



# Introduction to Ergonomics

This material is for training purposes only. Its purpose is to inform Oregon employers of best practices in occupational safety and health and general Oregon OSHA compliance requirements. This material is not a substitute for any provision of the Oregon Safety Employment Act or any standards issued by Oregon OSHA.

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## INTRODUCTION

Ergonomics is a way of designing workstations, work practices, and work flow to accommodate the capabilities of workers. Ergonomic design reduces risk factors known to contribute to occupational ergonomic injuries and illnesses, such as sprains and strains and cumulative trauma disorders (CTDs).

If work is performed in awkward postures or with excessive effort, fatigue and discomfort may result. Under these conditions muscles, tendons, ligaments, nerves, and blood vessels can be damaged. Injuries of this type are known as musculoskeletal disorders (MSDs).

### The problem

The increased rate and high cost of ergonomic injuries and illnesses such as carpal tunnel syndrome, tendinitis, and MSDs cut across all industries and occupations. Some of the hardest hit are manufacturing, retail, and service industries. Take a look at your OSHA 300 Log. You will probably notice that most (30%-50%) of your recordable injuries are somehow related to ergonomics.

MSDs can increase the cost of doing business both directly and indirectly. Direct costs may include medical services and higher workers' compensation premiums. The direct cost to close an ergonomic-related workers' compensation claim in Oregon averages over \$9,000. Indirect costs from increased employee turnover, absenteeism, and retraining may also occur. Productivity, product quality, and employee morale may also suffer. Estimates indicate that the indirect costs associated with MSDs may be four to 10 times higher than the direct costs. Preventing and controlling ergonomic risk factors in the workplace often costs a fraction of what one such claim would cost. In smaller companies, one ergonomic-related claim can mean the difference between being above or below the profit margin.

### An important strategy to solve the problem

One of the important services your company's workers compensation premiums pay for is Oregon OSHA consultation and training. Oregon OSHA consultants work with you to provide cost-effective recommendations to solve your ergonomics problems. They recognize that no two organizations are alike and help you make changes that fit into your company's existing management programs and work practices.

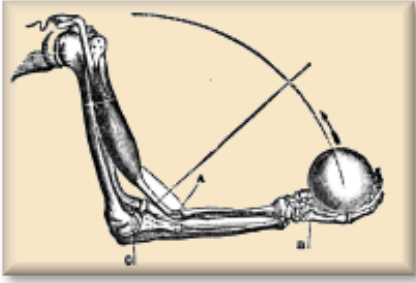
Oregon OSHA's Consultative Services Section has a team of trained professional ergonomics consultants with many years of experience providing ergonomic services to such areas of industry as electronics, pulp and paper, secondary wood products, retail grocery, food processing, healthcare, office environments, public transportation, municipalities, school districts, higher education, and state government. Consultants also provide customized presentations and training for groups and associations. An ergonomic consultation may include:

- Workstation analysis and design
- Task-specific and company-wide risk factor assessment
- Training and education
- Development and implementation assistance for ergonomic programs
- Help prioritizing ergonomic needs
- Answers to questions about current and possible regulatory requirements

**This is a confidential service** for employers, completely separate from OR-OSHA enforcement, to help your organization reduce work-related injuries and illnesses and their costs. Think about this important opportunity as you continue your training in this course.

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## MODULE ONE: DEFINING ERGONOMICS



Webster's New World Dictionary (College Edition) defines ergonomics as "The Study of the problems of people in adjusting to their environment; especially the science that seeks to adapt work or working conditions to suit the worker."

Ergonomics may also be thought of as the science of fitting the job to the individual worker. When there is a mismatch between the physical requirements of the job and the physical capacity of the worker, musculoskeletal disorders (MSDs) can result.

### Who is at risk?

Workers who must repeat the same motion throughout their workday, who must do their work in an awkward position, who must use a great deal of force to perform their jobs, who must repeatedly lift heavy objects or who face a combination of these risk factors are most likely to develop MSDs. The level of risk depends on how long a worker is exposed to these conditions, how often they are exposed, and the level of exposure.

### What Are MSDs?

MSDs include a group of conditions that involve the nerves, tendons, muscles, and supporting structures such as intervertebral discs. They represent a wide range of disorders, which can differ in severity from mild periodic symptoms to severe chronic and debilitating conditions. Examples include:

- carpal tunnel syndrome
- tenosynovitis
- tension neck syndrome
- and low back pain

MSDs are often confused with ergonomics. Ergonomics is the science of fitting workplace conditions and job demands to the capabilities of workers. In other words, **MSDs are the problem and ergonomics is a solution.**

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

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

There are also environmental factors associated with the workplace that can cause problems.

Extreme high temperatures can increase the rate at which the body will fatigue. Exposure of the hands and feet to cold temperatures can decrease blood flow, muscle strength, and manual dexterity. These conditions can also cause excessive grip force to be applied to tool handles or objects. Another problem may be caused by tools or equipment that exhaust cold or hot air directly onto the operator.

In addition, the lighting in a workplace may be too dark or too bright for the work task. This may result in employees assuming awkward postures to accomplish work tasks and a loss of product quality. We will cover these factors in more detail in upcoming modules.

### What Are Work-Related Musculoskeletal Disorders (WMSDs)?

Occasionally, in reading safety literature, you will come across this term. WMSDs are nothing more than MSDs caused or made worse by the work environment. WMSDs can cause severe and debilitating symptoms such as:

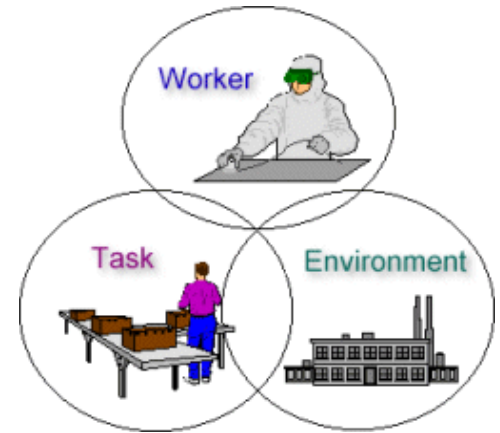
- pain, numbness, and tingling; reduced worker productivity
- lost time from work
- temporary or permanent disability
- inability to perform job tasks
- an increase in workers compensation costs.

## The interaction of three risk factor areas

Ergonomics studies the various risk factors brought to a job. There are three areas within which ergonomics risk factors exist:

- Risk factors inherent in the worker
- Risk factors inherent in the task
- Risk factors inherent in the environment

Workers come in all shapes and sizes, each with unique attributes that present certain ergonomic risk factors to a given job. The task(s) of the job, itself, can present risk factors that increase the likelihood of an injury. Finally, the workplace environment, within which the worker and job exist, may also contain exposures to risk factors. We will cover each of these three risk factor categories in the course.



## The impact of ergonomics

### Oregon statistics

Claims costs (incurred losses) are the costs of all benefits paid out of workers' compensation premiums to an injured worker, over the life of a claim. In Oregon, losses for MSDs were around \$190 million in 2000, and more than \$1.8 billion from 1990 through 2000. The majority of MSDs have been sprains, strains, and tears caused by overexertion. These claims alone account for 60 percent of all the MSD claims accepted between 1996 and 2000. Recently however, the share of MSDs due to overexertion has been shrinking as the proportion of disorders resulting from repetitive motion and bodily reaction is on the rise. Of MSD claims accepted through 1996 to 2000, the back (22,053 claims) and wrists (6,788) were the parts of body stricken most often. More information on [Oregon Statistics](#).

### National statistics

Musculoskeletal disorders are among the most prevalent medical problems in the U.S., affecting 7% of the population. They account for 14% of physician visits and 19% of hospital stays. 62% of persons with MSD report some degree of limitation on activity compared with 14% in the population at large.

Often MSDs can be prevented by simple and inexpensive changes in the workplace. Adjusting the height of working surfaces, varying tasks for workers and encouraging short rest breaks can reduce risks. Reducing the size of items workers must lift or providing lifting equipment also may aid workers. Specially designed equipment, such as curved knives for poultry processors, may help.

In 2001, the Bureau of Labor Statistics (BLS) reported there were about 333,800 newly reported cases of occupational illnesses in private industry nationally. Manufacturing accounted for 54 percent of these cases. Disorders associated with repeated trauma, such as carpal tunnel syndrome and noise-induced hearing loss, accounted for 4 percent of the 5.2 million total workplace injuries and illnesses in 2001. They were, however, the dominant type of illness reported, making up 65 percent of the 333,800 total illness cases.

### Last Words

Medical costs and workers' compensation claims for serious MSDs may total \$15,000 to \$85,000 or more. It makes sense to give serious consideration to the risk factors in your workplace and the information in this course will help

you do that. Before moving on to the next module, take the time now to answer the quiz questions below. Later, you'll enter these answers in the Final Exam and Quiz page online.

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## MODULE Quiz

1. Ergonomics is the science of fitting the job to a group of workers.
  - a. True
  - b. False
2. Musculoskeletal disorders can result when there is a mismatch between the physical \_\_\_\_\_ of the job and the physical \_\_\_\_\_ of the worker.
  - a. demands, requirements
  - b. requirements, capacity
  - c. requirements, requirements
  - d. demands, demands
3. Workers are likely to develop MSDs when they:
  - a. work in an awkward position
  - b. use a great deal of force
  - c. repeatedly lift heavy objects
  - d. Any of the above
4. Which of the following is not one the three areas within which ergonomics risk factors exist?
  - a. the worker
  - b. the procedure
  - c. the task
  - d. the environment
5. Musculoskeletal disorders are among the most prevalent medical problems in the U.S., affecting \_\_\_\_\_ of the population:
  - a. 3 percent
  - b. 7 percent
  - c. 40 percent
  - d. 72 percent
6. According to the text, MSDs can often be prevented by simple and inexpensive changes in the workplace:
  - a. True
  - b. False
7. Work-Related Musculoskeletal Disorders are musculoskeletal disorders caused or made worse by the work environment.
  - a. True
  - b. False
8. According to the text, MSDs include a group of conditions that involve all of the following, except:
  - a. nerves
  - b. tendons
  - c. muscles

d. skin

9. According to the text, all of these factors may contribute to MSDs, except:

- a. vibration
- b. unique motions
- c. awkward postures
- d. forceful exertions

10. Recently the share of MSDs due to overexertion has been increasing as the proportion of disorders resulting from repetitive motion and bodily reaction.

- a. True
- b. False

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## MODULE TWO: RISK FACTORS INHERENT IN THE WORKER



**The worker brings certain ergonomic risk factors to the job.**

It's important to understand that each worker's ability to respond to external factors, such as high force demands, is different and unique. The level, duration, and frequency of the loads imposed on tissues, as well as adequacy of recovery time, are critical components in whether increased tolerance (a training or conditioning effect) occurs, or whether reduced capacity occurs which can lead to cumulative trauma disorders CTDs as well as other musculoskeletal disorders (MSDs).

### The Musculoskeletal System

The musculoskeletal system is made up of the soft tissue and bones in the body. These are the parts of the musculoskeletal system:



- Bones: the load-bearing structure of the body.
- Muscles: tissues that contract to create movement.
- Tendons: tissue that connects muscles to bones.
- Ligaments: tissue that connects bones to bones.
- Cartilage: tissue that provides cushioning and reduces friction between bones.
- Nerves: the communication system that links muscles, tendons, and other tissue with the brain.
- Blood vessels: tubes that circulate nutrients throughout the body.

The following personal risk factors may be generalized across populations, but it's important to understand that, when designing a workstation or procedure, you should design for the specific individual(s) working at that workstation. Among these are the following:

### AGE

The prevalence of CTDs increases as people enter their working years. By the age of 35, most people have had their first episode of back pain. Once in their working years (ages 25 to 65), however, the prevalence is relatively consistent. Musculoskeletal impairments are among the most prevalent and symptomatic health problems of middle and old age.



Nonetheless, age groups with the highest rates of compensable back pain and strains are the 20–24 age group for men, and 30–34 age group for women. In addition to decreases in musculoskeletal function due to the development of age-related degenerative disorders, loss of tissue strength with age may increase the probability or severity of soft tissue damage from a given insult.

Another problem is that advancing age and increasing number of years on the job are usually highly correlated. Although older workers have been found to have less strength than younger workers, hand strength does not appear to decline with aging; in one study, average hand pinch and grip scores remained relatively stable in their population with a range of 29 to 59 years. Other studies have reported a lack of increased risk associated with aging.

## GENDER



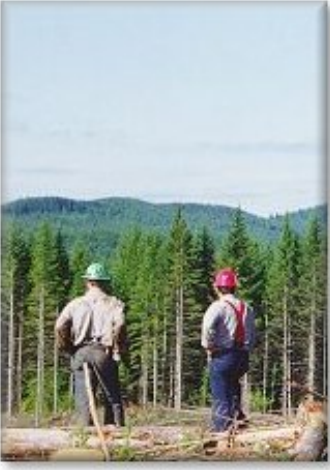
Whether the gender difference seen with some MSDs in some studies is due to physiological differences or differences in exposure is unclear. One 1991 study found no gender difference in workers compensation claims for CTS. Another study found no gender difference in reporting of neck or upper extremity MSD symptoms among newspaper employees using video display terminals (VDTs).

In contrast, other studies have reported that neck and shoulder muscular pain is more common among females than males, both in the general population and among industrial workers.

An important study noted that significant gender differences in work posture were related to stature and concluded that the lack of workplace accommodation to the range of workers' height and reach may, in part, account for the apparent gender differences. Also, the fact that more women are employed in hand-intensive jobs and industries may account for the greater number of reported work-related MSDs among women. Another study reported that men were more likely to develop deQuervain's disease\* than women; they attributed this to more frequent use of hand tools.

\*DeQuervain's Disease is an irritation and swelling of the sheath or tunnel that surrounds the thumb tendons as they pass from the wrist to the thumb.

## PHYSICAL ACTIVITY



The relationship of physical activity and MSDs is more complicated than just “cause and effect.” Physical activity may cause injury. However, the lack of physical activity may increase susceptibility to injury, and after injury, the threshold for further injury is reduced.

We can define “fitness” for most physical activities as combinations of strength, endurance, flexibility, musculoskeletal timing and coordination. In a study of male fire fighters, physical fitness and conditioning appeared to have significant preventive effects on back injuries. However, the most fit group had the most severe back injuries.

When physical fitness is examined as a risk factor for MSDs, results are mixed. One study reported that only 7% of absenteeism could be explained by age, sex, and physical fitness. On the other hand, another study found that physical capacity was related to musculoskeletal fitness.

Although physical fitness and activity is generally accepted as a way of reducing work-related MSDs, the present epidemiologic literature does not give such a clear indication.

## STRENGTH

Some epidemiologic support exists for the relationship between back injury and a mismatch of physical strength and job tasks. One important study found a sharp increase in back injury rates in subjects performing jobs requiring strength that was greater or equal to their isometric strength-test values. The risk was three times greater in the weaker subjects.

A second study evaluated the risk of back injuries and strength and found the risk to be three times greater in the weaker subjects. They found that job matching based on strength criteria appeared to be beneficial.

In another prospective study, it was found that reduced strength of back flexor muscles was a consistent predictor of recurrent or persistent back pain, but this association was not found for first time occurrence of back pain.

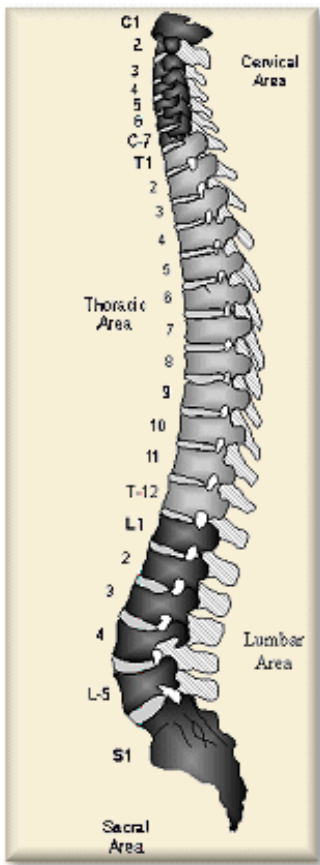


## Strength vs. energy of work: Which is most important?

Strength is important, but not necessarily the key. “Heavy work” stresses the heart and lungs which may result in rapid fatigue - general or localized. The probability of injury increases as muscles weaken. Consequently, demanding repetitive or static muscular work requires energy, not necessarily strength. You may be strong, but not have sufficient energy to do the task.

There are four factors that increase forces compressing the L5/S1 vertebrae together:

- Weight on the upper body
- Deviation of the an erect posture stance
- Weight of the load
- Pull of the lower back muscles



## ANTHROPOMETRY



Workers come in all shapes and sizes, and so designing for only the "average" person in one group or segment causes problems for everyone else who does not fit into that group.

Anthropometry studies the differences by measuring various body characteristics, including weight, physical range of mobility, and body dimensions. This information is then used by designers to engineer tools, equipment, furniture and workstations for maximum efficiency for each individual worker.

Weight, height, body mass index (BMI) (a ratio of weight to height squared), and obesity have all been identified in studies as potential risk factors for certain MSDs, especially Carpal Tunnel Syndrome (CTS) and lumbar disc herniation.

The relationship of CTS and BMI has been suggested to relate to increased fatty tissue within the carpal canal or to increased hydrostatic pressure throughout the carpal canal in obese persons compared with slender persons. Carpal tunnel canal size and wrist size has been suggested as a risk factor for CTS, however, some studies have linked both small and large canal areas to CTS.

Some studies have reported that people with back pain, are, on the average, taller than those without it. A Finnish population study found that height was a significant predictor of herniated lumbar disc in both sexes, but a moderately increased BMI was predictive only in men.

Severe obesity (exceeding 30 kg/m<sup>2</sup>) involved less risk than moderate obesity. One study found an association between obesity and radiological disc degeneration. However, another study of Finnish white collar and blue collar workers found no association between overweight, (relative weight >120%) and lumbosacral disorders either cross-sectionally or in a 10-year follow-up [Aro and Leino 1985].

Another study of workers in 11 factories found that short stature was significantly associated with pain in the neck and shoulder, but not in the back, forearm, hand and wrist. However in two other studies involving thousands of workers, height was not a factor for neck, shoulder or hand and wrist MSDs.

Anthropometric data are conflicting, but in general indicate that there is no strong correlation between stature, body weight, body build and low back pain. Obesity seems to play a small but significant role in the occurrence of CTS.

So there you have it. Not everything you need to know, but it's a start. The only task left is the module quiz, so let's get to it.

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## MODULE Review Quiz

11. Which of the following is not described in the text as a critical component which can lead to cumulative trauma disorders CTDs as well as other musculoskeletal disorders?

- a. level
- b. duration
- c. capacity
- d. frequency

12. The musculoskeletal system is made up of all of the following parts, except:

- a. Muscles
- b. Lymphs
- c. Tendons
- d. Nerves

13. By the age \_\_\_\_\_, most people have had their first episode of back pain:

- a. 25
- b. 35
- c. 45
- d. 55

14. The age groups with the highest rates of compensable back pain and strains are the \_\_\_\_\_ age group for men, and \_\_\_\_\_ age group for women.

- a. 30-34, 40-44
- b. 29-34, 39-44
- c. 25-29, 35-39
- d. 20-24, 30-34

15. It is clear that differences seen with some MSDs is due to physiological differences rather than differences in exposure:

- a. True
- b. False

16. One important study concluded that the lack of workplace accommodation to the range of workers' height and reach may, in part, account for the apparent gender differences.

- a. True
- b. False

17. When physical fitness is examined as a risk factor for MSDs, results are mixed. One study reported that \_\_\_\_\_ of absenteeism could be explained by age, sex, and physical fitness.

- a. 7%
- b. 14%
- c. 39%
- d. 54%

18. When physical fitness is examined as a risk factor for MSDs, results are clear that it is a way of reducing work-related MSDs.

- a. True
- b. False

19. Demanding repetitive or static muscular work requires energy, not necessarily strength:

- a. True
- b. False

20. Anthropometric data are conflicting, but in general indicate that there is strong correlation between stature, body weight, body build and low back pain.

- a. True
- b. False

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## MODULE THREE: RISK FACTORS INHERENT IN THE TASK

### Risk factors the task, itself, brings to the job

In addition to considering those worker attributes that may increase the risk of injury, we must also analyze those risk factors the job, itself, brings to the work. We look at the task variables in the workplace that may each increase or decrease the risk of CTDs depending on its design and location.

### In large measure, work processes are determined by:

Tools	Equipment
Furniture	Machinery
Materials	Workstation layout

### Design to reduce risk factors

The objective in designing and locating these workplace objects should be to reduce the following task risk factors. A number of questions need to be asked:

### How much force is required?



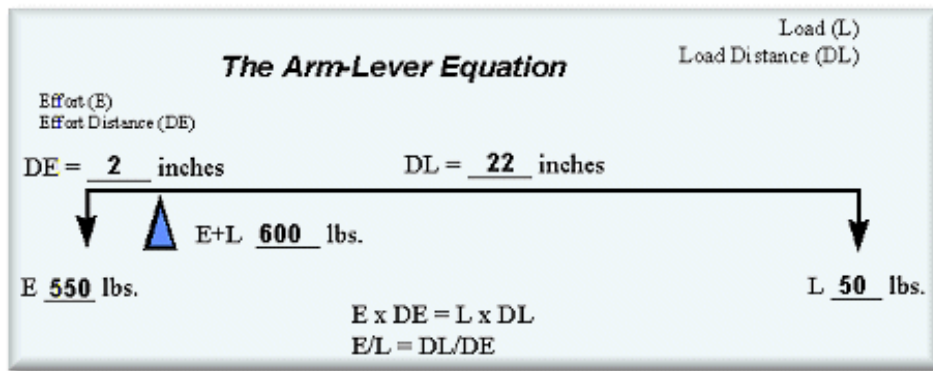
Forcefulness is the amount of physical effort required by the person to do a task and/or maintain control of tools and equipment. The effort depends on the type of grip, object weight, object dimensions, body posture, type of activity, slipperiness of object, temperature, pinching, vibration, duration of the task and number of repetitions. Using the body to move another object can result in forces being exerted on internal body tissues that can result in compression of the spine, tension within a muscle/tendon groups.

Examples of work activities that exert force on the body include lifting, lowering, pushing, pulling, pinching, pounding, hitting, and jumping.

### You're a lever!

Every time you lift, a lever action is accomplished that amplifies the compressive forces on the back. Take a look at the drawing below. Lifting 55 pounds at a distance from your shoulder (the fulcrum) of 22 inches will result in 550 pounds of compressive forces on the lower back.

Compressive forces on L5 / S1 disc exceeding 550 lbs. (250 kg.) causes four times the injuries than forces of less than 550 lbs. (The Joyce Institute, Principles and Applications of Ergonomics)



As you might guess, the greater the force required to do the work, the greater the degree of risk. Remember, too, that you must consider other risk factors (such as posture, velocity, repetition, and duration) in conjunction with force to accurately estimate the degree of risk of injury.

For instance, the likelihood of injury from pushing a 200 lb. cart would increase depending on the posture assumed while pushing. Common locations of injury due to exerting excessive force are the neck/shoulder, low back, foot/ankle and wrist/hand.

**There are five force-related conditions to consider which may increase the risk of injury.**

**Contact Trauma.** When any part of your body presses against an external object, the resulting sustained force may cause too much mechanical stress on tissues. It is also possible for excessive mechanical stress to be produced from the impact shock of an object against a part of the body.



**Grip.** There's a right way and a wrong way to grip an object. This combination of force and posture, if not accomplished correctly, may result in harm to the hand. Two basic grips are used when handling tools, equipment

or materials:

- The **Pinch Grip** which depends on the fingers to exert the force and manipulate the object. This grip strategy requires much greater muscle strength so it is more likely going to cause an injury.
- The **Power Grip** uses the muscles of the entire hand to apply force and manipulate objects. Consequently, it's the most effective, and safest, grip to use.

**Static Exertion.** Standing, sitting, or otherwise remaining in one posture for a long duration while you perform a task, can increase the likelihood of injury. Static exertion combines force, posture, and duration to create a condition that quickly fatigues our muscles which increases the chances of acquiring a cumulative trauma disorder (CTD). The greater the force, more awkward the posture, and longer the duration, the greater the risk.

**Symptoms of excessive static load**

<b>Symptoms</b>	<b>Possible Ergonomic Cause</b>
Feet, legs ache, varicose veins	Standing in one place too long.
Lower back pain	Trunk curved forward while standing or sitting.
Shoulder and arm pain	Arms outstretched, sideways, forward or upwards. Shoulders forced up due to position of work.
Neck pain	Head inclined too much backwards or forward.
Forearm pain	Unnatural grip. Static grip too forceful.
Wrist pain	Repetitive hand or finger motion.

**Gloves.** Have you ever worn thick leather gloves while trying to accomplish some kind of intricate manipulation of small objects? Try it: you will be frustrated. Whenever you wear gloves, more grip force is required to a particular task. With the need for more force, increased risk of injury is occurs.

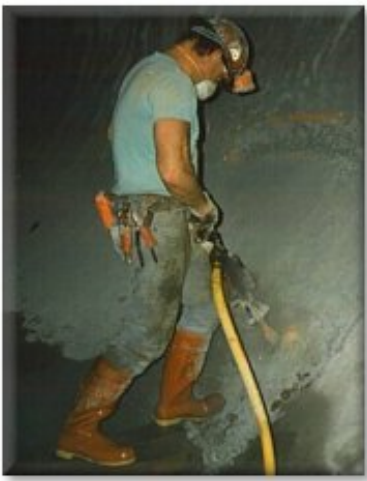
**Bulky clothes.** Wearing bulky clothes, like heavy rain gear or protective clothing for removing hazardous waste, will increase the effort required by muscles to do work. Any time you increase the force necessary to complete a task, risk of injury also increases.



**Segmental Vibration**

**Vibration**

When handling vibrating tools for a prolonged duration, vascular insufficiency in the hand and fingers which can also result in interference with sensory receptor feedback. If a worker can't "feel" the grip properly, he or she may compensate by applying more force than is necessary to hold and handle an object. Segmental vibration has also been linked to carpal tunnel syndrome.



## Repetition



Repetition is a measure of how frequently we complete the same motion or exertion during a task. The severity of risk depends on the frequency of repetition, speed of the movement or action, the number of muscles groups involved, and the required force. Repetitiveness is influenced by machine or line pacing, incentive programs, piece work and unrealistic deadlines. For instance, an experienced worker packing apples (piece work) may complete many more similar exertions or movements than a new worker. Unfortunately, he or she may be performing as such a rapid rate that they may be developing a CTD. Repetition, alone, is not an accurate predictor of injury. Other factors, like force, posture, duration, and recovery time must be considered.

## High Risk Repetition Rates by Different Body Parts

From Kilbom Å [1994]. Repetitive work of the upper extremity; Part II: The scientific basis for the guide. *Int J Ind Erg* 14:59–86.

Body Part	Repetitions Per Minute
Shoulder	More than 2½
Upper Arm/Elbow	More than 10
Forearm/Wrist	More than 10
Finger	More than 200

**Caution:** Do not to judge the risk of MSDs solely on the basis of repetition. Much depends on force and the postural factors that reflect the effort intensity of each action. In making risk determinations, NIOSH typically supplements repetition measurements with ratings of the forces being exerted and postural deviations of the body parts that may be involved. High repetitiveness, when combined with high external forces and extreme postures, probably represents the highest risk of MSDs.

## Duration



Duration is a measure of length of time of exposure to a risk factor. Of course, the assumption is that the longer the duration of exposure, the greater the risk of injury. Duration may be measured in seconds, minutes, hours, days, weeks, months, and even years.

As with most individual risk factors, duration must be considered along with other person, task, and environmental risk factors such as the physical conditioning of the worker, posture, force, weight, temperature, stress, etc.

### **Recovery time**

Recovery time is a measure of the rest (or low stress activity) period available to the muscle group between similar exertions. Recovery time is important in preventing muscle fatigue because oxygen and metabolites are allowed to rejuvenate while uric acid and other waste products are removed from the muscle group. Recovery time needed will lengthen as the duration of the task increases.

### **Posture**



Posture is the position of the body while performing work activities. Awkward posture is a deviation from the ideal working posture of arms at the side of the torso, elbows bent, with the wrists straight. Awkward postures typically include reaching behind, twisting, working overhead, kneeling, forward or backward bending, and squatting. If the posture is awkward during work, there is an increased risk for injury. The more the joint departs from the neutral position, the greater the likelihood of injury.

### **There are some specific postures that may be associated with increased risk of injury:**

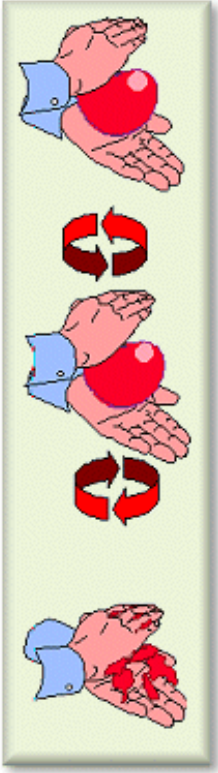
- Wrist flexion or extension which occurs regularly is associated with a greater risk of carpal tunnel syndrome.
- Ulnar deviation of the wrist of greater than 20 degrees increases the risk of pain and other disease.
- Shoulder abduction or flexion is greater than 60 degrees for more than one hour a day increases the risk of acute neck and shoulder pain.
- Hands working at or above shoulder level can result in increased risk of tendinitis and various shoulder disease.
- The greater the angle of flexion of the neck, the more quickly potentially severe neck and shoulder pain results.
- Bending at the lower back while working increases the likelihood of low back disorders.

### **Some rules to follow for sitting workstations:**

- The angle between the upper arm and the forearm should be 70 to 135 degrees.
- The angle between the upper and lower leg should be 60 to 100 degrees.
- The angle between the torso and the thigh should be 90 to at least 100 degrees.
- The feet should be placed flat on the floor.

### **Some rules to follow for standing workstations:**

- The work surface should be 2 - 4 inches below elbow height for precision work.
- The work surface should be 4 - 6 inches below elbow height for if lifting light weights and working with bins, tools and other materials.
- The work surface should be 6 - 16 inches below elbow height if lifting heavy weights.



### Twisting in the middle of a lift amplifies forces on the lower back.

Imagine placing a tomato between the palms of your hands and applying direct pressure. It might take a great deal of force to burst the tomato. However, give the motion a twist while applying the pressure, and it will take far less pressure to burst the tomato.

Twisting while lifting, pushing, pulling, lowering, or raising may have the same effect on the back. Consequently, if twisting while taking any of these actions exposes the back to much greater risk of injury.

### Velocity/Acceleration

Angular velocity is nothing more than the speed at which the body part moves. Acceleration is the rate of change of the speed at which the body part moves. For example, a drummer's hand/wrist may move very rapidly back and forth while drumming. The faster that back and forth motion occurs, the greater the risk of injury. Other factors like the weight of the object being moved, will also increase risk.



### Heavy Dynamic Exertion



Work requiring heavy physical exertion places a greater demand on the body's cardiovascular system to provide the necessary oxygen and metabolites to muscle tissue. If a muscle group's demand for metabolites and oxygen cannot be met, that muscle group will become fatigued, increasing the risk of injury. When the muscle is tired and sore, it's fatigued, and injury may more likely occur. If the entire body becomes fatigued, an actual cardiovascular failure may occur.

### Last Words

We've had quite a discussion of the risk factors associated with the task. I hope you have gained some information that will help you better consider ergonomic risk factors while conducting job hazard analysis.

Circle the correct answer to each quiz question below. Later you'll enter these answers on the Final Examination and Quiz page.

---

## MODULE Review Quiz

21. The amount of effort in performing a task depends on a number of factors. Which of the factors below is not mentioned in the text?

- a. Type of grip
- b. Object weight
- c. Object dimensions
- d. Fatigue

22. According to the Joyce Institute, compressive forces on the L5/S1 exceeding 550 lbs. causes \_\_\_\_\_ times the injuries than forces of less than 550 lbs.

- a. 2
- b. 4
- c. 6
- d. 8

23. According to the text, all of the following are common locations of injury due to exerting excessive force, except:

- a. neck/shoulder
- b. foot/ankle
- c. upper back
- d. wrist/hand

24. What condition exists when any part of your body presses against an external object and the resulting sustained force has caused too much mechanical stress on tissues?

- a. Mechanical trauma
- b. Recovery trauma
- c. Force trauma
- d. Contact trauma

25. This grip strategy to manipulate objects requires much greater muscle strength so it is more likely going to cause an injury:

- a. pinch grip
- b. power grip
- c. sustained grip
- d. intermittent grip

26. This form of exertion combines force, posture, and duration to create a condition that quickly fatigues our muscles which increases the chances of acquiring a cumulative trauma disorder (CTD):

- a. intermittent exertion
- b. repetitive exertion
- c. static exertion
- d. forceful exertion

27. If a worker can't "feel" the grip properly, he or she may compensate by applying more force than is necessary

to hold and handle an object:

- a. True
- b. False

28. This term describes a measure of the rest (or low stress activity) period available to the muscle group between similar exertions:

- a. rest period
- b. recovery time
- c. degree of recovery
- d. muscle group rest time

29. According to the text, awkward postures typically include all of the following, except:

- a. squatting
- b. working overhead
- c. bending
- d. standing

30. \_\_\_\_\_ is nothing more than the speed at which the body part moves and \_\_\_\_\_ is the rate of change of the speed at which the body part moves:

- a. angular velocity, acceleration
- b. acceleration, angular velocity
- c. angular acceleration, velocity
- d. velocity, angular acceleration

---

## MODULE FOUR: ENVIRONMENTAL RISK FACTORS

**What are risk factors the environment brings to the job?**

### Heat Stress



Externally generated heat in the workplace can cause an excessive total heat load on the body, which can result in heat stroke, a potentially life-threatening condition. Heat exhaustion, heat cramps, dehydration, electrolyte imbalance, and loss of physical/mental work capacity can also result from heat stress. Heat stress is made even more dangerous in the presence of high humidity due to the reduced ability of the body to cool itself.

High temperature conditions may be brought on by:

- Summer heat
- Tropical heat
- Heat from engines
- Heat from chemical processes and reactions
- Body heat
- Welding
- Friction

### Cold Stress

If the worker is exposed to an environment so cold that the body cannot maintain adequate deep core temperature, hypothermia, which can also be life-threatening, may result. Symptoms brought on by cold stress include shivering, clouded consciousness, pain in the extremities, dilated pupils, reduced grip strength and coordination, and possibly ventricular fibrillation.

Low temperature conditions may be caused by winter cold, high altitudes, refrigerated surfaces and/or cryogenic lines and equipment. These can result in muscle strain as well as cold "burns," frostbite, and hypothermia.



## Whole body vibration



When the whole body is subjected to vibration, as most commonly experienced by truck drivers, there is an enhanced risk of injury, especially to the lower back.

Whole-Body Vibration usually results from two types of forces acting on the worker.

- A non-cyclical force over a very short period of time (instantaneous shock load). A vehicle striking an obstacle or a sudden drop into a hole may produce these shock loads. If these shock loads are sufficiently great, the operator may be thrown from his seat or struck by objects flying around in the cab.
- The most common whole-body vibration forces are not sudden, but rather occur over a period of time. For example, this type of vibration is usually created by large vehicles as they travel over highways and especially terrain.

Duration of exposure plays a large role in the effects of vibration forces. Vibration forces delivered over time are more difficult to define than the instantaneous damage caused by high shock loads. The body will respond significantly to vibrations in the range of .5 to 80 Hz (Hertz, cycles/second). Certain parts of the body are resonant at various frequencies in this range. The body's response to vertical vibration will be greatest between 4 and 8 Hz, while vibrations between 2.5 and 5 Hz generate strong resonance in the vertebra of the neck and lumbar region. Vibrations between 20 and 30 Hz set up the strongest resonance between the head and shoulders. Prolonged exposure to these vibration forces in these frequency ranges may create chronic stresses and sometimes even permanent damage to the affected organs or body parts.

## Lighting

Lighting in one workstation may be appropriate, but for another workstation, that same lighting may be potentially harmful. Illumination may be too high, too low, or cause glare. Illumination levels above 1000 lux present such problems in the office environment.

Outside lighting is an important factor to consider. Light for outside work should aid production and, at the same time, be high enough to be safe.



Adequate general and local lighting must be provided for rooms, building and work areas during the time of use. Factors influencing the adequacy and effectiveness of illumination include the following:

- The quantity of light as specified in American National Standard ANSI A11.1-1965, "American Standard Practice for Industrial Lighting".
- The quality of light in terms of freedom from glare, and correct direction, diffusion and distribution.

- Freedom from shadows and extreme contrasts.
- All skylights, side windows, lamps and other accessories which are necessary for illumination must be kept clean, and in working order.

< It's interesting to note that lighting has been used to treat depression associated with light deprivation, and may also affect biological clocks and sleep patterns in humans. Although controversial, light has been used maintain alertness and to increase productivity in shift workers.

## Noise



Noise is any sound that is unwanted. It can be so powerful as to cause pain in the ears, or it may represent only a nuisance. Its pitch may be quite high or very low; its duration, continuous or intermittent; and its onset, sudden or gradual.

Exposure may lead to serious temporary or permanent deafness, tinnitus, paracusis, and other hearing disorders. The louder the noise and the longer the duration, the greater the risk of injury. Nuisance noise may interfere with a worker's ability to focus or concentrate on the work at hand, and may therefore, actually be the indirect cause of an accident.

OR-OSHA staff has measured and found sound levels produced by VDT workstations and associated equipment to be consistently below those that damage hearing. However, equipment noise can still be disruptive, annoying, or distracting, and many people are sensitive to the low-level, high-frequency noise that the Central Processing Unit (CPU) may emit. As a result, ambient sound levels should be kept below 55 decibels on the A-scale (dBA). Also, narrow-band tones above ambient sound levels should be reduced. It is good practice to isolate main CPUs and disk drives and provide noise-control covers on high-speed printers.

## Psychosocial Risk Factors

A healthy ergonomic work environment depends a great deal on the attitudes of those involved. How management handles or responds to problems or concerns relating to ergonomics may determine the development and the severity of many problems in the workplace. To create a healthy work environment, all parties should understand their roles in the overall work process; end users should participate in the selection of equipment, software, tools and accessories; and employers should provide adequate operator training on the setup, adjustments, and risks associated with performing the job.



In general, four plausible types of explanations have been suggested to account for associations between work-related psychosocial factors and MSDs.

- Psychosocial demands may produce increased muscle tension and exacerbate task-related biomechanical strain.
- Psychosocial demands may affect awareness and reporting of musculoskeletal symptoms, and/or perceptions of their cause. Within this second explanation may fall the "perverse incentive" view, in which societies may provide workers with systems (such as workers' compensation) that may lead to over-reporting of MSD symptoms.
- Initial episodes of pain based on a physical insult may trigger a chronic nervous system dysfunction, physiological as well as psychological, which perpetuates a chronic pain process.
- In some work situations, changes in psychosocial demands may be associated with changes in physical demands and biomechanical stresses, and thus associations between psychosocial demands and MSDs occur through either a causal or effect-modifying relationship.

Though the findings of the studies reviewed are not entirely consistent, they suggest that perceptions of intensified workload, monotonous work, limited job control, low job clarity, and low social support are associated with various work-related MSDs. As some of these factors are seemingly unrelated to physical demands, and a number of studies have found associations even after adjusting for physical demands, the effects of these factors on MSDs may be, in part or entirely, independent of physical factors.

Epidemiologic studies of upper extremity disorders suggest that certain psychosocial factors (including intensified workload, monotonous work, and low levels of social support) have a positive association with these disorders. Lack of control over the job and job dissatisfaction also appear to be positively associated with upper extremity MSDs, although the data are not as supportive.

There is also increasing evidence that psychosocial factors related to the job and work environment play a role in the development of work-related MSDs of the upper extremity and back.

### Last Words

There you have it! I hope you have a better understanding of the environmental risk factors impacting MSDs and that you'll be able to apply that knowledge in your workplace. We'll find out, because now it's time complete the quiz below.

---

## MODULE Quiz

31. Heat stress can result in:

- a. Heat exhaustion
- b. Heat cramps
- c. Dehydration
- d. All of the above

32. Heat stress is made even more dangerous in the presence of \_\_\_\_\_ due to the reduced ability of the body to cool itself.

- a. low humidity
- b. high humidity
- c. greater exertion
- d. higher force

33. This condition may result if the worker is exposed to an environment so cold that the body cannot maintain adequate deep core temperature:

- a. hyperthermia
- b. hypothermia
- c. hyperthermitis
- d. hypothermitis

34. Which of the following is not mentioned in the text as one of the symptoms brought on by cold stress?

- a. pulmonary pain
- b. dilated pupils
- c. ventricular fibrillation
- d. shivering

35. The most common whole-body vibration forces are sudden, rather than that occurring over a period of time.

- a. True
- b. False

36. The body's response to vertical vibration will be greatest between \_\_\_\_ Hz:

- a. 2 and 4
- b. 4 and 8
- c. 8 and 10
- d. 10 and 12

37. Factors influencing the adequacy and effectiveness of illumination include the following, except:

- a. freedom from concentration
- b. freedom from diffusion
- c. freedom from glare
- d. freedom from shadows

38. Nuisance noise is not considered an environmental risk factor that may interfere with a worker's ability to focus or concentrate on the work:

- a. True
- b. False

39. According to the text, to create a healthy work environment that reduces the risk of ergonomics injuries, management should do all of the following, except:

- a. understand roles
- b. allow participation
- c. secure compliance
- d. conduct adequate training

40. Which of the following are not mentioned as employee perceptions associated with various work-related MSDs.

- a. intensified workload
- b. limited job control
- c. monotonous work
- d. poor labor-management relations

---

## MODULE FIVE: CONTROLLING RISK FACTORS

### Rid the job of risk factors

Ergonomic improvements are changes made to improve the “fit” between a job and the capabilities of the employees performing it. Analyzing jobs to identify factors associated with risks for MSDs lays the groundwork for developing ways to reduce or eliminate ergonomic risk factors for MSDs.

### Types of Controls

The following control measures are widely accepted as intervention strategies for controlling workplace ergonomic hazards:

- **Engineering Controls.** Reduce or eliminate potentially hazardous conditions through design, redesign, substitution, and replacement.
- **Management Controls.** Change work procedures and scheduling to reduce exposure to the hazard.
- **Interim Measures** Temporary use of engineering and/or management controls until permanent controls are in place.

### 1. Engineering Controls

Engineering controls involve making changes to workstations, tools or equipment used on the job. These controls are preferred over all others because they make permanent changes that can totally eliminate hazards at the source. Although they may be more expensive to implement than other controls, their effect is often more significant.

Let's take a look at some of the various engineering control strategies that may be effectively used to eliminate hazards.



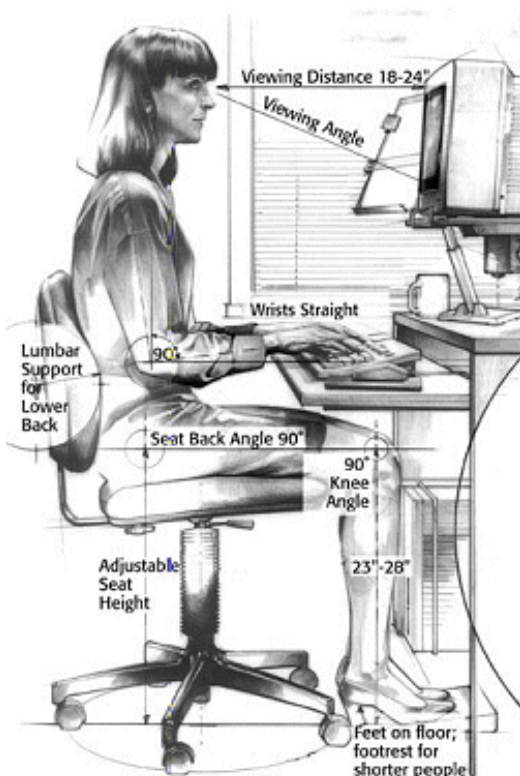
## Workstation design

Aspects of workstations you can change with engineering controls include:

- workspace layout
- work surfaces
- standing and walking surfaces
- seating
- storage
- work fixtures
- work environment

## Computer workstations

Computer workstations have special considerations you should be aware of. The monitor and keyboard positions, lighting and seating are especially important in preventing work-related MSDs and eye discomfort. Shared workstations should be easily adjustable so the screen and keyboard can be at the proper level. Take a look at some specific [workstation design considerations](#) and [problems/solutions](#) for computer workstations.



There are five components of proper computer workstation design that you must address to maintain proper posture: the work surface, the keyboard, the pointing device or trackball, the monitor and the chair.

### Work Surfaces

- Surface needs to be deep enough to allow proper keyboard positioning and to accommodate a monitor viewing distance of 18-24".
- Surface needs to be wide enough to accommodate keyboard, mouse and reference material.
- Surface height (or keyboard height independent of the main surface) should be adjusted for the user or adjustable for multiple users.
- Avoid resting your wrists on a hard or sharp surface (use a wrist rest if necessary).
- Leave enough leg room to allow your legs to move freely.

## Keyboards

Should be thin and detachable. Must be positioned low enough to keep wrists straight, shoulders relaxed, and elbows angled between 90 and 120 degrees. (A wrist rest can help you maintain straight wrists.) Alternative keyboards now on the market provide additional options which may alleviate discomfort.

### **Mouse or Trackball**

Should be within easy reach and at the same height as the keyboard. Trackballs may be a better alternative because they eliminate some arm movement required by the mouse.

### **Monitors**

Should be positioned so that the top of the screen is slightly below eye level, for a viewing angle of about 30 degrees. The viewing distance should be 18-24".

### **Chairs**

Should have adjustable back support that presses firmly against your lower back and extends at least up to mid-back. Should have an easily adjustable seat height to permit your feet to rest flat on the ground with a knee angle of roughly 90 degrees. (some people might need a foot rest to achieve this angle.) Should have a rolling, five-pronged base for stability and to prevent unnecessary twisting. Should have adjustable padded arm rests to support the weight of the shoulders and the arm. Should have an adjustable seat pan to allow the computer user to work comfortably in a forward or reclined position.

### **Workspace layout**

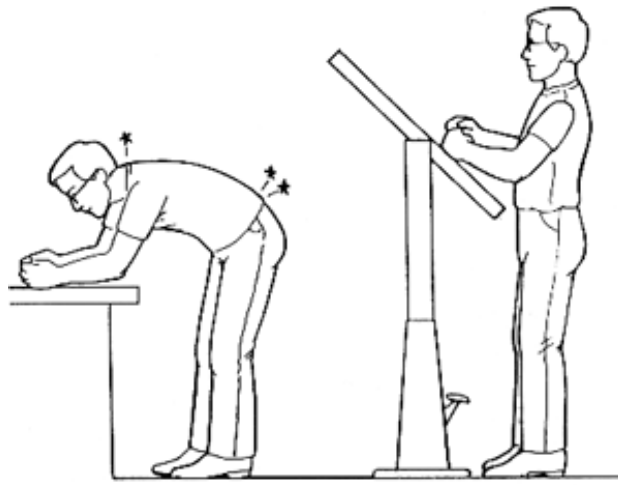
Workspace layout and arrangement should be carefully designed so that it meets the following requirements:

- The workspace should be adjustable to fit each worker's size.
- The worker should be able to maintain the neutral position and avoid awkward or extended reaches and jerky movements while performing the task.
- A full range of motion with adequate leg room, as well as a variety of working positions to avoid static postures should be provided.
- The worker should have adequate space for access to all necessary tools and equipment, and frequently used tools should be within easy reach.

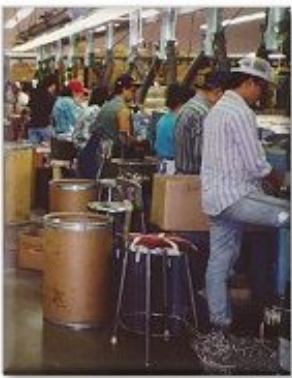
### **Work surfaces**

- Work surfaces should be at the proper height and angle for the individual worker's size and tools and equipment used.
- They should permit neutral postures and be adjustable, especially where different kinds of tasks are performed or the workstation is shared.

For example, where workers inspect or assemble small parts, or perform other visually intensive task, work surfaces could be tilted to reduce neck, shoulder and arm strain.



## Walking and standing surfaces



Surfaces on which people stand for long periods should be designed to prevent slipping and provide adequate traction and comfort. Anti-fatigue floor mats, sit-stand stools, and footrests can help make workers more comfortable.

## Seating

Seat-height adjustability and lower back support are important for work done for a long time while seated. Some workers may choose to sit part of the time and stand other times to reduce stress on the body from working in one position too long. Chairs or seating should:

- Adequately support the back and legs.
- Have padded seats.
- Have separately adjustable back and seat cushions.
- Permit feet to be supported either on the floor or with a foot rest.
- Be easily adjustable while seated.
- Be able to swivel for most tasks.
- Isolate the worker from whole-body vibration.
- Have adjustable arm support when appropriate.

## Storage

Storage areas should be organized so that workers maintain good body positions, reduce muscular forces and avoid excessive reach. Store heavy items between knee and shoulder height and frequently used items close to the worker.

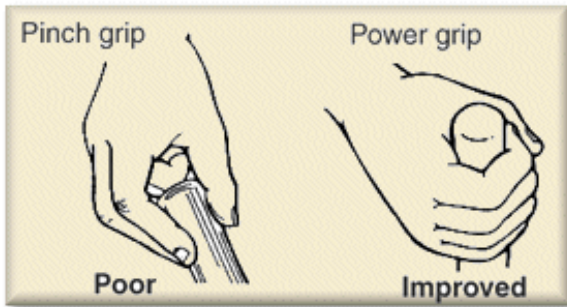
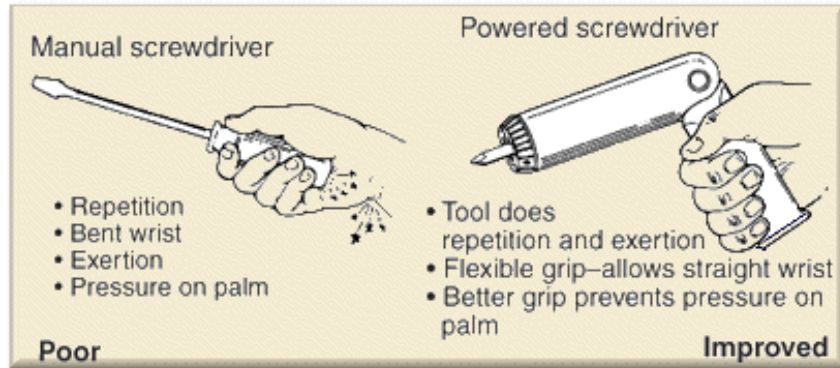
## Work fixtures

Workers should not have to use their hands or bodies as a vise to hold objects; mechanical devices do this much better. Tooling fixtures and jigs should be set up to avoid awkward postures and excessive forces.

Improper hand tool selection or improper use of tools can cause CTDs. Hand tools should fit the

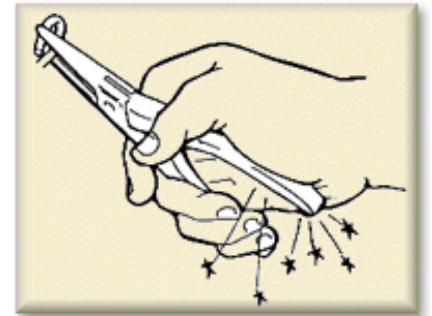
employee's hand; employees with small hands or who are left-handed may need tools designed specifically for these situations. Hand and wrist posture are important because they affect how much force the muscles must produce to hold objects. When selecting and purchasing hand tools, these guidelines should be followed:

Select tools that allow the wrist to be held straight and that minimize twisting of the arm and wrist. Good working posture can be maintained when properly designed tools are used.



Select tools that allow the operator to use a power grip, not a pinch grip. Minimal muscle force is required to hold objects in a power grip posture. The pinch grip requires excessive fingertip pressure, and can lead to a CTD.

Avoid tools that put excessive pressure on any one spot of the hand (i. e., sides of fingers, palm of the hand).



For power or pneumatic tools, select tools with vibration dampening built in whenever possible. Provide personal protective equipment such as gel-padded gloves to reduce exposure to vibration.



## Work environment

Workplace environmental factors interact with those the worker and the task bring to the job, and deserves careful consideration. Methods to minimize work-environment hazards include:

- Isolating equipment or operations that produce loud or distracting noise.
- Making [lights](#) bright enough without causing glare.
- Isolating hands and feet from cold.
- Reducing whole-body vibration while riding in vehicles or standing near equipment.
- Isolating workers from excessive [heat](#) by providing adequate cooling and ventilation.

## 2. Management Controls



Management controls are management-dictated procedural and scheduling changes designed to reduce or prevent exposures to ergonomic risk factors. Although engineering controls are preferred, management controls may be needed as well, especially when engineering controls can not totally eliminate a hazard or when engineering controls are not technically feasible. Since management controls do not eliminate hazards, managers must continually ensure safe procedures and policies are followed to make sure exposure to hazards is minimized.

Common examples of management control strategies for reducing the risk of MSDs are as follows:

- **Safe procedures** that maintain workers in neutral postures, and reduce frequency, duration, and severity of exposure to risk factors. Lifting, carrying, pushing or pulling objects can strain the back, arms and shoulders. Strength and lifting limits should not be exceeded; extreme muscular exertion can cause injury. [Effective lifting techniques](#) should always be used.
- **Broadening or varying the job content** to offset certain risk factors (e.g., repetitive motions, static and awkward postures).
- **Adjusting the work pace** to relieve repetitive motion risks and give the worker more control of the work process.
- **Training in the recognition of risk factors** for MSDs and instruction in work practices that can ease the task demands or burden.
- **Requiring the use of Personal Protective Equipment (PPE)** while performing tasks.

**Reducing shift length or curtailing the amount of overtime.**

- **Rotating workers** through several jobs with different physical demands to reduce the stress on limbs and body regions.
- **Scheduling more breaks** to allow for rest and recovery.

## Work rates

The capacity of workers should be considered in establishing production goals. Increased work rates, excessive overtime and incentive programs for piece work can cause fatigue, increasing the chance for injury.

## Job Enrichment

Tasks involving repetitive motion are major contributors to CTDs. You can minimize repetition by:

- Using automation, such as in stapling, sorting, labeling or filling operations.
- Changing the job to include tasks that don't use the same muscle groups.

For example, in a check-sorting operation, instead of having one person open mail, another take stamp them and yet another record the figures, each worker could do each of those tasks.

### Personal Protective Equipment

One of the most controversial questions in the prevention of MSDs is whether the use of personal equipment worn or used by the employee (such as wrist supports, back belts, or vibration attenuation gloves) are effective. Some consider these devices to be personal protective equipment (PPE).

In the field of occupational safety and health, PPE generally provides a barrier between the worker and the hazard source. Respirators, ear plugs, safety goggles, chemical aprons, safety shoes, and "hard hats" are all examples of PPE. Whether braces, wrist splints, back belts, and similar devices can be regarded as offering personal protection against ergonomic hazards remains open to question.

Although these devices may, in some situations, reduce the duration, frequency, or intensity of exposure, evidence of their effectiveness in injury reduction is inconclusive. In some instances they may decrease one exposure but increase another because the worker has to "fight" the device to perform his or her work. An example is the use of **wrist splints** while engaged in work that requires wrist bending.

On the basis of a review of the scientific literature completed in 1994, NIOSH concluded that insufficient evidence existed to prove the effectiveness of **back belts** in preventing back injuries related to manual handling job tasks [NIOSH 1994]. A recent epidemiological study credits mandatory use of back belts in a chain of large retail hardware stores in substantially reducing the rate of low back injuries [Kraus 1996]. Although NIOSH believes this study provides evidence that back belts may be effective in some settings for preventing back injuries, NIOSH still believes that evidence for the effectiveness of back belts is inconclusive. More on [backbelts](#) [Still more!](#).



Less controversial types of personal equipment are vibration attenuation **gloves** [NIOSH 1989] and **knee pads** for carpet layers [Bhattacharya et al. 1985]. But even here, there can be concerns. For example, do the design and fit of the gloves make it harder to grip tools?

### 3. Interim Measures

Interim measures are nothing more than temporary applications of engineering and/or management controls until more permanent solutions can be applied. For instance, if a computer monitor is too low, placing a phone book under the monitor might be an effective temporary solution. Having two people lift heavy objects until a pneumatic lift can be purchased is another example of a temporary fix to the problem.

### Safety System Improvements

An effective ergonomics program operates within a larger safety management system that is composed of many interrelated programs. Each program or "subsystem" includes specific processes that may not interrelate directly to ergonomics. When hazardous conditions and unsafe behaviors exist, it's usually because the safety management system is failing somehow. These failures represent the root causes for accidents and may be categorized as follows:

- **Design root causes.** Inadequate design of the safety management system. The development of written safety plans, policies, processes, procedures and practices is very important to make sure appropriate conditions, activities, behaviors, and practices occur.
- **Implementation root causes.** Failure to carry out the plan as designed. Failure to effectively implement the safety management system is critical to the success of the system. You can develop a wonderfully designed system, yet if it's not implemented correctly, it won't work.

A missing or inadequate component in any one of these subsystem processes might negatively impact on ergonomics. Examples of safety subsystems include:

- Safety training
- Safety accountability
- Hazard identification and control
- Employee involvement
- Incident/Accident investigation
- Safety communications
- Evaluation and improvement

Missing or inadequate safety system components may represent the root causes for ergonomic injuries. Hazardous conditions and unsafe behaviors represent the outward **symptoms** that give clues about the underlying safety system weaknesses. Therefore, every effort should be made to improve system components to ensure long term workplace safety.

Making safety system improvements might include some of the following:

- Including "safety" in a mission statement.
- Improving safety policy so that it clearly establishes responsibility and accountability.
- Changing a work process so that checklists are used that include safety checks.
- Revising purchasing policy to include safety considerations as well as cost.
- Changing the safety inspection process to include all supervisors and employees.

Notice that in each example we are describing a missing or inadequate process, policy, procedure, plan, or program that may or may not be directly related to ergonomics.

## Last Words

Controlling ergonomics hazards requires a balanced approach of both engineering and management control strategies. It's an ongoing effort that needs the help of everyone in the organization. Now it's time to draft your answers to the quiz questions below.

---

## MODULE Quiz

41. Which of the three ergonomics control strategies is only temporary?

- a. Technical Controls
- b. Engineering Controls
- c. Management Controls
- d. Interim Measures

42. Which of the three ergonomics control strategies is most effective?

- a. Technical Controls
- b. Engineering Controls
- c. Management Controls
- d. Interim Measures

43. Which of the three ergonomics control strategies attempt to permanently reduce exposure to an existing hazard?

- a. Technical Controls
- b. Engineering Controls
- c. Management Controls
- d. Interim Measures

44. Which of the following is not listed as a component of proper computer workstation design you must address to maintain proper posture?

- a. the printer
- b. the work surface
- c. the keyboard
- d. the chair

45. For proper work surface design, all of these factors should be considered, except:

- a. deep enough
- b. wide enough
- c. high enough
- d. flat enough

46. Changing work procedures and schedules describe which ergonomics control strategy?

- a. Engineering Controls
- b. Management Controls
- c. Personal Protective Equipment
- d. Interim measures

47. According to the text, effective and safe procedures should incorporate each of the following ergonomics goals, except:

- a. decrease recovery time
- b. maintain neutral postures
- c. reduce duration of exposure
- d. reduce frequency of exposure

48. One of the most controversial questions in the prevention of MSDs is whether the use of interim measures are effective.

- a. True
- b. False

49. When hazardous conditions and unsafe behaviors exist, it's usually because:

- a. employees lack common sense at work
- b. employees have poor attitudes
- c. managers don't care about employees
- d. the safety management system has failed

50. According to the text, inadequately developed written safety plans, policies, processes, procedures and practices describes this safety management system failure:

- a. system implementation failure
  - b. system design failure
  - c. system personal failure
  - d. system management failure
- 

## ASSIGNMENTS

**Important Tip!** Writing drafts first, either offline or online, before submitting coursework, will help improve the quality of your work. On a sheet of paper, write your first draft responses for the following assignments. When finished, return to the online assignments page, enter your final coursework, and complete the course evaluation and certificate information.

See [Appendix B](#) for help in answering the extended response assignments.

**Assignment 1: Discuss and give at least one example of the risk factors in the person, task, and environment that might increase the risk of injury.**

**Assignment 2: Both workers below work 8-hour shifts. Which job below presents greater task and environmental risk factors to the worker? Discuss at least three risk factors that justify your conclusion.**



Scraping paint



Sewing garments

Hint. For this assignment, assume both worker bring the same personal risk factors. Focus on risk factors the **job** and **environment** present.

**Assignment 3: Describe at least one engineering control and one management control that might be used to make your current or previous job more ergonomically correct for you.**

**Hey, great job!** You've completed all the modules. I hope the information within these five modules as been helpful to you and I hope to see you participate in another course soon. When you're ready, go back online to the Course Outline page, scroll down and click on the Final Assignments and Quiz Page to enter and submit your coursework, evaluation, and certificate information. I'll see you in a workshop or another internet course! If you have any questions or comments, just drop me an email directly at [steve.j.geigle@state.or.us](mailto:steve.j.geigle@state.or.us).