worker must reach across the conveyor to get access to the food bin.

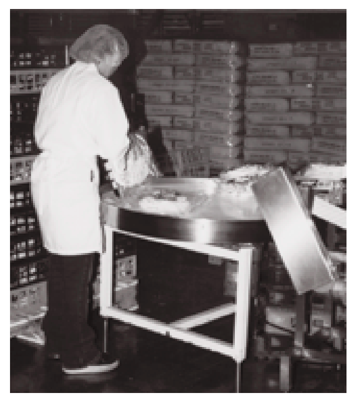
A tilted food bin allows the worker to reduce the reach into the bin.

Awkward Posture. Posture affects the muscle groups in use during a work activity. Awkward postures make work tasks more physically demanding. They increase the exertion required from smaller muscle groups and prevent 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.



Workstations with adjustable feet can be raised or lowered to fit the worker and the task and prevent awkward postures.

A work surface that is too low requires the worker to stoop.



A raised work surface allows the worker to work in a more upright posture.

Reaching up to work at or above shoulder height is an awkward posture.

A raised platform allows work to be performed at waist height.

A work surface that is too deep for the worker requires reaching across.

Manual shrink wrapping forces a worker into an awkward posture.

Automated shrink wrap equipment eliminates the need for workers to be in awkward postures.

Awkward postures typically include repeated or prolonged reaching, twisting, bending, working overhead, kneeling, and squatting. They may affect various areas of the body, such as the hands, wrists, arms, shoulders, neck, back, legs, and knees. The effects of awkward postures are worse if work tasks also involve repetitive motions or forceful exertions. Using poorly designed tools, equipment, or workstations may cause awkward postures. (Further details on how to reduce awkward postures are presented in the section "Improving Tools, Equipment, and Workstations.")

Awkward postures include repeated or prolonged:

- Reaching
- Twisting
- Bending
- Working overhead
- Kneeling
- Squatting

As the contents are removed, the worker bends over to reach deeper into the bin.

Awkward bending can be prevented by using bins that open from the side.

A tilted container provides the worker with easy access to the contents of the container.

Elevated and long reaches are common in food-processing tasks. Those awkward postures in work tasks require employees to work with their hands above their head and shoulders, their arms fully extended or their elbows angled from their body. Awkward postures place strain on the shoulders, elbows, and back and may result in musculoskeletal disorders.

Awkward posture

Overhead reaching

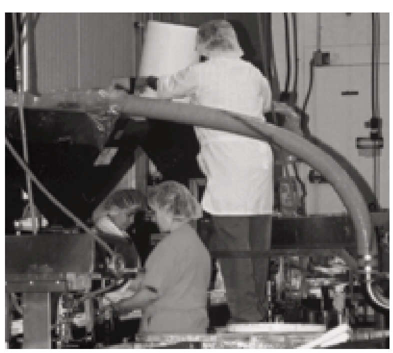
Overhead reaching

Tasks that require employees to reach or work repeatedly with their hands above their head or their elbows above their shoulders might include:

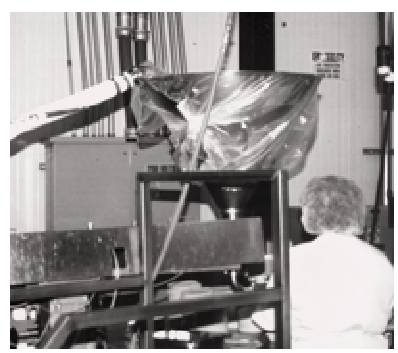
- Using containers or shovels to dump products into bins or vats
- Stacking or unloading boxed products above the shoulders

The following job improvements may reduce the amount of reaching:

- Using mechanical feed conveyors
- Reducing the height of stacked boxes or products



Moving food products manually



Moving food products mechanically

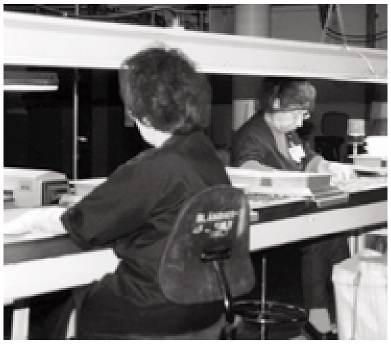
Employees may have to perform extended reaches across wide conveyors for products at the far edge of the conveyor. Long reaches across conveyors force employees, particularly shorter employees, to lean forward to reach the product. The following job improvements can reduce potential fatigue and damage to the shoulders, upper back, and neck:

Extended reaches across a wide conveyor

- Raised work platforms to reduce elevated reaches
- Narrow conveyors to reduce extended reaches
- Sloped or inclined conveyors, which vary the height at which workers perform work and reduce shorter employees' extended reaches across conveyors
- A diverter or push bar to move materials on a conveyor belt closer to the employee

Sustained Static Posture. Even the best posture or the most ergonomically correct workstation will not prevent fatigue or musculoskeletal disorders if one remains in the same posture for a long time. In the food-processing industry, employees remain in static postures on assembly lines, sorting stations, and inspection stations. Employees may stand or sit for long periods of time, placing strain on the legs and back. Circulation is reduced, blood pools, and localized fatigue increases the longer the employees must stand. Muscles and tendons become more susceptible to strain as they become fatigued from prolonged standing.

Static posture—standing



Static posture—sitting

Static posture—sitting

It is important for employees to have recovery time from static postures so that fatigued muscles have time to relax. The timing is more important than the length. Recovery time is most effective if taken beforehand to avoid the onset of fatigue rather than afterward to recuperate from fatigue.

Other ways to reduce fatigue from static postures are:

- Allowing workers the opportunity to alternate between sitting and standing postures
- Providing anti-fatigue mats
- Providing sit/stand stools
- Installing footrails
- Providing shoes with cushioned soles or insoles

Cushioned shoes

Sit/Stand stool

Footrail

Anti-fatigue mat

Forceful Exertion. Force is the amount of muscular effort expended to perform work. Exerting force may 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:

- 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
- Number of times the load is handled per hour or per 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)
- Horizontal distance of the load from the worker
- Vertical location of the load (overhead, waist level, or ground level)

Forceful exertion to start the move

Forceful exertion to start the move

Manually lifting heavy, bulky load with no handles

Lifting above shoulder level

Many food-processing tasks require employees to lift, push, pull, and move heavy objects—actions that can result in back injuries or other types of musculoskeletal disorders. Some common lifting tasks include stacking products onto pallets, dumping products into vats or cooking pots, and transferring products from a conveyor to a workstation and then back to a conveyor belt.

The task of stacking food products onto pallets may require employees to bend forward at the waist when placing the product on pallets. Stacking food products may also require employees to lift above the shoulder or above the head to place the object on top of the stack. Possible engineering improvement options include:

- Reducing the size of the package or the size of the boxes to decrease the amount of weight to be lifted
- Using adjustable palletizers or scissors lifts that allow stacking at waist level
- Using pallets that can rotate
- Using vacuum lifts
- Putting handles or grips on boxes

Manually lifting heavy, bulky load with no handles

Material-handling devices can be used to transport products from one area of the plant to the other. These lift-assist devices include hand dollies, carts, lift trucks, and forklifts. In addition, using chutes or slides to maneuver loads across conveyors or in new directions can reduce the amount of lifting.

Vacuum lifting device

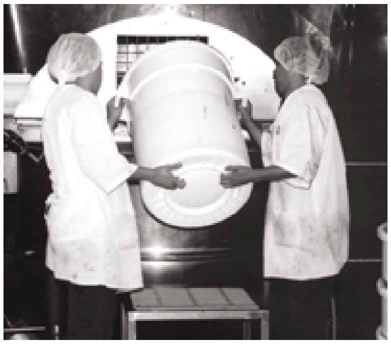
Cart

Forklift

Administrative improvements include:

- Training employees to use safe work practices for manual lifting, carrying, pushing, and pulling
- Using teams or getting help for heavy or bulky materials and difficult work tasks
- Replacing tasks that involve lifting with tasks that involve pushing or pulling

Lifting a heavy load



Getting a coworker's help for heavy loads.

Contact Pressure. Contact pressure results from parts of the body pressing against surfaces or edges. Certain areas of the body are more susceptible to injury because nerves, tendons, and blood vessels are close to the skin and underlying bones. These areas include the fingers, palms, wrists, forearms, elbows, thighs, and knees.

Employees working on a conveyor belt line often rest their arms on the sides of the metal conveyor, causing contact pressure on the elbows and forearms.

Contact pressure at the elbows

Areas of the body that are more susceptible to injury from contact pressure include:

- Fingers
- Palms
- Wrists
- Forearms
- Elbows
- Thighs
- Knees

To reduce contact pressure, try to disperse the weight of the arms over a larger surface area. One way to accomplish this is by padding hard or sharp edges. If padding the work area is not possible because cleaning agents might damage the padding, try to pad the person's arms and elbows by building pads into the work clothes.

In crowded workstations or on conveyor assembly lines, employees' thighs and knees may press against the conveyor or workstation. One way to reduce contact pressure is by providing enough legroom under workstations or conveyors. If employees are seated, shallow seat pans on chairs may cause contact pressure on the back of the thighs. Providing chairs with deeper seat pans can give better upper leg support.

Contact pressure at the elbows

Vibration. Vibration is the action of shaking or moving an object, tool, or person up and down, side to side, or back and forth, causing a disturbance in its stability. Vibration exposure is of concern when it is continuous and/or at very high or low intensity. Whole-body vibration commonly results from sitting or standing on work surfaces that vibrate. Examples of such surfaces include vibrating vehicles, equipment, conveyors, and platforms. Whole-body vibration may be associated with general discomfort and lower back pain.

Maintenance staff in food-processing facilities often use vibrating hand tools. Common vibrating hand tools include hammers, chisels, sanders, grinders, drills, and sharpeners. Prolonged or repeated exposures to hand and arm vibration may result in fatigue, pain, numbness, tingling, and a decreased sensitivity to touch in the fingers, hands, and arms.

Ways to reduce whole-body vibration exposures may include:

- Mounting equipment and work platforms on vibration-dampening pads or springs
- Using vibration dampeners or shields to isolate the source of vibration from employees
- Altering the speed or motion of equipment
- Providing cushioned floor mats for work tasks that involve standing

Ways to reduce vibration from hand tools may include:

- Using low-vibration tools
- Inspecting and maintaining power tools regularly
- Reducing the grip force on the tool handle and following safe work practices
- Reducing the force applied to the object and following safe work practices
- Providing gloves that are made with vibration-absorbing material

Environmental Factors

Environmental factors in the workplace also have been shown to contribute to the development of musculoskeletal disorders and other health problems. Hot temperatures can increase the rate at which the body will feel fatigue. Alternatively, exposure of the hands and feet to cold temperatures can decrease blood flow, muscle strength, and manual dexterity. In addition to temperature differences, the lighting in a workplace may be too dark or too bright for the work task. Inadequate lighting may result in employees assuming awkward postures to accomplish tasks, such as leaning forward to examine small food products at an inspection station.


Blanching causes heat and steam.

Temperature. Exposure to heat and cold may come from various sources: the ambient temperature, the climate, the tools, and the processing equipment workers use to perform their tasks. Examples of exposure include heat from cooking, blanching, ovens, or heat exchangers. Cold temperatures may come from washing and cleaning food products, from walk-in freezers or refrigeration units, from tools, or from equipment that exhaust cold air directly onto the worker.

Hot and cold environments may affect workers' safety and health as well as their work performance. By minimizing the effects of temperature differences, employers can reduce the chances of injury to workers while maintaining production schedules and meeting deadlines.

Heat. Exposure to heat can cause fatigue by shifting blood from the muscles to get rid of accumulating body heat. This condition may lead to heat exhaustion, heat cramps, and dehydration. Elevated temperatures may result in heat illness, which can be life threatening or result in irreversible damage. Be sure that workers are given frequent breaks from the heat. Heavy work is more fatiguing in the heat than moderate or light work; therefore, allow employees who perform heavy work more recovery time to cool down. This practice will reduce fatigue and costly mistakes. Encourage employees to drink water or liquids frequently even if they are not thirsty.

The potential for health problems may intensify in a work environment with the combination of heat and elevated humidity. Humidity affects the body's ability to reduce body heat through sweating and evaporation. Some people will experience an increase in body temperature, pulse, and breathing rates and the effects of heat exhaustion. (See Table 1.) With elevated humidity, performance may be affected even though there is a lower temperature. Employees may have difficulty concentrating and become irritable and fatigued.

Although experts agree that heat and humidity can affect performance, the point at which the effect occurs will vary. There are, however, some general ranges to know about.

Table 1. Effects of Temperature and Humidity on Humans

Temperature and Humidity	Effects on Humans
70º – 80ºF, humidity 70%	Climate is comfortable.
85ºF, humidity 70%	Climate is uncomfortable to most.
92ºF, humidity 70% or more	Some will experience an increase in body temperature, pulse, and breathing rates and might experience heat exhaustion if conditions persist for more than 2 hours.

Source: Suzanne Rodgers, *Ergonomics Design for People at Work, Volume 1: Workplace, Equipment, and Environmental Design and Information Transfer.* Edited by Elizabeth Eggleton for Eastman Kodak Company. New York: Van Nostrand Reinhold, 1983.

Frozen-food processing

Cold. Working in a cold environment affects the blood circulation system by slowing the flow of blood to the skin. The blood warms the body parts it reaches and carries healing nutrients to these structures. When the skin's blood flow is restricted, body parts near the skin are harder to keep warm, and the process of healing sore or fatigued tissue may be impaired. A cold environment may increase the chances of an injury or aggravate an existing injury. Cooler temperatures, with relative humidity of less than 20 percent, may be uncomfortable to most people.

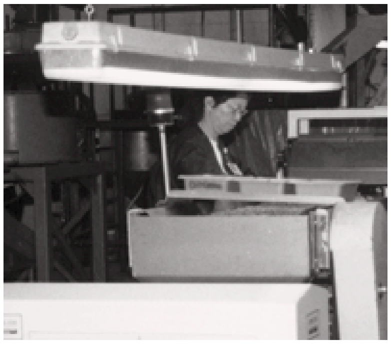
One way of improving work in cold environments is to provide workers with clothing that adequately insulates them from the cold, including gloves, boots, and hats. Encourage workers to wear layers of clothes. Provide a way for workers to dry outer clothing when extended periods of moderately heavy to heavy work in the cold are required. Sweating can reduce the insulation value of the outer clothing from 40 percent to 60 percent.[3]

If employees wear gloves to protect their hands from either heat or cold, be sure that the gloves fit. Gloves that are big and bulky will reduce a worker's capacity to grip tool handles or objects.

When designing work areas where workers are exposed to either extreme heat or cold, also provide non-work areas for workers to warm up or cool down. In places where employees cool down, provide fresh, tepid drinking water and keep the room temperature above 74 degrees Fahrenheit so workers' sweating mechanisms do not shut down.

Illumination. It is important to provide adequate lighting in the work environment to reduce potential physical and production problems. In different food-processing jobs, visual requirements may vary from task to task, depending on the type of products handled. For example, food-packaging tasks may require less lighting than inspection tasks.

Sometimes employees assume awkward postures or experience eyestrain and fatigue because it is hard for them to see their work. Color choice and contrast sensitivity of work surfaces are two reasons for awkward postures. For example, low lighting levels can cause poor contrast between small food products on a work surface and a dark background. If overhead lighting is inadequate for the task, you may need to add supplemental or task lighting at individual workstations. Supplemental lighting is usually necessary for inspection tasks.



Task lighting

Many surface colors and surface materials are *reflective*, meaning that surfaces produce glare or may throw back light. For work surfaces that are highly reflective, such as stainless steel, aluminum, and white surfaces, lower levels of overhead or task lighting may be used.

Reflectance from a shiny work surface

The effect of lighting on worker safety must be considered as well as proper lighting that reduces eyestrain and awkward postures. Proper lighting is especially important where the worker is operating equipment, machinery, or controls. Poor lighting can affect visual task performance and result in:

- Physical discomfort, including headaches and eye fatigue
- Accidental injury from equipment or machinery
- Production errors
- Increased project time and missed deadlines

Recommended Lighting Levels. Illumination is the rate of light energy transmitted onto a surface. This rate or light intensity is measured either in *lux* or *foot-candles*. It may be necessary to perform a lighting survey at a facility to identify the needed lighting levels for different job tasks. A lux or foot-candle meter can be used to perform an in-house lighting assessment.

Recommended lighting levels have been developed to provide a range of illumination needed to perform tasks. Table 2 provides some examples of recommended lighting levels for various activities. Other resources for recommended lighting levels include *The IESNA Lighting Handbook*.[4]

Table 2. Recommended Lighting Levels

Type of Activity or Area	Range of Illuminance (in Foot-candles)
Public spaces with dark surroundings	2–5
Simple orientation for short temporary visits	5–10
Working spaces where visual tasks are only occasionally performed	10–20
Performance of visual tasks of high contrast or large size	20–50
Performance of visual tasks of medium contrast or small size (difficult inspection or medium assembly)	50–100
Performance of visual tasks of low contrast or very small size (very difficult inspection)	100–200
Performance of visual tasks of low contrast and very small size over a prolonged period (fine assembly or highly difficult inspection)	200–500
Performance of very prolonged and exacting visual tasks (the most difficult inspection)	500–1,000
Performance of very special visual tasks of extremely low contrast and small size	1,000–2,000

Source: Fundamentals of Industrial Hygiene. Edited by Barbara A. Plog, Jill Niland, and Patricia J. Quinlan. Itasca, Ill.: National Safety Council, 1996.

The level of lighting should be designed for the most difficult tasks. “In general, the more demanding a visual task and the longer it is sustained, the higher the recommended illumination level will be. The upper end of the range should be used to accommodate older workers on difficult visual tasks.”[5]

In addition to the quantity of light, another important aspect is the quality of light or the light source used (e.g., fluorescent or incandescent). In many instances, where fine visual tasks are done, it is better to change the quality of lighting rather than increase the quantity. See specific lighting techniques in *The IESNA Lighting Handbook*[6] or *Ergonomics Design for People at Work, Volume 1*.[7]

Individual Factors

Employees' abilities to perform physical tasks may vary because of differences in age, physical condition, strength, gender, stature, visual capabilities, and other health conditions. Individual factors, such as level of physical fitness, weight, diet, habits, and lifestyle, may affect the development of musculoskeletal disorders. In addition, some medical conditions may predispose individuals to musculoskeletal disorders:

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

Human bodies do not stop functioning when workers go home. Risk factors exist in home and recreational activities and may contribute to musculoskeletal disorders. 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 musculoskeletal disorders include:

- Knitting or crocheting
- Using home computers
- Gardening
- Food preparation
- Auto repair
- Playing musical instruments
- Playing video games
- Playing recreational sports

Work Organization Factors

Work organization factors include the way jobs are designed, the way work is carried out, the work arrangements, and the management systems, which can have an effect on workers' health.

The National Institute for Occupational Safety and Health (NIOSH) suggests that work organization factors can play a role in the development of'musculoskeletal disorders. Other health problems that may be associated with work organization factors include high blood pressure, heart disease, and psychological disorders (e.g., depression and anxiety).

Examples of work organization factors that can affect workers' health include:

- Fast work pace
- Task complexity
- Limited worker control
- Monotonous and repetitive job tasks
- Excessive workload demands
- Scheduling—shift work, long work hours, infrequent rest breaks
- Human resource practices (low staffing levels, flexible labor force, overtime policy)
- Limited opportunities for skills development or advancement
- Unclear job expectations
- Poor social environment and lack of support or help from coworkers and supervisors
- Lack of open lines of communication between supervisors and employees
- Manufacturing practices and production methods that change the work environment and expose workers to new safety and health hazards
- Lack of participation by workers in the decision-making process

Are there work organization factors listed above that may have contributed to the development of musculoskeletal disorders or other health problems at your workplace? What can be done at the organizational level to improve the work environment? For example, because of the nature of food processing jobs, many employees have little control over their work. Production flow is usually machine paced, and the speed of the line is set so employees cannot speed up or slow down the line. The goal is to increase production rates, which can sometimes run counter to the needs of the workers. This type of working condition can place demands on employees to perform above their physical and mental capabilities.

It may be difficult to measure the impact of work organization factors on workers' health, but companies can implement some prevention strategies to try to lower injury and illness rates. NIOSH research has identified several characteristics of an organization that are known to both improve worker health and enhance productivity. Examples of these characteristics include the following:

- Recognition of employees for good work performance
- Opportunities for career development
- An organizational culture that values the individual worker
- Management actions that are consistent with organizational values

Stress at Work, a publication by NIOSH, suggests other strategies that companies can implement to reduce work-related health problems:[8]

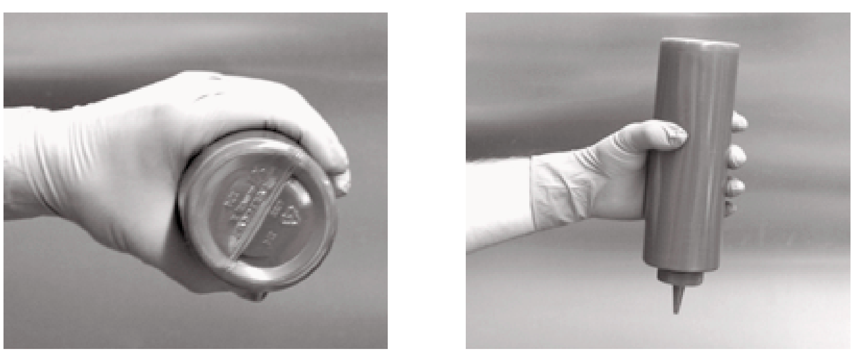
- Ensure that the workload is in line with workers' capabilities and resources.
- Design jobs to provide meaning, stimulation, and opportunities for workers to use their skills.
- Clearly define workers' roles and responsibilities.
- Give workers opportunities to participate in decisions and actions affecting their job.
- Improve communications by reducing uncertainty about career development and future employment prospects.
- Provide opportunities for social interaction among workers.
- Establish work schedules that are compatible with demands and responsibilities outside the job.

Improving Tools, Equipment, and Workstations

To reduce or eliminate contributing factors for musculoskeletal disorders and improve the fit between the worker and the task, look at how the tools, equipment, and workstations are designed and used.

Tools

Tools that are not properly designed or are inappropriate for the task may increase awkward postures or forceful exertions. For example, using a pistol grip tool on a horizontal work surface at waist height may cause the worker to use an awkward wrist, elbow, and shoulder posture. Using tools, such as squeeze bottles, can cause fatigue if the diameter exceeds 2 inches. Look at the tools that are being used at each workstation. Do they provide a good fit between the worker and the task? Is there a better tool for the job?

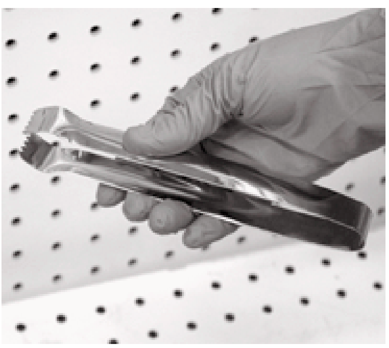


A squeeze bottle can cause fatigue if the diameter exceeds 2 inches.

Many food-processing workers use hand tools for cutting and gripping. Other food-processing workers use hand tools for machine operation or maintenance. It is necessary to understand the importance of selecting the right tool for the job and the right tool for the worker's hand. Therefore, hand tool selection should be based on the task and the worker and the following goals:[9]

- Maximize performance.
- Enhance work quality.
- Minimize the physical demands of the work.
- Prevent worker fatigue.

There are two basic grips: a power grip and a precision grip. In a power grip the four fingers grasp one side of the object with the thumb on the other side, making a fist. This kind of grip is used when the application of a high or stabilizing force is the objective and precision is not a major concern.



Precision grip

In a precision grip the object is pinched between the fingers and thumb. A precision grip can supply only about 20 percent of the force of a power grip, but it provides much more control. For every precision grip, there is an optimum distance between the thumb and fingers that maximizes grip force. For grip spans below 2 inches, the maximum force produced decreases substantially.

Pliers, scissors, and other pinching tools also require the hand to exert pressure against the metal handle when opening the jaws. This action can cause calluses and trauma (contact pressure) to the back and sides of the hand or fingers. Spring-loaded tools open automatically and reduce exposure to trauma and cramping of the fingers.

Force with contact stress to fingers

Spring-loaded tool

In general, the smaller the hand grip, the less power the worker has. When high force is required for precision work, consider using a power tool instead of a manual tool. A power tool allows the tool, rather than the hand, to generate the force so the worker can use the small hand muscles to guide and position the tool precisely.

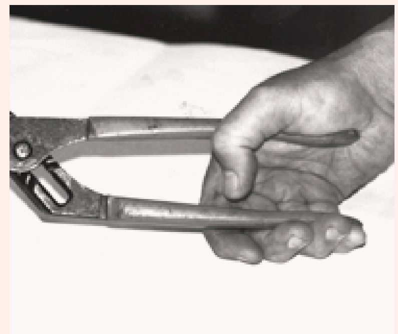
For a power grip around a cylindrical handle, the worker's fingers and thumb should surround more than half of the handle. The optimal power grip force with cylindrical handles is 1 1/4 to 2 inches in diameter.[10]

Power grip

The length of the tool handle should be long enough to extend past the tender middle part of the palm. For most people, a minimum length of 4 1/2 to 5 inches is recommended.[11] At this length, the handle will not put pressure on the tender middle part of the palm, which is the area through which the tendons and the median nerve pass. This area is called the *carpal tunnel.*

Handle length too short

Gripping a tool with high force may quickly fatigue muscles as well as place unhealthy forces on the involved joints. Watch for white knuckles or overextension of the index finger and overbending of the thumb. Table 3 provides guidelines on hand tool selection.



Force with contact pressure in the palm of the hand

Overbending the thumb

White knuckles

Table 3. Guidelines for Selecting Hand Tools

Handle Shape	Type of Tool	Purpose of Tool	Handle Length	Handle Diameter	Handle Span	Recommended Handle Attributes
For Power Grip						
Open/Close for POWER GRIP	• Pliers • Scissors • Clippers	• Pinching/gripping • Cutting/crushing	• Longer than the width of the user's hand • 4" minimum • When used with gloves, the length should be 1/2" longer.		• A distance of 2 1/2" to 3 1/2" between handles at the point of application • Maximum grip strength is produced with span of 2 1/2" to 3 1/2".	• No finger edges or recesses • Smooth, slightly compressible, and nonconductive • Flanged at the end to prevent slippage from the hand • Nonslip surface • Bent handle • Spring-loaded to open
Cylindrical for POWER GRIP	• Screwdriver • Hammer	• High-torque performance • Hammering	• Longer than the width of the user's hand • 4" minimum • 4 1/2" to 5" is preferred to provide freedom of hand placement. • When used with gloves, the length should be 1/2" longer.	• 1 1/4" to 2" • Diameter of 1 1/2" produces maximum grip strength. • Diameter of 2" to 2 1/2" is within the acceptable range.		• Rounded handle • Smooth, slightly compressible, and nonconductive • Nonslip surface • No finger edges or recesses • Bent handle
For Precision Grip						
Cylindrical for PRECISION GRIP	• Screwdriver	• Low-torque performance	• Small	• Up to 1/2"		• Rounded handle • Smooth, nonconductive • Nonslip surface • No finger edges or recesses • Bent handle

Sources: Fred Robinson, Jr., and Bruce K. Lyon, "Ergonomic Guidelines for Hand-Held Tools,"*Professional Safety,* Vol. 39 (August 1994), 16-21; Paul White and William J. Cohen, *Tools for the Task: Ergonomic Product Evaluation Series for Business and Industry.* Edited by Michael Gauf. Horsham, Pa.: LRP Publications, 1996; and Suzanne Rodgers, *Ergonomic Design for People at Work, Volume 1: Workplace, Equipment, and Environmental Design and Information Transfer.* Edited by Elizabeth Eggleton for Eastman Kodak Company. New York: Van Nostrand Reinhold, 1983.

Control panels are too far from the worker.

Equipment

Sometimes the equipment or machines that employees use to move products are poorly designed. Look at where control panels, levers, or handles are installed. Are they to the left or right of the worker? Or are they in front of the worker? Right-handed workers may need to use awkward postures to operate control panels installed to their left side. Are the controls too high or too low for easy and quick access without making extended reaches or awkward postures? Are emergency shut-off controls visible and accessible?

Workstations

If the workstation is not designed to provide a good fit between the worker and the work task, it can expose workers to awkward postures, extended reaches, contact pressure, or unnecessary movements that can contribute to musculoskeletal disorders.

A work surface that is too high can cause an awkward shoulder posture.

Is the workstation designed for the tools, equipment, and products that are handled and used there? For example, if employees are filling boxes, is the work surface too high, causing awkward postures? If employees are sorting small pieces of debris or bad products, is the work surface or conveyor high enough for employees to see the pieces without leaning forward?

Is the work too far away, or are materials blocking the field of vision? Employees may have to bend, reach, twist, or hold fixed postures to see or work with the products.

Space planning and workstation design. Mistakes made in space planning during the early stages of facility layout and process design may be costly in terms of rework; however, it is also costly in terms of future workers' compensation costs. Space planning and workstation design are so important in preventing musculoskeletal disorders in the workplace that it may be cost-effective to consult with a professional during the design and construction phases. Consultation may ensure that mistakes are not made early in the facility design process.

Planning the work space includes consideration of the following:

- Size of the work space in square footage
- Height, depth, width, and shape of the work surface
- Ease of access to frequently used tools or equipment
- Access to and type and configuration of storage space
- Access for maintenance
- Space to perform manual work if automation fails

Some common problems include:

- Left-handed workstations for right-handed employees (or vice-versa)
- Work surfaces that are too high or too low for the employees
- Work surfaces that are too high or too low for the tools being used or the products handled
- Work surfaces that are too deep for the employees
- Work surfaces that are too deep or too shallow for the tools being used or the product being handled
- Workstations that occupy too much square footage
- Inadequate work surface space
- Poorly designed work areas that are not next to each other and interrupt the work flow
- Controls that are too high or too far away from the employees
- Location and placement of equipment within the work space
- Poorly placed pieces of equipment that are used at the same time
- Poorly designed equipment
- Display panels that are not in the employees line of sight

Adjustability. Employees occupy space while working, and the way they use their work space and equipment can bring on musculoskeletal disorders. Therefore, it is important to recognize the employees' individual factors such as size, shape, and physical condition. Each worker occupies work space and relates to work equipment differently. Whenever possible, it is best to design for adjustability. This approach will provide the best chance of meeting the needs of many people. It is not cost-effective to design for everyone, so adjustable equipment will generally meet the requirements of 90 to 95 percent of the population. The equipment may not fit the remaining 5 to 10 percent (e.g., extremely tall and extremely short individuals), and individual accommodations may be needed in some cases.

Anthropometrics. The measurement of body dimensions is called *anthropometrics*. These dimensions might include overall height (stature), arm reach distances, seated eye height, standing knee height, and other body dimensions. Charts and tables depicting body dimensions may be used to determine representative ranges for a workforce. The information is important in efforts to reduce awkward postures and extended reach requirements for a workforce. Use of the information will help to ensure that the work space promotes an efficient work flow. It is important to eliminate unnecessary movements from the work flow; they may contribute to employee fatigue. Anthropometric data are found in many books and articles about ergonomics and human factors. For examples of anthropometric data, refer to K. H. E. Kroemer, *Fitting the Tasks to the Human*, and Suzanne H. Rodgers, *Ergonomics Design for People at Work, Volume 1 and 2*, listed in Section 4.

Ergonomics in Action

At the Woodbridge Winery by Robert Mondavi, employees apply labels to bottles that are placed on an angled wooden rack. Reaching for the bottles proved to be awkward for taller employees, forcing them to lean forward. Tori, an employee, discovered that by placing the rack on a 5” base, she did not have to lean forward while applying labels to the bottles, and her back did not hurt after a full day as it had in the past. The maintenance department designed bases of various heights to accommodate a range of employees. This idea helped Tori and many of her coworkers.

When all employees are expected to work at the same height, some will work in awkward postures.

Adjustable workstations allow employees to work in a comfortable, neutral position.

The addition or removal of a platform allows the height of the work surface to be adjusted to fit each worker.

Work surface height. To find the best work surface height for employees, look at legroom, elbow height, and the nature of the tasks being performed. The space beneath the work surface must be adequate for legs, thighs, and knees. To minimize fatigue, work with the arms close to the body and the forearms parallel to the floor. This is often referred to as a neutral position. To meet these guidelines, the work surface height will be determined by the size of the individual.

The work surface height must accommodate the postures, movements, and chair height of the worker. The height of the workpiece or product on the work surface is what affects the worker's posture. For precision and close inspection, the workpiece or product should be about 2 inches above the worker's elbows. At this height, the worker will be able to support the elbows and relax the back muscles.

For light assembly tasks, the workpiece or product should be about 2 to 4 inches below the worker's elbows. This range will allow adequate space for tools, materials, and containers.

For heavy work requiring downward force during packaging or assembly, the workpiece or product should be about 4 to 8 inches below the worker's elbows. This range will allow the worker to use the weight of the upper body to exert downward force.

These guidelines emphasize the importance of providing adjustable work surfaces that fit the individual workers. However, it may not always be possible to provide adjustable work surfaces. One option is to build work surfaces to fit the tallest workers. Shorter workers can be accommodated by providing them with platforms to work at the work surface.[12] Another option is to build work surfaces to fit the shortest workers. In that case, taller workers can add platforms to raise the work surface.

Notes

1. Stephan Konz, *Work Design: Industrial Ergonomics* (Fourth edition). Edited by Nils Anderson. Scottsdale, Ariz.: Publishing Horizons, Inc., 1995.
2. Ibid.
3. Suzanne Rodgers, *Ergonomics Design for People at Work, Volume 1: Workplace, Equipment, and Environmental Design and Information Transfer.* Edited by Elizabeth Eggleton for Eastman Kodak Company. New York: Van Nostrand Reinhold, 1983.
4. *The IESNA Lighting Handbook: Reference & Application* (Ninth edition). Edited by Mark S. Rea. New York: Illuminating Engineering Society of North America, 2000.
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6. *The IESNA Lighting Handbook*.
7. Suzanne Rodgers, *Ergonomics Design, Volume 1.*
8. *Stress at Work.* Prepared by Steve Sauter and others. National Institute for Occupational Safety and Health Publication No. 99-101. Cincinnati, Ohio: U.S. Department of Health and Human Services, 1999.
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10. Suzanne Rodgers, *Ergonomics Design, Volume 1.*
11. Ibid.
12. K. H. E. Kroemer and E. Grandjean, *Fitting the Task to the Human: A Textbook of Occupational Ergonomics* (Fifth edition). Bristol, Pa.: Taylor & Francis, Inc., 1997.

3. A "Best Practices" Approach

Involving Employees

Developing an Ergonomics Team

Analyzing Job Tasks

Making Improvements Step by Step

3. A "Best Practices" Approach

This section provides a "best practices" approach for improving a workplace by involving employees, developing an ergonomics team, and analyzing the different types of job tasks. This section outlines a process to help you identify jobs with factors that contribute to musculoskeletal disorders and select tasks for ergonomic improvements.

Involving Employees

Employee involvement is the key to improving the work environment. Open communication between management and employees throughout the ergonomic improvement process allows for a flow of information critical to identifying contributing factors and solving problems. Once the communication channel is in place, it is time to form an ergonomics team. The members can begin looking for job tasks that may lead to fatigue and musculoskeletal disorders.

Developing an Ergonomics Team

A critical aspect of a team approach is the creation of an environment in which workers have the freedom and are encouraged to voice their opinions without fear of reprisal. Such an environment makes employees motivated to participate in the ergonomic improvement process. Management will need to demonstrate the value of the team approach by taking action and following through with suggested job improvements.

When putting together an ergonomics team, you should include production workers because their opinions come from the users' perspective. Employees often know exactly what is wrong and how to fix it. When given the opportunity to participate in problem solving, workers closest to the problem will support, adopt, and use the improvements they helped to create.

The ergonomics team should also consist of front-line supervisors, engineering staff, and maintenance/facilities personnel. They understand how existing equipment works and whether the equipment can be retrofitted or modified. They may offer suggestions that can be easily implemented with minimal cost and mechanical intervention.

Ergonomics in Action

Packaging Department

Employees on the packaging line were having trouble placing the three-pound cans in cardboard cartons. They were experiencing pain and discomfort in their hands and wrists.

Sergio's Modification

Sergio, an employee from the Blue Diamond Growers' maintenance department, came up with the idea of designing a lever that would hold the three-pound cans on the line. Release of a lever would allow the cans to roll into the carton without employees having to manually lift the cans into the carton.

Before

Placing three-pound cans into boxes involves repetitive hand and wrist movements.

After

Redesign the workstation to eliminate repetitive hand and wrist movements.

Redesign the workstation to take advantage of gravity.

Analyzing Job Tasks

Before improving the fit between the tasks of a job and the worker, one must define a "job." 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. Table 4 provides some examples.

Table 4. Breakdown of Jobs, by Tasks

Jobs	Tasks
Food Processor	• Wrap food product. • Place product into food tray. • Assemble boxes. • Package food trays in boxes. • Fill carton with packaged food tray.
Fruit Sorter	• Inspect fruit visually on the conveyor for defects or size. • Pick out defective or small fruit from the conveyor and deposit them in the discard bin. • Pick out foreign particles from the conveyor and deposit them in the discard bin.

To understand the nature of the jobs that are performed within a department, ask yourself, What are the tasks that are performed there? What do employees do throughout their work shift? What is the path of the employees' work flow? A *job task analysis* can be performed to help you answer these questions. There are many different methods of analyzing job tasks. These methods consist of various techniques for taking a systematic look at jobs and work tasks. They help determine which jobs and particular tasks may contribute to musculoskeletal disorders. Once it is known where problems exist, it is easier to come up with ideas for making improvements.

Some methods are relatively simple, and others require detailed analysis and special equipment. Using work sheets and checklists is generally a simpler, less comprehensive method of analyzing job tasks. More comprehensive methods break jobs down into particular movements (e.g., reach, grasp, place) or use other specialized techniques. Job task analysis methods also vary according to the types of work activities they address. Some methods focus on workstation design. Others are more specific to certain types of work (e.g., manual handling of materials or the office environment).

Note: The three work sheets provided in this booklet may not be the best method for addressing problems in your workplace. More detailed methods may be needed for addressing musculoskeletal disorders. If you feel uncomfortable using these work sheets or if problems seem complicated, severe, or widespread, you probably need additional help. Consult one or more of the following sources:

- Ergonomics consultants
- Industrial hygiene or safety professionals
- Cal/OSHA Consultation Service
- Occupational medicine professionals
- Vocational rehabilitation counselors
- Physical therapists
- Exercise physiologists or wellness specialists
- Trade associations/industry groups
- Unions or employee organizations
- Equipment vendors

Making Improvements Step by Step

Ergonomics should be thought of as a *process* of making improvements a little at a time rather than as a one-time "fix" or a "solution." The workplace is a dynamic environment, always changing. Ergonomics is one way in which you can continue to improve the workplace. The process 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.

Figure 1. The Ergonomic Improvement Process

Assessing

1. Identify job tasks.
2. Analyze the tasks.
3. Determine why the contributing factors are present.

Planning

4. Prioritize the tasks.
5. Select several ergonomic improvements.

Doing

6. Implement specific ergonomic improvements.
7. Monitor ergonomic improvements.

Verifying

8. Evaluate the effectiveness of the ergonomic improvements.
9. Revise/adjust ergonomic improvements as needed.

Figure 1 illustrates the ergonomic improvement process, which is similar to quality management concepts discussed in different management and leadership textbooks. (This process was modified from the one mentioned in *Safety and Health Programs Assistance Training: Achieving Excellence*).[1]

Assessing

For step 1 use work sheet 1, "Ergonomic Assessment," to help identify job tasks that may have contributing factors for musculoskeletal disorders.

1. Identify job tasks.

Try to find out which jobs may be contributing to musculoskeletal disorders. Look around the workplace, talk to employees, and be 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
- Employee reports of problems
- High absenteeism or employee turnover rates
- Poor product or service quality
- High error rates or waste of materials
- Customer complaints
- Production bottlenecks
- Missed deadlines

Besides talking to employees, you can determine the types, numbers, and severity of musculoskeletal disorders and particular work tasks associated with them by reviewing written records. These records may include:

- Cal/OSHA Form 300, "Log of Work-Related Injuries and Illnesses"
- Cal/OSHA Form 301, "Injury and Illness Incident Report"
- "Employers' and Doctors' First Reports of Occupational Injury and Illness"
- Workers' compensation claim records
- Medical or first aid records
- Workplace inspections, maintenance records, and incident or accident records

For each job you have identified as having contributing factors, rate the tasks in that job. For each task you have noted for this job, ask the employee who performs the work the following questions:

- How physically difficult is the task? (intensity)
- How often is the task done? (frequency)

Next, rate each task listed and multiply the two numbers together to get a total score for the task. The total score for the task is an indicator of the chances of developing musculoskeletal disorders. You may refer to this score later when you prioritize tasks for improvement. The higher the score, the higher will be the priority to seek improvements.

For steps 2 through 7, use work sheet 2, "Task Analysis," to help identify, select, and implement ergonomic improvements for tasks you selected from work sheet 1.

2. Analyze the tasks.

Analyze the tasks by observing the work being performed in each job you have selected. Look at each task in the job separately. Begin with those tasks that receive the highest total score. Any tasks that are rated "very difficult" (i.e., score of 5) should be looked at immediately because they might contribute to fatigue and musculoskeletal disorders even if they are performed very rarely (e.g., on a seasonal basis). For each task, list the contributing factors you observe and describe the reasons or root causes for them.

Talk to each employee or a representative sample of employees who perform the tasks. Employees who perform the work can provide valuable information about why particular tasks are difficult and how they may be improved.

Note: Musculoskeletal disorders can be associated with a combination of risk factors in multiple tasks.

3. Determine why the contributing factors are present.

How do you know when repeated movements, forceful exertions, and/or other contributing factors may lead to fatigue or symptoms of musculoskeletal disorders? It is important to uncover the reasons or root causes for contributing factors occurring in job tasks. Understanding the *why* is important because it allows you to fully understand the nature of the problem and eventually come up with cost-effective ergonomic improvements.

Look at the whole system to find the root cause of the problem. Continually ask the question *Why?* Ask employees why they perform a task in a certain way. Try to follow the "why" questions back to the real reason for the problem. Do not try to solve the problem by coming up with ergonomic improvements until you have determined why the contributing factors are present.

Planning

Making changes in a workplace requires planning.

4. Prioritize the tasks.

Setting priorities will help to sort out which tasks to improve first. To determine which tasks to address, consider the following:

- Frequency and severity of complaints, symptoms, and musculoskeletal disorders
- Risk factors or other contributing factors you have identified in a particular task
- Technical and financial resources at your disposal
- Difficulty of implementing various improvements
- Your time frame for making improvements
- Employees' ideas for improvements
- Potential effects on productivity, efficiency, and product or service quality

Taking into account these important considerations or others in your organization, prioritize the tasks within each job you plan to improve.

5. Select several ergonomic improvements.

Next, for each task you plan to improve, identify several potential task improvements. Start with the tasks assigned the highest priority. For each task, focus on making a list of improvements that you think will most effectively address the reasons (root causes) for the contributing factors or other issues identified. Remember that a single ergonomic improvement may reduce or eliminate multiple contributing factors.

At this stage the ergonomics team, with its open communication and employee involvement, can play a major role in coming up with cost-effective ergonomic improvements. Always involve employees and ask what improvements they think will work best. Improvements are more likely to be successful if employees are a part of the problem-solving process.

Once the team members have listed potential improvements for each task, evaluate each one separately by asking questions listed below. Then mark or highlight the particular improvements selected for use in the workplace.

Will this improvement:

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

Doing

Steps 6 and 7 help carry out the improvements selected.

6. Implement specific ergonomic improvements.

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 practices. You may want to use one or more of the following arrangements:

- Set up a mock-up of an improved workstation.
- Modify a single workstation first (put in full-scale changes to other workstations later).
- Insert an extra workstation on a full-speed production line.
- Provide demonstration periods for new equipment, tools, or work practices.

7. Monitor ergonomic improvements.

During the trial period, the selected improvements should be examined to determine how effective they are. Do not make final decisions on the effectiveness of the improvements until employees have had enough time to adjust to the changes. Employees should have a "break-in period" during which they have a chance to practice, at a slower pace, using the new workstation, tool, piece of equipment, or work practice and then ramp up to production speed. An adjustment period may prevent rejection of an otherwise beneficial ergonomic improvement. Some modifications may require employees to use new muscle groups or different parts of the body, causing employees to feel initially fatigued, tired, or sore. Remember to check periodically with employees to find out how they think the improvements are working and always seek their suggestions for further improvements.

Keep in mind that the process of improving the workplace is not exact. Do not expect to find the best solution right away. Expect to try out improvements, see how they are working, and either tinker with them or discard them in favor of alternatives.

Verifying

For steps 8 and 9, use work sheet 3, "Improvement Follow-up," to help evaluate the ergonomic improvements for the selected tasks.

8. Evaluate the effectiveness of the ergonomic improvements.

After an appropriate adjustment period, evaluate the effectiveness of each improvement separately by asking 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 musculoskeletal disorders?
- 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., raised 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?

9. Revise/adjust ergonomic improvements as needed.

A good way to determine whether you have reduced or eliminated contributing factors or other problems associated with a particular task is to go back to step 1 and review the job task analysis process. Check to see if you need to adjust the ergonomic improvements that you have implemented.

Notes

1. *Safety and Health Programs Assistance Training: Achieving Excellence,* Tuscaloosa: University of Alabama College of Continuing Studies, 1997.

4. Resources

Ergonomic Improvement Work Sheet 2

TASK ANALYSIS

The purpose of this work sheet is to analyze tasks selected for improvement.

Employee's Name: ____________ Job Title: ____________ Date: ____________

Name of Observer: ____________ Job Location: ____________

A	B	C	D	E	F	G
Tasks	Contributing Factor(s)	Reasons for contributing factor(s)	Priority	Task improvement	Target date	Follow-up date

It is recommended that follow-up on all improvements be conducted within 3 months of implementation. Use work sheet 3, "Improvement Follow-up," to document findings.

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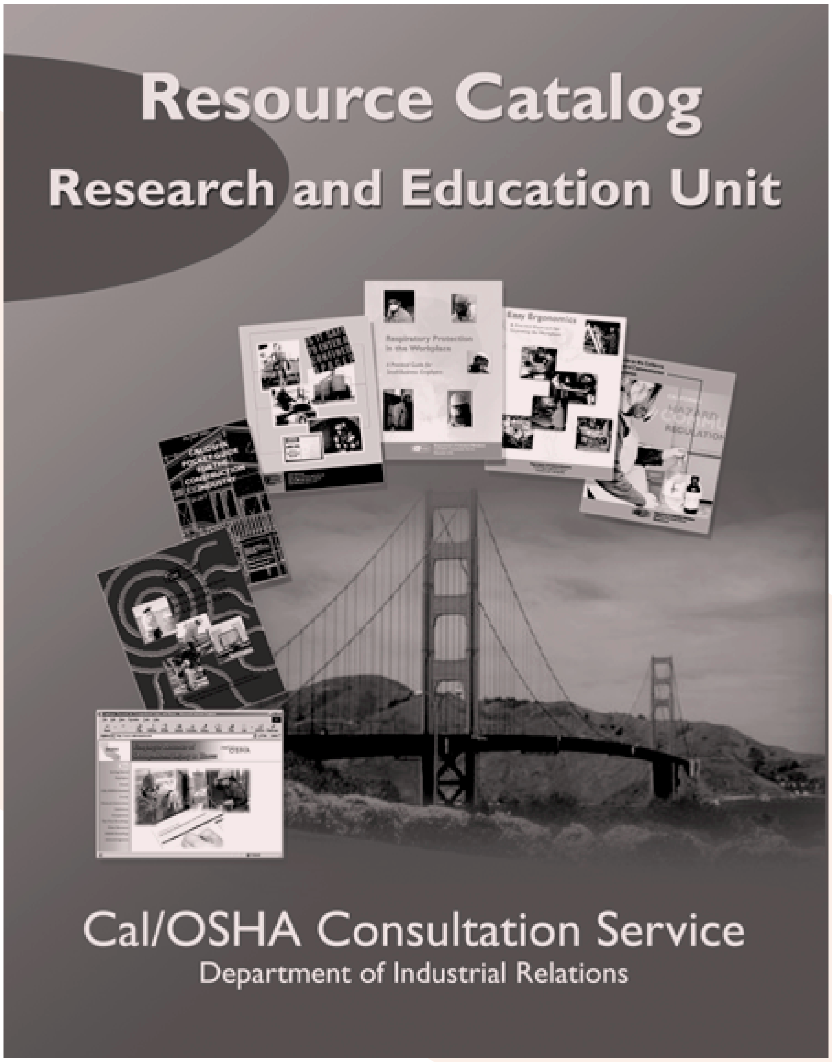
Other Educational Resources from Cal/OSHA

Cal/OSHA Consultation Service has a series of publications designed to assist employers and employees in California. To receive a copy of the resource catalog, fax a request to Cal/OSHA Consultation Service, Research and Education Unit at (916) 574-2532. Current Cal/OSHA publications may be viewed, ordered, and downloaded from the Department of Industrial Relations Web site <*http://www.dir.ca.gov/dosh/puborder.asp*>.



Ergonomic Improvement Work Sheet 1

ERGONOMIC ASSESSMENT

The purpose of this work sheet is to identify job tasks that may have contributing factors for musculoskeletal disorders.

Date: ______________________

Employee's Name: ______________________ Job Title: ______________________

Name of Observer: ______________________ Job Location: ______________________

Give a brief description of the job: ______________________

____

Intensity *How physically difficult is this task?*	**Scale**
Very easy	1
Easy	2
Somewhat difficult	3
Difficult	4
Very difficult	5

Frequency *How often is this task done?*	**Scale**
Seasonally (a few times a year)	1
Occasionally (a few times a shift or week)	2
Frequently (up to 4 hours per shift)	3
Constantly (more than 4 hours per shift)	4
Extended hours (more than 8 hours per shift)	5

A	B		C		D
TASKS List each task that is performed in the job	Rate the physical difficulty of the task.		Rate how often the task is done.		Total score *
		X		=	
		X		=	
		X		=	
		X		=	
		X		=	
		X		=	
		X		=	
		X		=	

* The higher the total score in column D, the higher will be the priority to seek improvement.

Make copies as needed

DIRECTIONS FOR USE

1. Enter the date, employee's name, job title, name of observer, and the job location.

2. Give a brief description of the job.

3. In **column A,** list each task that is performed in the job. Provide a general description of each task. Some jobs may have only one task.

4. In **column B,** for each task listed, ask the employee to rate it for intensity (how physically difficult the task is). Remember that this number is the employee's perception of difficulty.

5. In **column C,** for each task listed, ask the employee to rate it for frequency (how often the task is done). Remember that this number is the employee's perception of frequency.

6. In **column D,** multiply the two scores (Columns B x C) to get a total score. This score may be used later for work sheet 2, "Task Analysis," to help prioritize tasks selected for improvement.

Ergonomic Improvement Work Sheet 2

TASK ANALYSIS

The purpose of this work sheet is to analyze tasks selected for improvement.

Employee's Name: ______________ Job Title: ______________ Date: ______________

Name of Observer: ______________ Job Location: ______________

A	B	C	D	E	F	G
Tasks	Contributing factor(s)	Reasons for contributing factor(s)	Priority	Task improvement	Target date	Follow-up date

It is recommended that follow-up on all improvements be conducted within 3 months of implementation. Use work sheet 3, "Improvement Follow-up," to document findings.

Make copies as needed

DIRECTIONS FOR USE

1. Enter the date, employee's name, job title, name of observer, and the job location.

2. In **column A,** list each task you have selected for improvement.

3. In **column B,** identify the contributing factor(s) observed in each task. If you observe more than one contributing factor related to a task, use a separate line for each contributing factor.

   Contributing Factors:
   Repetitive motion - Performing the same types of motions again and over again using the same muscles, tendons, or joints
   Awkward posture - Reaching, twisting, bending, working overhead, kneeling, squatting, or pinch grips
   Sustained static posture - Working in the same position for a long time with little or no change in position
   Forceful exertion - The amount of muscular effort used to perform a task
   Contact pressure - The body pressing against hard or sharp surfaces
   Vibration - Continuous high- or low-intensity hand-arm or whole-body vibration
   Environmental Factors - Hot/cold temperatures and high/low lighting
   Individual Factors - Age, physical condition, gender, stature
   Work Organizational Factors - Fast work pace, low staffing levels, shift work

4. In **column C,** identify the part of the task that caused the contributing factor(s). Ask the question, *Why?* Describe the reasons (root causes) for the contributing factor(s).

5. In **column D,** prioritize tasks for improvement. Although prioritization may be accomplished according to the scores in column D of work sheet 1, "Task Analysis," prioritization may be influenced by other considerations.

   Consider the following items:
   - Frequency and severity of complaints, symptoms, and musculoskeletal disorders
   - Risk factors or other contributing factors identified in a particular task
   - Technical and financial resources at your disposal
   - Difficulty of implementing various improvements
   - Time frame for making improvements
   - Employees' ideas for improvements
   - Potential effects on productivity, efficiency, and product or service quality

6. In **column E,** identify possible ways to improve each contributing factor observed. Evaluate each improvement by answering the following questions.

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

Mark or highlight the specific improvements to try out in your workplace.

7. In **column F,** set the target date for the improvement to be made.
8. In **column G,** set the follow-up date.

Ergonomic Improvement Work Sheet 3

IMPROVEMENT FOLLOW-UP

The purpose of this work sheet is to follow up on the implemented ergonomic improvements.

Employee's Name: ____________________ Job Title: ____________________ Date: ____________________

Name of Observer: ____________________ Job Location: ____________________

A	B	C	D	E
Date	Task	How did you improve this task?	What happened as a result of your improvement?	Follow-up date (if required)

Make copies as needed

DIRECTIONS FOR USE

1. Enter the date, employee's name, job title, name of observer, and the job location.

2. In **column A**, list the date when the improvement was put in place.

3. In **column B,** list each task for which improvements were made.

4. In **column C**, describe the improvements that were made.

5. In **column D,** describe the results of each improvement implemented by answering the following 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 musculoskeletal disorders?
   - 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., raised 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?

6. In **column E,** establish another follow-up date, if necessary.
   Continue to use this work sheet for subsequent follow-up evaluations.

Questionnaire:

We want to hear from you

Questionnaire

We Want to Hear from You

Your comments on *Ergonomics in Action: A Guide to Best Practices for the Food-Processing Industry* are valued and welcome. Please fill out this questionnaire and fax it to (916) 574-2532 or mail it to:

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

Instruction: Please answer the questions below by circling the number that corresponds to your response.

1. Overall, how would you rate the booklet?

1	2	3	4	5
Poor	Fair	Good	Very Good	Excellent

2. How useful is the booklet in real work situations?

1	2	3	4	5
Not Useful	Somewhat Useful	Mostly Useful	Very Useful	Extremely Useful

3. How useful are the examples that illustrate ergonomic improvements?

1	2	3	4	5
Not Useful	Somewhat Useful	Mostly Useful	Very Useful	Extremely Useful

4. How useful are the ergonomic improvement work sheets?

1	2	3	4	5
Not Useful	Somewhat Useful	Mostly Useful	Very Useful	Extremely Useful

Questionnaire *(continued)*

5. What aspect of the booklet did you like the best?

6. Are any parts of the booklet unclear or confusing?

7. Do you have any suggestions for improving the ergonomic improvement work sheets or any other portions of the booklet?

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

Additional comments:

Optional Information:

Name:

Organization:

Telephone Number:

May we call you if we have any questions? _____ Yes _____ No

Thank you for your participation!

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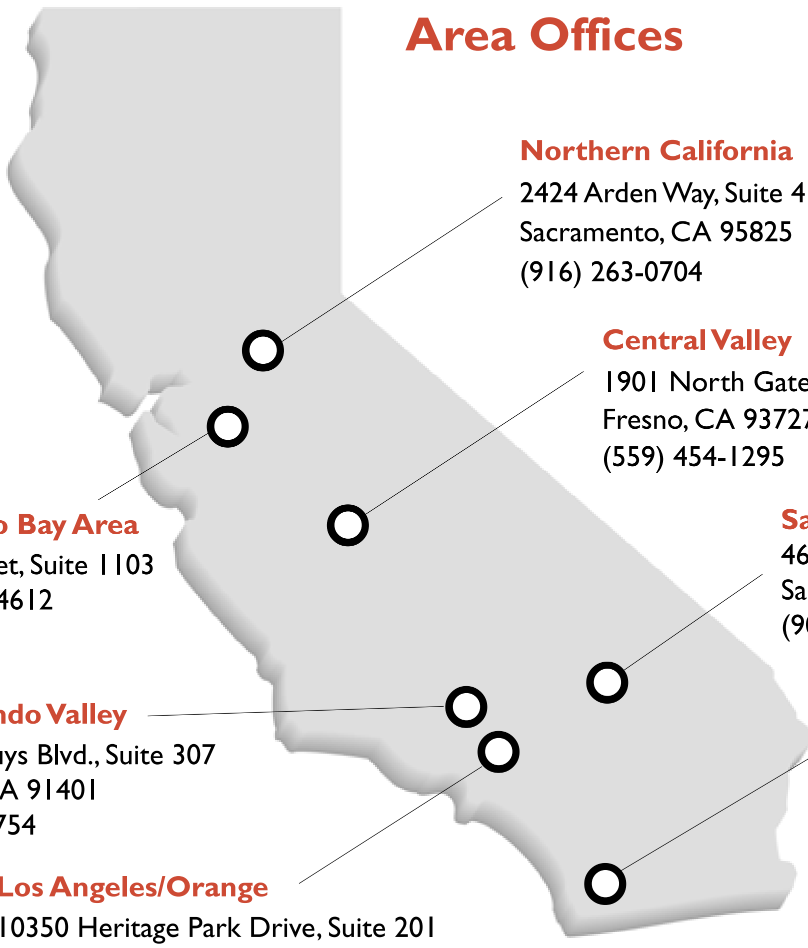

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Notes

Learn how ergonomics can help reduce work-related musculoskeletal disorders.

Find out if your workplace has contributing factors that can cause musculoskeletal disorders.

Involve your employees in the ergonomic improvement process.

Take action by using the three easy step-by-step work sheets to make your workplace safer.

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