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Ergonomics and Risk Factor Awareness Training for Miners

Department of Health and Human Services
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National Institute for Occupational Safety and Health

Information Circular 9497

Ergonomics and Risk Factor Awareness Training for Miners

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OVERVIEW

Introduction

Ergonomics is the science of fitting the work task to the user. It seeks to prevent serious injury by considering designs that accommodate the abilities and limitations of people.

Many workers perform tasks that involve exposure to ergonomic risk factors. Musculoskeletal disorders (MSDs) resulting from such exposure account for one-third of all occupational injuries and illnesses reported to the U.S. Bureau of Labor Statistics. MSDs are a type of injury that can take a long time to develop (i.e., they are a cumulative type of injury) and are associated with more lost time and higher compensation costs than other types of injuries. Exposures to risk factors can lead to the development of permanent, disabling injuries, and illnesses that may prevent workers from returning to their jobs and performing simple tasks that are part of their everyday routine. Reducing and eliminating risk factors will lead to healthier employees.

Ergonomics is about putting “people first.” It is a way to better match tools, equipment, and work methods with workers. The application of ergonomics should be practical. It should benefit workers through better task designs and work procedures. Increasing the awareness of mining personnel to the benefits of applying ergonomics allows both management and employees to work together to gain significant benefits to worker health. Research has shown that ergonomics is most successful when it is approached as a participatory process—management and employees working together to modify job tasks, including equipment, tools, environment, and methods. The first step toward achieving a participatory process is to give employees knowledge of ergonomics and how it can be used to align their jobs to their abilities.

The overall objective of Ergonomics and Risk Factor Awareness Training is to help reduce injuries and illnesses resulting from exposures to risk factors. Specifically, this training will increase awareness of risk factors and encourage miners to take action to report and reduce their exposures to risk factors.

Content

This training is designed specifically for the mining industry. Because mining is a diversified industry, examples representing both surface and underground mining processes for several different commodities and support services are incorporated into the training. This training package includes two components:

- **Ergonomics and Risk Factor Awareness Training for Instructors**

  The training is designed to give instructors sufficient information about ergonomics and risk factors to allow them to adequately present similar training to employees. It includes information that should allow the instructor to respond to questions regarding material included in training given to other employees.

- **Guide to Conducting Ergonomics and Risk Factor Awareness Training**

  This guide will assist the instructor in conducting the Ergonomics and Risk Factor Awareness Training. It includes examples of slides, along with discussion notes, descriptions of demonstrations, equipment needed for demonstrations, and suggested references. Suggested handout materials and training evaluation forms are also included in this guide.

Training Topics

This training includes four topics relevant to gaining a basic understanding of ergonomics, as well as how it applies to mining jobs. The last section contains interactive exercises that require trainees to apply what they learned in the previous topics.

Topic 1: Introduction to Ergonomics

This topic defines ergonomics and provides an example of using ergonomics to solve a problem. There is also a discussion on the benefits of using ergonomics to improve jobs.

Topic 2: Musculoskeletal Disorders

This topic defines cumulative trauma disorders or work-related musculoskeletal disorders and describes how a worker may progress from experiencing discomfort to developing a permanent, debilitating injury. The discussion includes three examples of this type of disorder.

Topic 3: Risk Factors and Root Causes

This topic presents descriptions and examples of ergonomic risk factors and their root causes. The four main risk factors receive special emphasis: forceful exertions, awkward postures, repetition, and vibration.

Topic 4: Prevention

This topic includes information about ways to control risk factors using engineering controls, administrative controls, work practices, or personal protective equipment (PPE).

Exercises

The exercises give trainees an opportunity to apply the knowledge gained in the previous sections. The participants review a video and then identify risk factors, potential body parts affected, root causes, and potential methods for controlling the risk factors

Performance Objectives

The following are objectives specific to each topic included in the training.

Topic	Objectives
Introduction to Ergonomics	· Understand that ergonomics is a science. · Know that ergonomics seeks to design and organize the workplace to better match the capabilities and limitations of workers.
Musculoskeletal Disorders	· Identify the similarities and differences of acute and cumulative type injuries. · Identify common cumulative trauma disorders. · Identify and discriminate the signs and symptoms of cumulative-type injuries.
Risk Factors and Root Causes	· Identify and discriminate between the common ergonomic risk factors that can contribute to signs, symptoms and cumulative trauma disorders. · Recognize and evaluate (from the video exercise) common ergonomic risk factors found in the workplace.
Prevention	· Select, apply, and discuss engineering controls, administrative controls, and PPE to reduce ergonomic risk factors. · Discuss applying ergonomics to your workplace. Identify examples.

File Formats

The information included in this guide is offered in two formats: electronic files and hard copies. The electronic files include:

- Ergonomics and Risk Factor Awareness Training for Instructors (Web and Adobe® PDF formats)
- Materials needed for conducting Ergonomics and Risk Factor Awareness Training
    - Slide presentations (Microsoft® PowerPoint and Adobe® PDF formats)
    - Documents that may need to be copied, such as handouts and evaluation forms (Microsoft® Word, RTF, or Adobe® PDF formats)
    - Discussion notes (Adobe® PDF formats)

All of the above electronic files, except for the training for instructors, are also provided in print formats. Instructions for accessing the training for instructions are included in the next section of this guide. Although a hard copy of this training can be printed from the PDF file provided on the enclosed CD, it is recommended that the Web format be used to complete this training because of the many videos and interactive exercises included in this training,

ERGONOMICS AND RISK FACTOR AWARENESS TRAINING FOR INSTRUCTORS

Purpose of This Training

This training will provide a trainer with sufficient information that will allow him/her to conduct a similar, but shorter version of the training for others.

Who Should Take This Training

Anyone who has not had any training in ergonomics should take this training. It would also be helpful for individuals who have had training, but their training either did not apply specifically to mining or did not emphasize the reporting of risk factor exposures.

Outline of Training Topics

Part 1 – Ergonomics

- What is ergonomics?
- It's job design
- Job design example
- It's how you do a job
    - Lifting
    - Using handtools
    - Using joysticks
    - Sitting postures
    - Standing postures
- Benefits of ergonomics
- Ergonomics summary
- Ergonomics review

Part 2 – Musculoskeletal Disorders (MSDs)

- What are MSDs?
- Acute versus cumulative
- MSD example
- Trigger finger
- Carpal tunnel syndrome
- Tennis elbow
- Symptoms of MSDs
- Signs of MSDs
- Injury progression
- MSDs summary
- MSDs review

Part 3 – Risk Factors

- What is a risk factor?
- Risk factor effects
- Ergonomic risk factors

    - Forceful exertions

        - Heavy or frequent lifting
        - Forceful gripping
        - Pushing or pulling

    - Awkward or static postures

        - Reaching
        - Twisting the head
        - Stooping
        - Kneeling or squatting
        - Static postures

    - Repetitive motions

        - Using equipment controls
        - Using handtools
        - Computer use

    - Vibration

        - Hand-arm vibration
        - Whole-body vibration
        - Jolting and jarring

- More ergonomic risk factors
- Root causes
- Root causes and ergonomics
- Risk factors and root causes
- Risk factors answers
- Root causes answers
- Risk factor summary
- Risk factors review

Part 4 – Prevention

- How to prevent MSDs
    - Reporting risk factors
- Don’t focus on injuries!
- Target risk factors
- Controlling risk factors
    - Engineering controls
    - Administrative controls
    - Personal protective equipment
- Prevention summary
- Prevention review

Part 5 – Exercises

- Exercise instructions
- Risk factor review
- Exercises

More Information

- Useful links
- Contact the authors

Glossary

How to Take This Training

Screen Resolution

The best screen resolution to view the site is **1,024×768** or better.

The minimum screen resolution to effectively view the site is **800×600**. At this resolution, you can improve readability by running your browser in Full Screen Mode (use the **View/Full Screen** menu option on your Web browser, or press **F11**.)

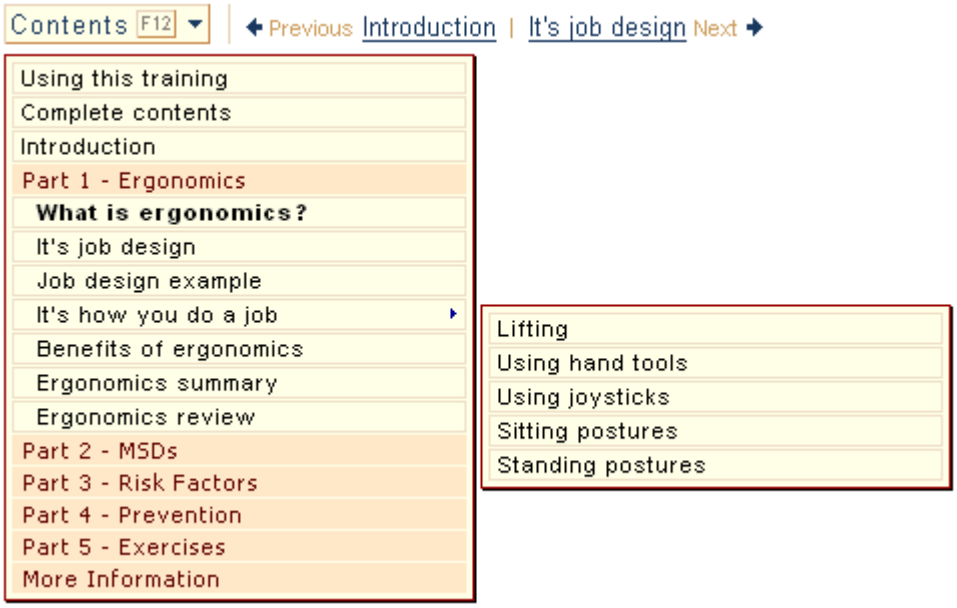
Text Size

If you use a screen resolution greater than **1,024×768**, you may want to increase the text size to improve viewing. The list below describes the menu options used to change text size in several Web browsers.

Internet Explorer 6+	View > Text Size
Firefox 1+ (Mozilla)	View > Text Size > Increase Ctrl++ / Decrease Ctrl+-
Netscape 7+	View > Text Zoom

Site Navigation

Every page on this site has a **Contents** menu like the one that appears under the title of this page. Click the **Contents** button, or press the **F12** key, for a drop-down menu that provides access to every major page of the site. When you access the **Contents** menu by pressing the **F12** key, you can move around the menu options with the arrow keys, select a menu option by pressing **Enter**, or exit the menu by pressing the **F12** key again. To the right of the **Contents** menu are the ordered **Navigation Links**, which provide access to the Previous and Next pages of the training. In some cases, the **Navigation Links** will take you up a level to a previous page.



Example of the dropdown Contents menu and ordered Navigation Links.

Direct Page Access Using Keyboard Shortcuts

The Up, Next, and Previous pages in the **Navigation Links** can be accessed directly from the keyboard. Under Windows, press ALT + Access Key. On Macs, press Control + Access Key. (NOTE: In Internet Explorer, you must press **Enter** after the access key combination):

Page	Access Key
Up	u
Next	n
Previous	p

In addition, the following pages can be accessed directly from the keyboard:

Page	Access Key
Exercise Index	1
Using This Training (this page)	2

PDF Files

This site uses Adobe Acrobat® PDF files. You can download the free Adobe Reader from Adobe Systems at http://www.adobe.com/prodindex/acrobat/readstep.html.

The entire training exercise is available as a PDF document formatted for printing. The link to the PDF file is in the upper right-hand corner of each page.

Verified Browser Compatibility

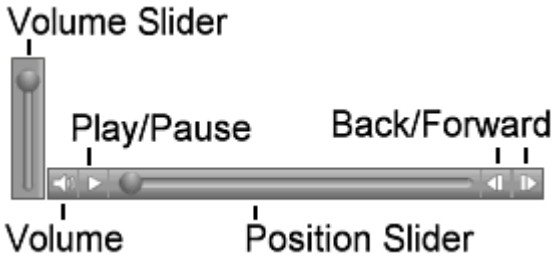
- Microsoft Internet Explorer 6 or greater
- Mozilla Firefox 1.5 or greater
- Netscape 8 or greater

Playing Movies

The Macromedia Flash Player is used for the videos and some of the illustrations. If you need the player and are connected to the Internet, you can download it by using this link: http://www.macromedia.com/go/getflashplayer/.

The illustration below shows the video controls:

- **Play/Pause** – Start and stop the video.
- **Back/Forward** – Advance the video backwards or forwards a frame at a time.
- **Volume** – Displays the Volume Slider.
- **Volume Slider** – Drag the button to set the volume for videos with sound.
- **Position Slider** – Drag the button to move forward or back through the video.



GUIDE TO CONDUCTING ERGONOMICS AND RISK FACTOR AWARENESS TRAINING

Purpose of This Guide

The information included in this section will provide a trainer with materials sufficient to conduct a similar, but shorter version of the Ergonomics and Risk Factor Awareness Training for Instructors.

Training Topics

Training materials provided in this guide are for the same topics as those included in the Ergonomics and Risk Factor Awareness Training for Instructors. However, some of the topics have been shortened so that this training could be given in two 60-minute sessions. The topics were divided into two parts, and a homework assignment was added that reinforces knowledge gained during the first part. The homework assignment is reviewed during the second part.

Part 1
- Introduction to Ergonomics
- Musculoskeletal Disorders
- Risk Factors
- Homework Assignment

Part 2
- Risk Factors (short review)
- Root Causes
- Prevention
- Exercises
- Review Homework Assignment

Outline of Training Topics

Part 1 – Ergonomics

- What is ergonomics?
- It's job design
- Job design example
- Benefits of ergonomics
- Ergonomics summary

Part 2 – Musculoskeletal Disorders (MSDs)

- What are MSDs?
- Acute versus cumulative
- MSD example
- Symptoms of MSDs
- Signs of MSDs
- Injury progression
- MSDs summary

Part 3 – Risk Factors and Root Causes

- What is a risk factor?
- Risk factor effects
- Ergonomic risk factors
  - Forceful exertions
  - Awkward or static postures
  - Repetitive motions
  - Vibration
- More ergonomic risk factors
- Root causes
- Root causes and ergonomics
- Risk factors and root causes
- Risk factor summary
- Homework assignment

Part 4 – Prevention

- How to prevent MSDs
- Controlling risk factors
  - Engineering controls
  - Administrative controls
  - Personal protective equipment

Part 5 – Exercises

Materials Included in This Guide

This guide includes several mining industry-specific resources to assist trainers at being effective at transferring knowledge about ergonomics and ways to improve jobs:

- Electronic version of the Microsoft® PowerPoint presentation
- Hard copy of the Microsoft® PowerPoint presentation
- Detailed notes, suggested demonstrations, and reference citations (Web links, books, and articles) for each slide
- Handouts for the employees attending the training
- Evaluation forms for obtaining feedback from trainees

How to Conduct This Training

Present this training in small group sessions (20–30 trainees). Make sure you are very familiar with the information on each slide so you do not simply read the information. You can use examples of experiences from your own site; workers will relate better to examples that are familiar to them. Use the graphics and the bulleted information on the slides to focus the information given during your presentation. The notes provided for each slide include additional information and demonstrations to enhance your discussion. Practice the demonstrations *before* the training.

Give the training in two sessions. The first should cover the first three topics, while the second session covers the last topic and the interactive exercises. Keep the time between the two sessions short so that only a brief review is necessary at the beginning of the second session. Also, give a homework assignment at the end of the first session. The homework assignment encourages trainees to look at their jobs and to identify potential risk factor exposures using the knowledge gained from the first three topics.

You should plan on approximately 60 minutes for each session. Allow extra time to handle any discussions or questions raised by the trainees.

Materials Needed to Present Training

Part 1

Materials for Presentation

- Flip chart, white board, or chalkboard
- Coin
- Timer

Materials for Demonstrations

- Screwdriver with combination pistol/inline grip
- Notebook or other object to simulate working surface
- Two chock blocks
- Vanilla wafers (two for each participant)
- Large (jumbo) marshmallows (enough for each participant)
- Empty aluminum soda pop can
- Paper clips (enough for each participant)

Handouts

- What Type of Injury?
- Risk Factor Report Card (use for homework assignment)
- Course evaluation (one for each participant)

Part 2

Materials for Presentation

- Flip chart, white board, or chalkboard
- Examples of personal protective equipment for ergonomic risk factors

Handouts

- Task evaluation forms (two for each participant)
- Summary page of common risk factors (one for each participant)
- Course evaluation (one for each participant)

Ergonomics and Risk Factor Awareness

PART 1

PART 1

Introduction

Musculoskeletal Injuries

Risk Factors

Ergonomics and Risk Factor Awareness

PART 1

Suggested Discussion Points:

Why is your company doing this training?

Handouts / Tools / Reference Materials:

International Labour Organization. Your health and safety at work: ergonomics.
http://www.itcilo.it/english/actrav/telearn/osh/ergo/ergoa.htm

Objectives

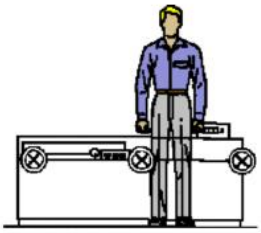
- To gain an understanding of:
  - **What is ergonomics**
  - **How cumulative trauma disorders develop**
  - **Ergonomic risk factors**
  - **Controlling risk factors**
- To gain an understanding of how ergonomics applies to your job

Suggested Discussion Points:

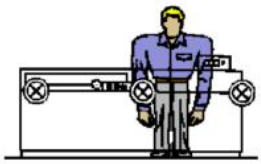
- There are principles and theories in ergonomics just like any other science
- Cumulative trauma disorders or musculoskeletal disorders (also referred to as “MSDs”)
- Risk factors that can impact the musculoskeletal system and result in MSDs
- Steps to identify and control risk factors
- Applying ergonomics to make *your* job safer

Ergonomics - What is it?

Most people look like this...



Some designers must think that people look like this...



Suggested Discussion Points:

- Some tools, equipment, and machines are not designed to accommodate the typical user. Few machines are designed for individual differences. This forces individuals to use awkward positions, such as bending and reaching.
- This "one size fits all" method of designing is opposite to the viewpoint of ergonomics.
- Applying the science of ergonomics considers the variety of end users at the beginning of the design process.
- In this example, the lathe was designed for a person who looks like the man in the bottom picture. The designer should have considered the end user's anthropometry (body measurements) before designing the lathe.

Handouts / Tools / Reference Materials:

Canadian Centre for Occupational Health and Safety: Work-related musculoskeletal disorders. http://www.ccohs.ca/oshanswers/diseases/rmirsi.html

Ergonomics is…

- Scientific study of human interaction with the work environment
- Considers physical and mental capabilities of workers as they interact with tools, equipment, work methods, tasks, and working environment
- Goal – to reduce work related injuries by adapting work to fit people

Suggested Discussion Points:

- Ergonomics is the systematic and scientific study of the worker's interaction with his/her work environment. Job safety analyses (JSAs) are a very systematic way to break down a job to discover safety issues. In ergonomics, we break down tasks to identify risk factors that can be minimized to reduce cumulative injuries.
- Ergonomics considers differences in people when designing job tasks.
- Applying ergonomics seeks to put "people first" and considers how the work can be better designed to accommodate the user, reduce injury risk, and improve the quality of worklife.

Handouts / Tools / Reference Materials:

The Ergonomics Society (U.K.): What is ergonomics?
http://www.ergonomics.org.uk/section.php?s=1

Oregon OSHA: Introduction to ergonomics – cumulative trauma disorders.
http://www.cbs.state.or.us/external/osha/educate/training/pages/201disorders.html

Suggested Discussion Points:

- Just because something is advertised as "ergonomic" does *not* mean it will reduce risk. How people use the tool is *very* important.
- For example, demonstrate an inline and pistol grip screw driver (demonstration pictures below).
- For example, you can adjust ergonomic chairs incorrectly. A chair may have all of the features needed to provide a good seated posture, but unless you know how to adjust it and the proper postures, it may not be used correctly.

Demos / Stories / Examples:

This example shows that even if a tool is well designed, it can be used the wrong way and will not reduce risk to the user.

Ask for a volunteer from the group and hand him or her the inline/pistol grip screwdriver. Then using a book, notebook, or sheet of paper, simulate a work surface. Hold the book/notebook/paper at approximately waist level of the volunteer with the book/notebook/paper parallel to the floor, as shown in Figures 1 and 2. Ask the employee to adjust the screwdriver (or choose either an inline or a pistol-grip style) to perform the task of placing a screw into the provided "work surface"

using the most appropriate method. Figure 2 is the appropriate way, removing most of the deviation from the wrist and lowering the shoulder.

Figure 1.—Poor posture.

Figure 2.—Good posture.

Now, rotate the book/notebook/paper so that it is perpendicular to the floor, as shown in Figures 3, 4, and 5. Ask the volunteer to perform the same task on this "work surface." Both Figures 3 and 4 show a poor posture, whereas Figure 5 is an example of an appropriate way to use this tool for a vertical surface at this height.

Figure 3.—Poor posture.

Figure 4.—Poor posture.

Figure 5.—Good posture.

Props/Materials Needed:

- Screwdriver with combination pistol/inline grips
- Notebook or other object to simulate working surface

Handouts / Tools / Reference Materials:

International Labour Organization. Your health and safety at work: ergonomics. Refer to section D: Hand tools and controls.
http://www.itcilo.it/english/actrav/telearn/osh/ergo/ergonomi.htm

Is this a problem?

Suggested Discussion Points:

Example of using ergonomics to solve a problem

Demos / Stories / Examples:

Problem: At one mine, employees are required to chock their vehicles whenever they are parked on the mine property. This means that some employees have to chock their vehicles several times a day. Because the two chock blocks are connected with a rope, performing this task results in excessive stooping and bending. Other issues occur during muddy or wet conditions.

Have the groups share their solution ideas.

Props/Materials Needed:

Two chock blocks

What one company did…

Demos / Stories / Examples:

Solution: A handle fabricated with conduit was attached to the two chock blocks by the Field Maintenance Department. This modification allowed employees to place the chock blocks in front and behind the tire and to pick the chock blocks off the ground with little or no stooping. The handle also helped alleviate issues that occur during unfavorable weather conditions.

Taking the Work Out of Work

Suggested Discussion Points:

Another example of using ergonomics to solve a problem.

Demos / Stories / Examples:

Problem: Swinging a standard sledgehammer to carry out a task can be very strenuous on the body. With the Slide Sledge, using a heavy and awkward sledge hammer to exert a force is no longer necessary. The Slide Sledge is able to deliver a powerful payload of impact with minimal effort from the employee.

Have the groups come up with more examples of how ergonomics has been used to solve problems, possibly from firsthand experience.

Props/Materials Needed:

Sledgehammer

What are the Benefits?

Suggested Discussion Points:

Applying ergonomics can lead to many benefits to the employee, including:

- Staying healthy as you get older
- Enjoying leisure time activities
- Reducing discomfort
- Reducing fatigue
- Enhancing quality of life
- Making your job safer
- Designing jobs for the next generation of workers – your children
- Improved quality of work
- Increased efficiency by working smarter – less wear and tear on the body
- Preventing musculoskeletal injuries

Demos / Stories / Examples:

1. Instead of telling them the benefits, ask the participants to offer benefits that they think would occur from applying ergonomics. Make a list on a flip chart, white board, or chalkboard. Then give them the list from the Suggested Discussion Points above.

2. An alternative for audience participation is to follow the format for the "Family Feud" TV game show. Divide the class into two groups: "Family A" and "Family B." Use a coin toss to decide which family goes first. Each family then takes turns until all of the benefits are identified. *Hints:* To control the time used to answer the question, set a time limit for each "family" to respond and/or limit the number of benefits that need to be identified to four or five.

Props/Materials Needed:

- Flip chart, white board, or chalkboard
- Coin

Handouts / Tools / Reference Materials:

Hendrick HW [2003]. Determining the cost-benefits of ergonomics projects and factors that lead to their success. Appl Ergon *34*(5):419–427.

Suggested Discussion Points:

Although applying ergonomics can lead to many benefits, many companies do not consider ergonomics for various reasons. These reasons are considered barriers, which could include:

- Lack of resources (staff, time, money)
- Lack of knowledge or expertise
- Attitudes toward ergonomics
- Safety culture
- Lack of a regulation
- Lack of commitment on all levels (top management to employees)

Demos / Stories / Examples:

1. Instead of giving them the list of barriers, ask the participants to name barriers to implementing ergonomics in the workplace. Make a list on a flip chart, white board, or chalkboard.

2. An alternative for audience participation is to follow the format for the "Family Feud" TV game show. Divide the class into two groups: "Family A" and "Family B." Use a coin toss to decide which family goes first. Each family then takes turns until all of the barriers are

identified. *Hints:* To control the time used to answer the question, set a time limit for each "family" to respond and/or limit the number of barriers that need to be identified to three or four.

Props/Materials Needed:

- Flip chart, white board, or chalkboard
- Coin

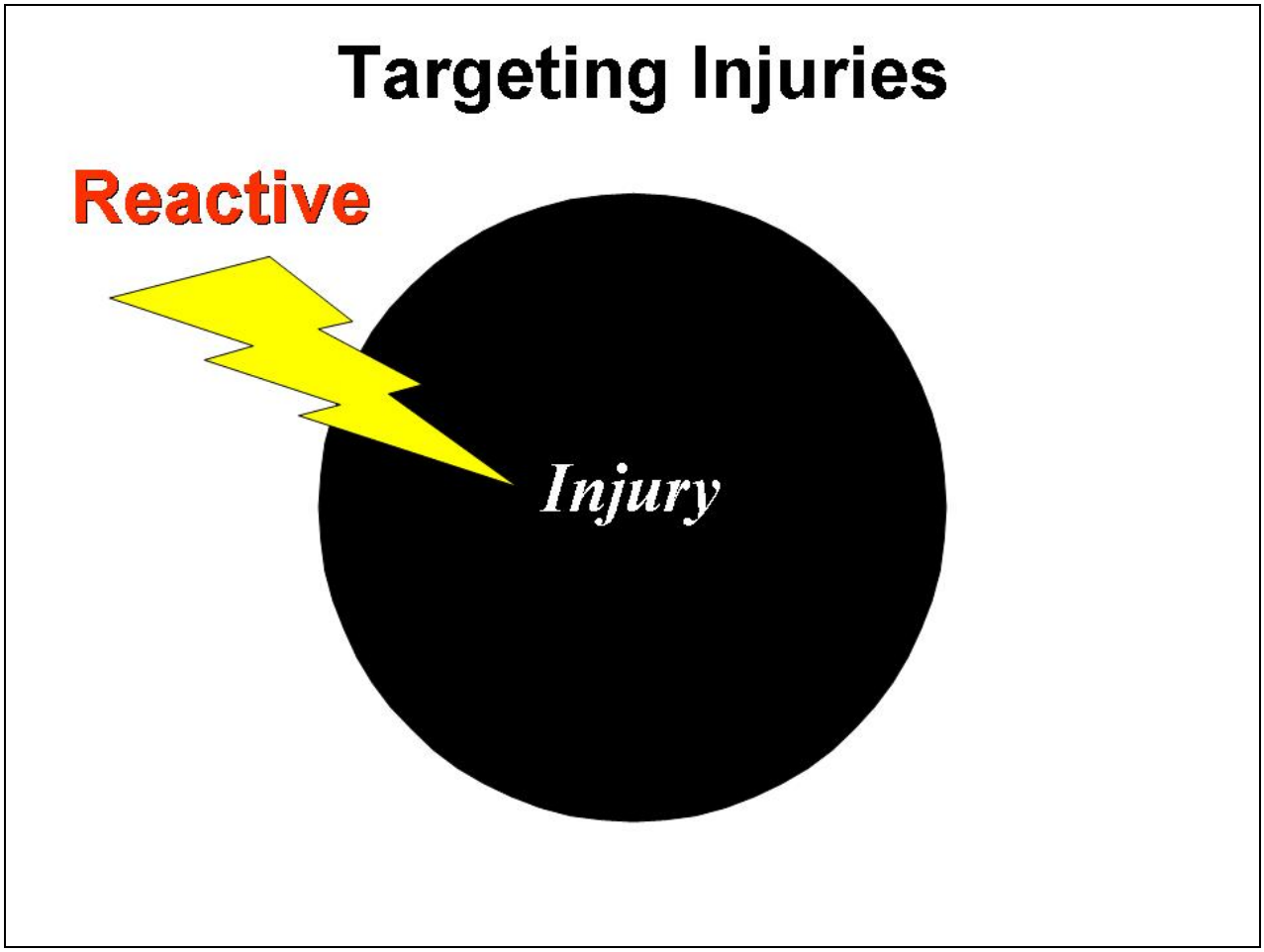
Suggested Discussion Points:

When an ergonomic approach is not used, musculoskeletal disorders (MSDs) may develop.

This section will include information on:

- How MSDs are different from acute injuries
- Examples of MSDs
- How MSDs may develop

NOTE: Other terms for MSDs are cumulative trauma disorders (CTDs) or musculoskeletal injuries (MSIs). All three terms are interchangeable for purposes of this training. Companies may choose the term consistent within their organization.



Suggested Discussion Points:

It usually takes an injury to draw attention to a problem. Reactive means that the main effort to reduce injury risk is *after* an injury has occurred. Efforts are focused on preventing future injuries, not on the current injury.

Reacting to injuries that have occurred does have value because of the cumulative nature of MSDs. Other workers may be developing an MSD, and action taken may be useful in preventing MSDs for these workers. However, with a reactive approach, one can sometimes wrongly assume that no injuries means no problems, when it really means that the injuries have not yet occurred because of the cumulative nature of MSDs.

Demos / Stories / Examples:

What would happen if you did not provide preventive maintenance for your equipment?

As an example:

- A Monday morning quarterback cannot do anything to prevent the losing outcome of Sunday's game; or
- Shutting the barn door after the horse has left the barn will not prevent the horse from leaving the barn.

Suggested Discussion Points:

Concentrate on the importance of being *proactive* versus solely reactive. Being proactive can be described as PM (preventive maintenance) for people.

Proactive means we avoid waiting for the injuries to occur and we keep an eye on risk factors connected to specific work tasks that can lead to signs, symptoms, and eventually injury.

To do this, trainees must understand:

- What musculoskeletal injuries are
- How musculoskeletal injuries progress
- Signals (signs and symptoms) that tell you when an injury might occur
- How to prevent them from happening

These will be presented in this portion of the training.

Demos / Stories / Examples:

Participants probably will be able to relate to obesity, high cholesterol, and high blood pressure as risk factors for heart disease.

Work-Related Injuries

- *Acute injuries* –
  - Occur instantly
  - Examples: fractures, cuts, bruises
- *Cumulative injuries* –
  - Develop gradually
  - Examples: sprains/ strains, herniated discs, tendonitis, carpal tunnel syndrome

Suggested Discussion Points:

- **Acute injuries** occur instantaneously. Types of acute injuries include fractures, cuts, and bruises. People are more familiar with acute injuries. These injuries can affect any part of the body, including internal organs.
- **Cumulative injuries** occur gradually over time with varying degrees of signs and symptoms, indicating that something is wrong. Some examples include herniated discs, tendonitis, carpal tunnel syndrome, and sprains/strains. These injuries affect muscles, nerves, tendons, ligaments, and blood vessels.

NOTE: Some types of injuries can be either acute or cumulative depending on the precipitating event. For example, a sprain/strain can be cumulative if the exposure is highly repetitive and involves submaximal forceful exertions, or it can be acute if the precipitating event is a single overexertion exceeding the maximum capability of the worker.

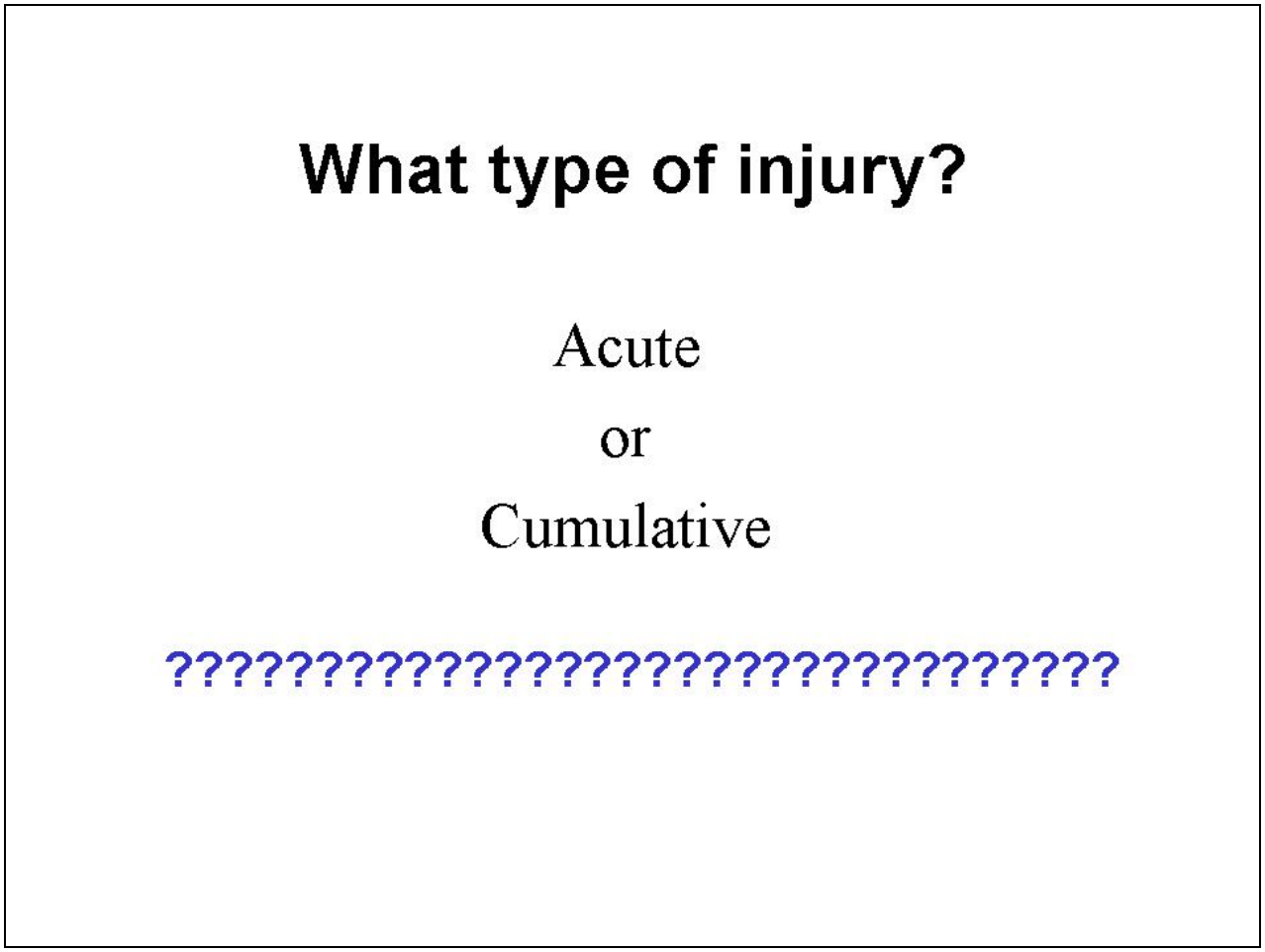
Demos / Stories / Examples:

Scenario: A person is smoking a cigarette by a gas pump.
Question: What is the risk?

Answer(s):

A. Acute injury: explosion and tripping hazard
B. Cumulative illness: lung cancer

It is common for risky situations to have both an acute and a cumulative risk associated.



Suggested Discussion Points:

- Reinforce the differences between acute and cumulative.
- Sometimes it is difficult to differentiate between the two types of injuries.

Demos / Stories / Examples:

Hand out the list of injury scenarios and ask the participants to determine which injuries are acute or cumulative. This exercise can be done by individual participants or by separating the participants into teams. One team can do the odd-numbered scenarios, while the other team does the even-number scenarios.

Handouts / Tools / Reference Materials:

Acute and Cumulative Injury Handout

Suggested answers to the injury scenarios:

1. Acute
2. Acute
3. Cumulative
4. Acute
5. Cumulative
6. Cumulative
7. Acute
8. Acute
9. Acute
10. Cumulative
11. Acute
12. Cumulative

Musculoskeletal Disorders

- **Median number of lost work days**
  - 5 days for all workers with injuries
  - 25 days for workers with MSDs
- **Average cost per injury**
  - $824 for all other cases
  - $8,070 for an MSD
- **MSDs tend to have**
  - Longer durations
  - Longer treatment time
  - Greater work disability

Suggested Discussion Points:

MSDs differ from other type of injuries in many ways.

- Lost workdays are greater for MSDs.
- MSDs cost more than other injuries.
- MSDs take longer to get better and require more treatment.
- MSDs increase a person's risk for reinjury. Once you have an MSD, the risk for the same injury is higher, especially if the first injury was not properly treated, the recovery time was not adequate, and/or the root cause of the problem was not addressed.

Sources of data shown in slide:

- *Days lost data:* U.S. Bureau of Labor Statistics [1998]. BLS issues: 1996 lost-work time injuries and illnesses survey. Am Coll Occup Environ Med Rep *98*:6–7.
- *Cost data:* Webster BS, Snook SH [1994]. The cost of compensable upper-extremity cumulative trauma disorders. J Occup Med *36*(7):713–717.
- *MSD info (1993–1994):* Feuerstein M, Miller VI, Burrell LM, Berger R [1998]. Occupational upper-extremity disorders in the federal work force: prevalence, healthcare expenditures, and patterns of work disability. J Occup Environ Med *40*(6):546–555.

Case Study – Back Injuries Can be Serious

Supervisor suffered back injury helping a worker move sheet metal in January 1978

- Original injury - $1000 medical costs and no lost time
- Recurrence in 1992 cost ***$18,000***
- Surgery/comp in 1993 cost ***$81,000*** and resulted in permanent partial disability
- Additional costs of ***$55,000*** in 2001 alone

By 2002, this 1978 back injury cost over *$517,000*!

Original injury cost data did not appear to warrant investment . . . until you consider future costs.

What about costs to the employee?

Suggested Discussion Points:

- High costs of MSDs
- A back injury is a good predictor for a future injury – should implement an intervention or job improvement to prevent future back injuries

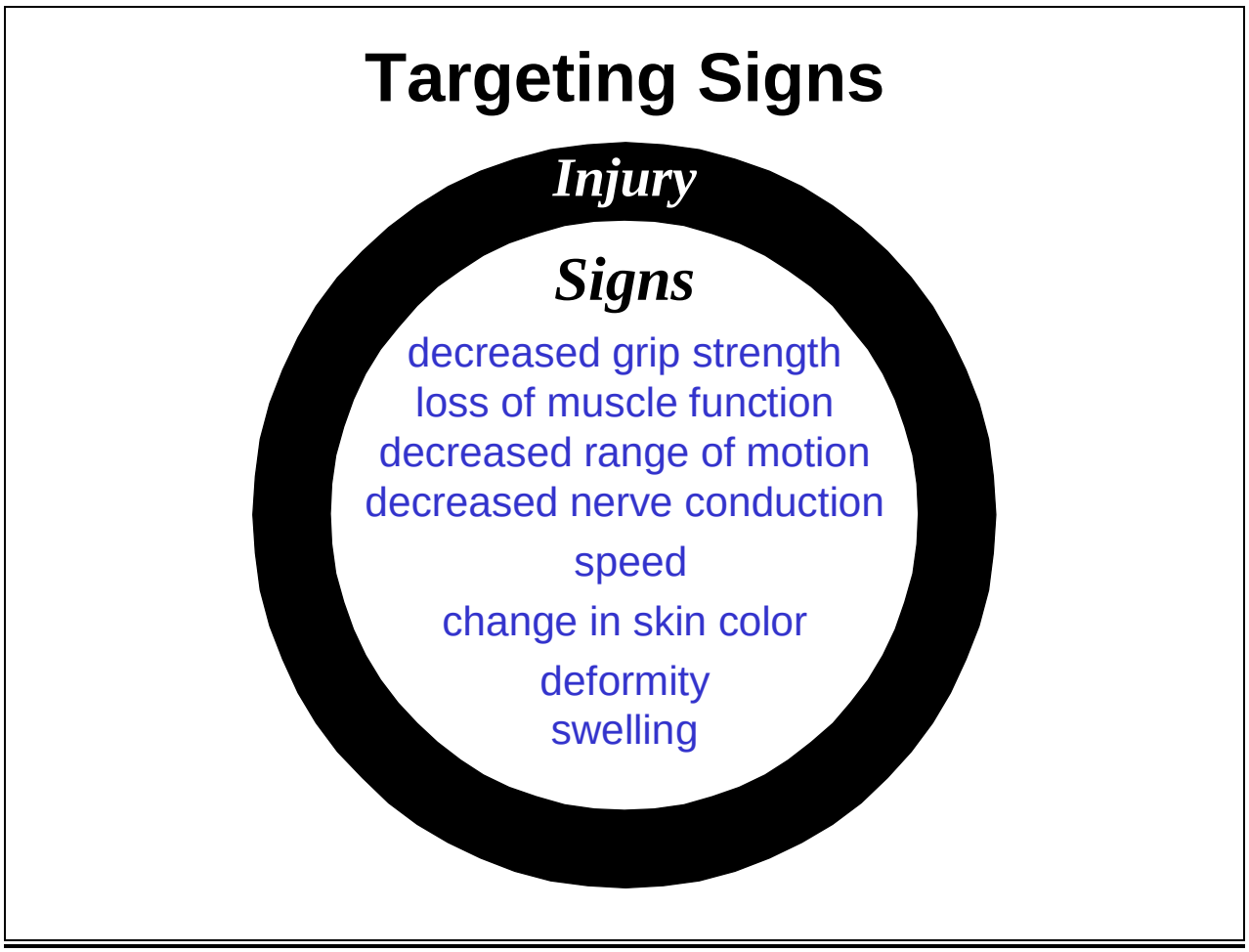
Demos / Stories / Examples:

This example can be replaced with your own example if you have the cost data. The example shown in the slide is an actual case that happened at a U.S. Navy facility. The injury cost was $517,000 by the year 2002.

Ask participants to think about the human cost to this type of situation. Ask them to give examples of what the worker would be experiencing, such as:

- Pain
- Time involved with rehabilitation
- Unable to participate in leisure time activities
- Reduced wages
- Loss of function

Source of data presented in slide: Barbara Wright, Ergonomics Program Manager, Naval Aviation Depot (NADEP), Jacksonville, FL 32223; phone: 904–542–3539; e-mail: Wrightbl@navair.navy.mil.



Slide Pointers:

- Must click mouse to reveal the "signs" ring. If you are making this interactive, stop here to have participation.
- Must click mouse to reveal the examples of "signs."

Suggested Discussion Points:

Signs are objective findings (the change can be measured and/or observed) that include:

- Decreased grip strength
- Loss of muscle function
- Decreased range of motion
- Decreased nerve conduction speed
- Change in skin color when exposed to cold or vibration
- Deformity
- Swelling

In some cases, signs can be reversed, but not always.

Demos / Stories / Examples:

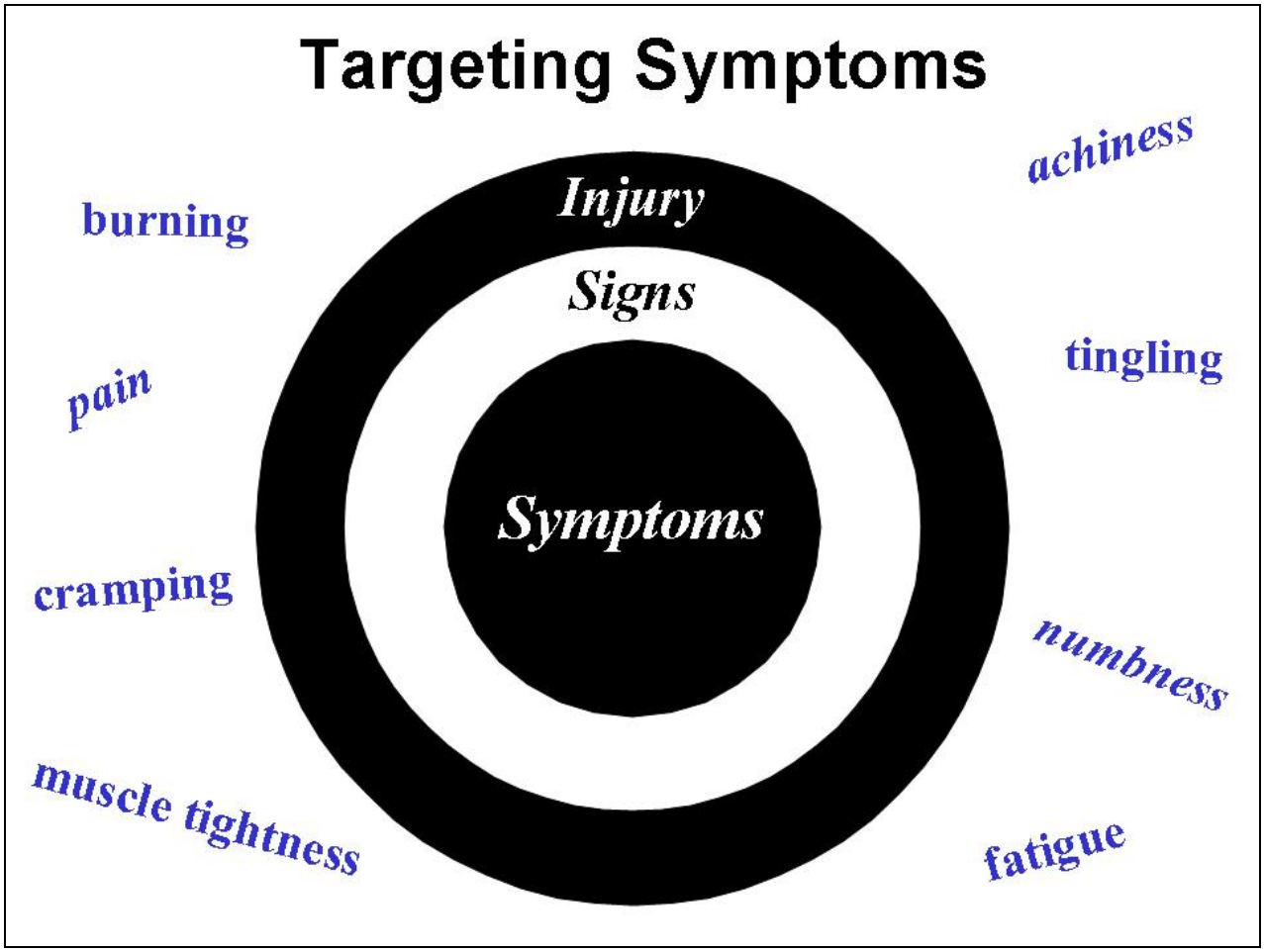
To emphasize what signs are, demonstrate decreased range of motion. Two examples affecting the shoulder and elbow joints include:

- Stand with your arm at your side. Raise your arm outward to the side as far as you can. Then repeat, but only raise your arm as high as your shoulder.
- Stand with your arm at your side with your palm facing forward. Raise your forearm as far as you can. Then repeat, but only raise your forearm so that it is parallel to the ground.

Ask the participants what they could not do either at home or at work if their range of motion were decreased as shown in the demonstration.

Ask the participants for examples of other signs and what they could not do as a result of that sign either at home or at work, such as:

- Decreased grip strength – not being able to hold a large milk bottle with one hand
- Decreased grip strength – not being able to open a bottle with a screw cap or even opening a door by turning a door knob
- Loss of muscle function – not being able to lift your child into a car seat
- Loss of muscle function – not being able to get dressed or to feed yourself



Slide Pointers:

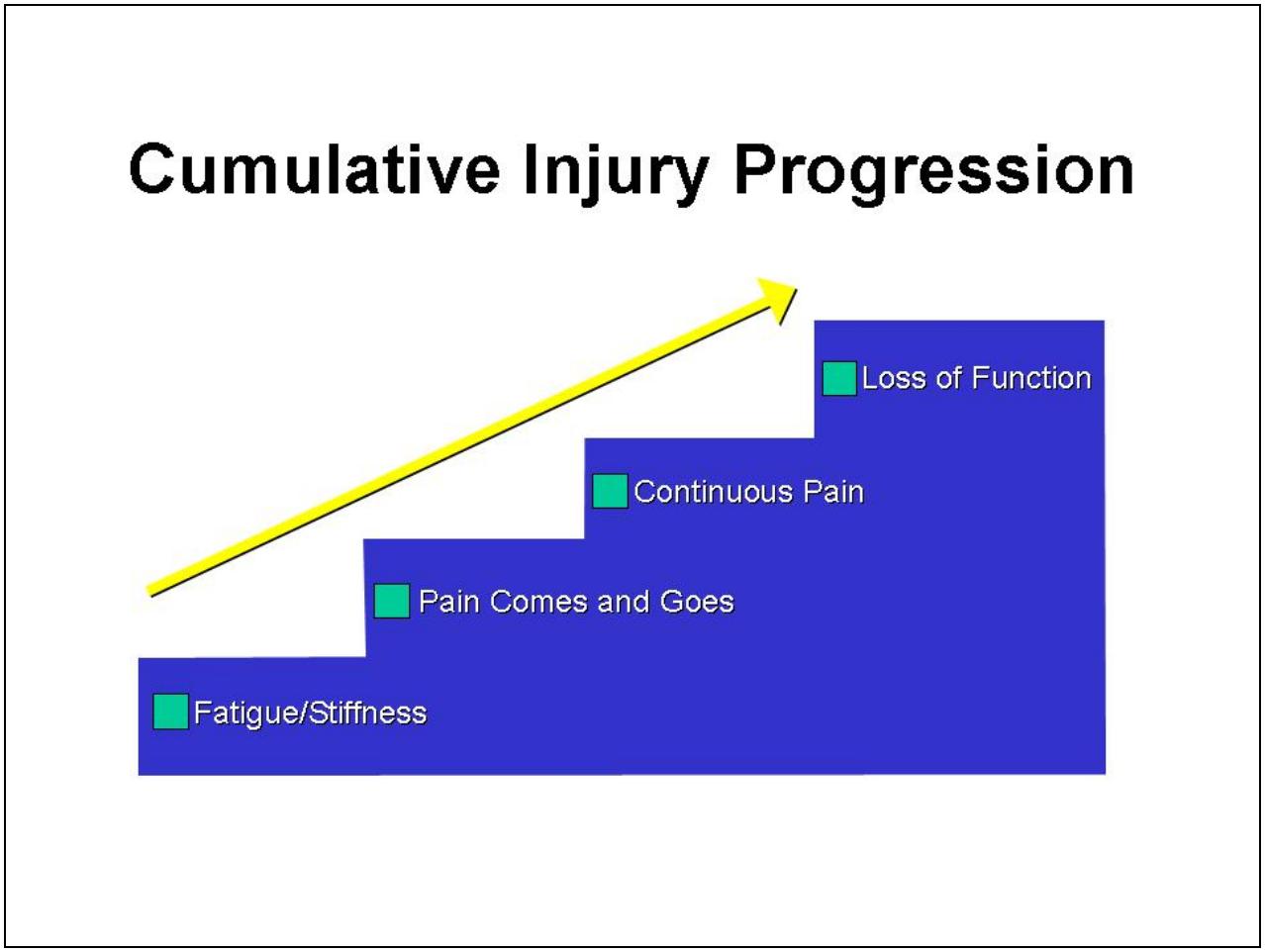
- Must click mouse to reveal the "symptoms" ring.
- Must click mouse to reveal the examples of "symptoms."

Suggested Discussion Points:

- Symptoms are more subjective in nature and include pain, fatigue, numbness, or tingling sensations.
- Any one or combination of these may be an early indicator that there is a problem. Symptoms that are ignored may progress to signs. The key is to recognize symptoms early before they progress to a sign or injury.
- Symptoms can be treated – are reversible.
- Failure to seek early treatment can result in chronic pain or permanent disability.
- It is important to know that symptoms may occur at *any* time, not just while you are working. Symptoms may be experienced while sleeping, watching TV, or in a cold environment.

Demos / Stories / Examples:

For instance, symptoms for carpal tunnel syndrome often occur at night.



Slide Pointers:

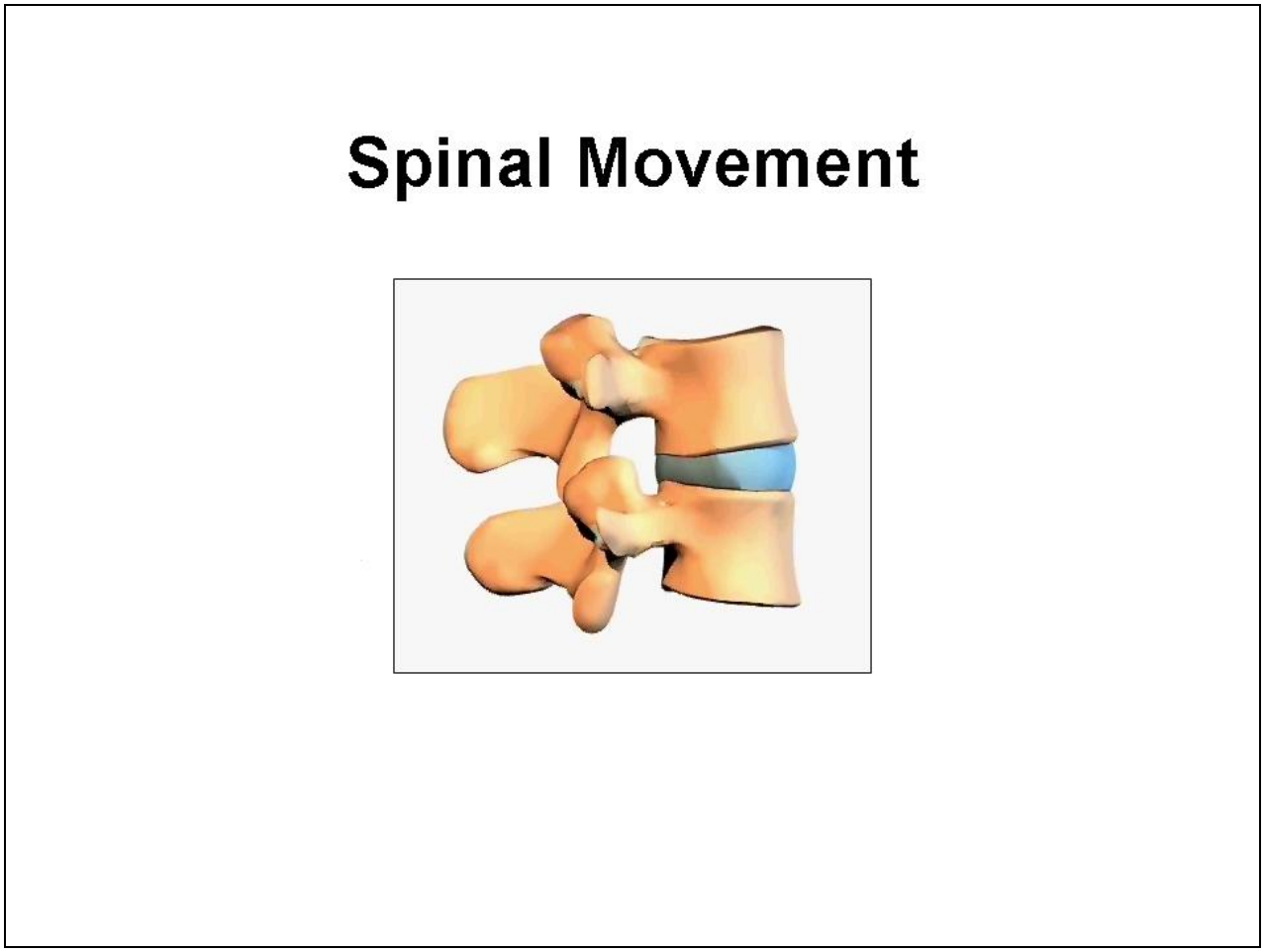
- Must click mouse to reveal each step of the progression. This will give you time to talk about each step.

Suggested Discussion Points:

- One possible progression for a cumulative injury starts with symptoms, such as fatigue or stiffness, then progresses to periodic pain and then continuous pain, and finally results in a loss of function.
- The sooner the exposure is reduced or eliminated, the better the chance of avoiding permanent injury.
- Preventing the progression of a cumulative injury by elimination of risk factors is ideal.
- The longer one waits to get treatment, the longer it usually takes to get better. In addition, once loss of function occurs, you may never regain full function.

Demos / Stories / Examples:

Ask participants if they can share any experiences with MSDs or cumulative disorders. Ask them to describe the progression of an MSD and to describe how long it took to get better.



Suggested Discussion Points:

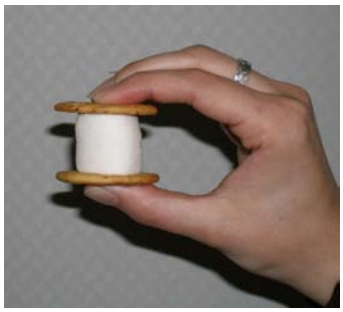
- The vertebrae are the bones of the spine.
- Vertebrae provide support and protection to the spinal cord.
- Between each vertebra is a disc. The disc is a large, round ligament that connects the vertebrae together.
- The disc serves as a shock absorber.

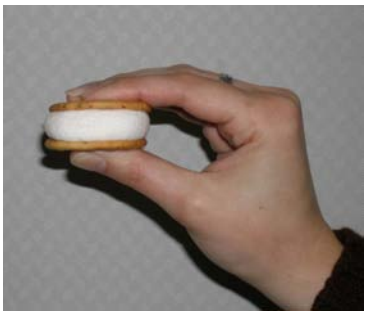
Demos / Stories / Examples:

Video: Click on the vertebrae to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. The disc is subjected to different types of stress as we use our backs each day. The disc generally acts as a shock absorber. Bending over results in compression of the disc and will cause the disc to bulge. Twisting and bending together is perhaps the greatest stress on the parts of the spine, especially the disc.

Marshmallow Demo: To demonstrate how the discs behave between the vertebrae, give each participant two vanilla wafers and a large/jumbo marshmallow. Have them place the marshmallow between the two vanilla wafers and squeeze the two vanilla wafers together causing the marshmallow to bulge outside of the vanilla wafer "sandwich." The marshmallow represents a

spinal disc and its ability to compress and expand. Vanilla wafers represent two vertebrae and their ability to protect the disc. The nature of the disc (marshmallow) allows us to be able to bend and twist.





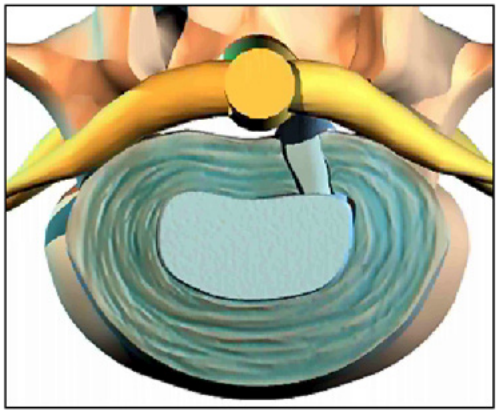
Props/Materials Needed:

- Vanilla wafers (two per participant)
- Large fresh marshmallows (one per participant)

Handouts / Tools / Reference Materials:

Marras WS [2003]. The case for cumulative trauma in low back disorders (editorial). Spine *3*(3): 177–179.

Herniated Disc



Suggested Discussion Points:

- Degeneration occurs when wear and tear causes deterioration of the disc—small tears occur in the ligament. Over time, the tears may become bigger and longer (like when your favorite jeans get old and begin to fray).
- Repeated lifting, combined with bending and twisting, may lead to injury and degeneration of the disc.

Demos / Stories / Examples:

Video: Click on the vertebrae to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. When the disc degenerates, pain receptors in the outer region are activated and a person can experience back pain. In addition, if the tears in the disc reach the outer layers, the center of the disc can protrude through the tears and push against the spinal nerves and cause severe pain. When this condition occurs, it is called a herniated disc.

Paper Clip: Pass out one paper clip per individual, and ask him/her to straighten the paper clip. Once the paperclips are unfolded and more or less straight, have the participants bend it back and forth at the same point, counting how many bends it takes to break the paper clip. Have the participants share the number of bends required to break the paper clip.

Soda Pop Can: Have the participants press down on the top of an empty soda pop can. No matter how hard the can is pressed, it will not collapse. Now have them gently press on the side of the can with one finger to cause a dent, and then press down on the top of the can. The can will compress off to one side.

The discussion point that should be addressed with these examples is that the same principle applies to the human back—the more you bend it, the weaker it becomes. Also, this example highlights that everyone's breaking point is different, which makes it difficult to define how many times it is safe to bend over and lift something or what weight is a safe weight to lift. It varies from person to person, just like the number of bends varied to break the paper clip.

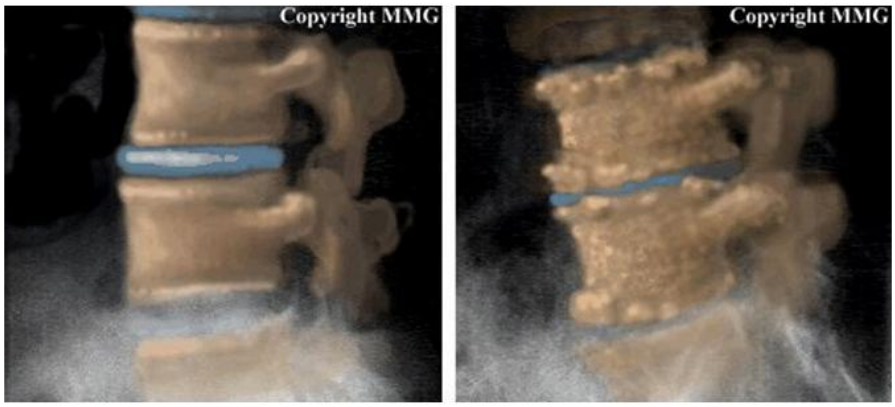
Props/Materials Needed:

- Paper clips (enough for one per participant)
- Empty soda pop can with no indentations

Handouts / Tools / Reference Materials:

American Academy of Orthopaedic Surgeons. Herniated disk.
http://orthoinfo.aaos.org/fact/thr_report.cfm?thread_id=185&topcategory=Spine

Spinal Degeneration



Suggested Discussion Points:

This slide shows the same spine 20 years apart. This is an example of the type and level of degeneration that can occur. Note the extensive level of degeneration of the disc and the bone.

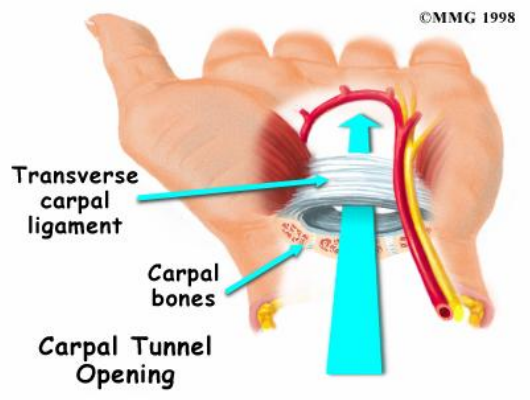
Although the specific cause of this degeneration is not important, it is important to know that its progress can be delayed. While some degeneration occurs with aging, its progress may be accelerated by heavy physical work, vibration exposure, smoking, and genetics.

Applying ergonomics will reduce the stress experienced by the body and will minimize the degree of degeneration from exposures to risk factors. Ergonomics promotes healthy aging so you can have a higher quality of living.

Handouts / Tools / Reference Materials:

Anatomical models illustrating normal spines and spines with degeneration are available from www.backtalksystems.com.

Wrist Anatomy



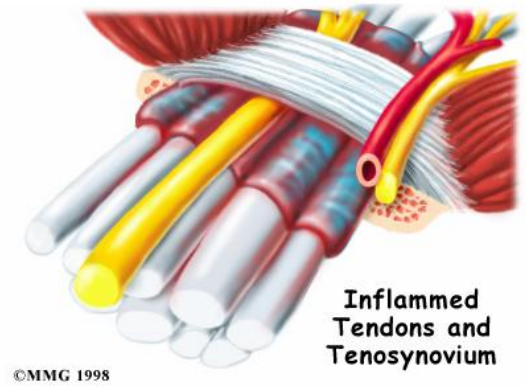
Suggested Discussion Points:

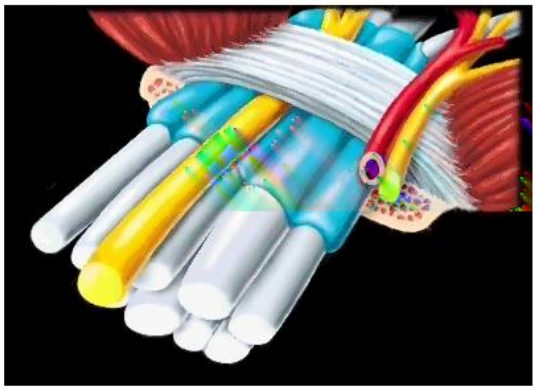
- The carpal bones in the wrist and the transverse carpal ligament form a “tunnel” in the wrist.
- The space in the tunnel is fixed and it cannot be expanded.
- The median nerve and the tendons that move the fingers pass through this tunnel.

Handouts / Tools / Reference Materials:

- NIOSH facts: carpal tunnel syndrome. http://www.cdc.gov/niosh/ctsfs.html
- National Institute of Neurological Disorders and Stroke. Carpal tunnel syndrome fact sheet. http://www.ninds.nih.gov/disorders/carpal_tunnel/detail_carpal_tunnel.htm
- Continuum Health Partners, Inc. Common injuries of the hand and wrist: carpal tunnel syndrome. http://www.wehealny.org/services/orthopedics/carpal.html

Tendon Movement





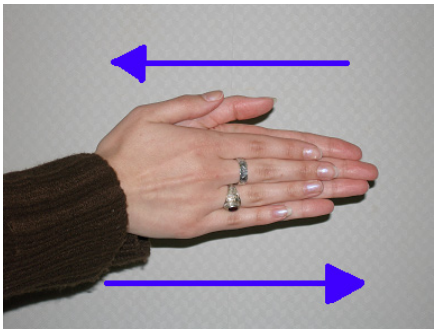
Suggested Discussion Points:

- The median nerve (yellow) and flexor tendons (white) pass through the carpal tunnel opening.
- The sheath (blue), or tenosynovium, that covers the tendons is very slippery and allows the tendons to glide against each other as the hand is used to grasp objects.
- Any condition that irritates the tendons, such as repeatedly bending the wrist and applying force, can result in swelling and thickening of the sheath.
- Inflammation of tendons and the sheath can cause discomfort or tendonitis.
- The swelling of the sheath reduces the space in the carpal tunnel.

If this condition gets to a point where increased swelling and pressure squeezes the median nerve against the ligament, carpal tunnel syndrome develops. This can result in numbness, tingling, and pain in the hand(s). Surgical releases are commonly performed to reduce the pressure, but scar tissue formed from the surgery can actually reduce the size of the tunnel. If the person goes back to the same working conditions, symptoms are likely to recur. Symptoms are often most acute while sleeping, since blood pressure is reduced. Advanced cases may result in permanent weakness and clumsiness of the hand.

Demos / Stories / Examples:

Ask the participants to rub their hands together and ask them what they feel. The heat that occurs is due to friction. Think about your hands as the tendons in your wrist passing through the carpal tunnel. This internal heat generated by the tendons rubbing against each other can lead to inflammation and pain.

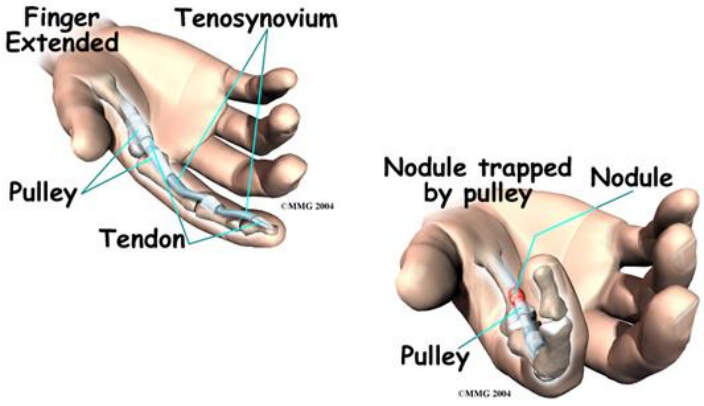


Video: Click on the tendon picture with the black background to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. The sheath (blue) that covers the tendons is very slippery and allows the tendons to glide against each other as the hand is used to grasp objects.

Handouts / Tools / Reference Materials:

Westmoreland R [1993]. Cumulative trauma disorders: some cautions for conservators. West Assoc Art Conserv Newsl *15*(2):37–38.

Trigger Finger



Suggested Discussion Points:

- Trigger finger affects the movement of the tendons as they bend the fingers to form a fist.
- The tendons that move the fingers are held in place on the bones by a series of narrow ligaments. These ligaments form an arch or tunnel on the surface of the bone for the tendon to run through along the bone.
- When trigger finger occurs, the constant irritation from the tendon repeatedly sliding through the tunnel causes the tendon to swell in this area and form a nodule.
- Repeated trauma from pistol-gripped power tools or long hours grasping a steering wheel can cause trigger finger.

The symptoms of trigger finger include pain and a clicking sensation when the finger is bent. Tenderness usually occurs over the area of the nodule. The clicking sensation occurs when the nodule moves through the tunnel. If the nodule becomes too large, it may pass under the ligament and then not be able to return. If the nodule cannot move back through the tunnel, the finger will be locked in a flexed trigger finger position.

MSDs vs. Heart Disease

Disease (Injury)	Heart Disease	MSDs
Signs	Artery blockage	Loss of muscle function/decreased range of motion
Symptoms	Shortness of breath/chest pain/arm pain	Pain/numbness/fatigue/ tingling
Risk Factors	High blood pressure/ smoking/no physical activity/age/male/race /high cholesterol/high triglycerides	Excessive force/poor posture/repetition
Root Cause	Lifestyle/Genetics	Object weight /workstation design/ position of work piece

Address root causes to improve health!

Suggested Discussion Points:

- MSDs develop over time similar to other types of diseases, such as heart disease.
  - MSDs and heart disease have signs and symptoms.
  - MSDs and heart disease have risk factors and root causes.
- MSDs are not like some diseases that progress even if the exposure stops. MSDs can be reversed if the exposure is reduced and permanent damage has not already occurred.

Demos / Stories / Examples:

Ask participants to name other diseases that would be similar to MSDs.

Examples: diabetes, arthritis, silicosis.

Take Action!

As soon as you are aware of early warning signals

Report Your Concerns

Early action may prevent loss of function and serious injury!

Suggested Discussion Points:

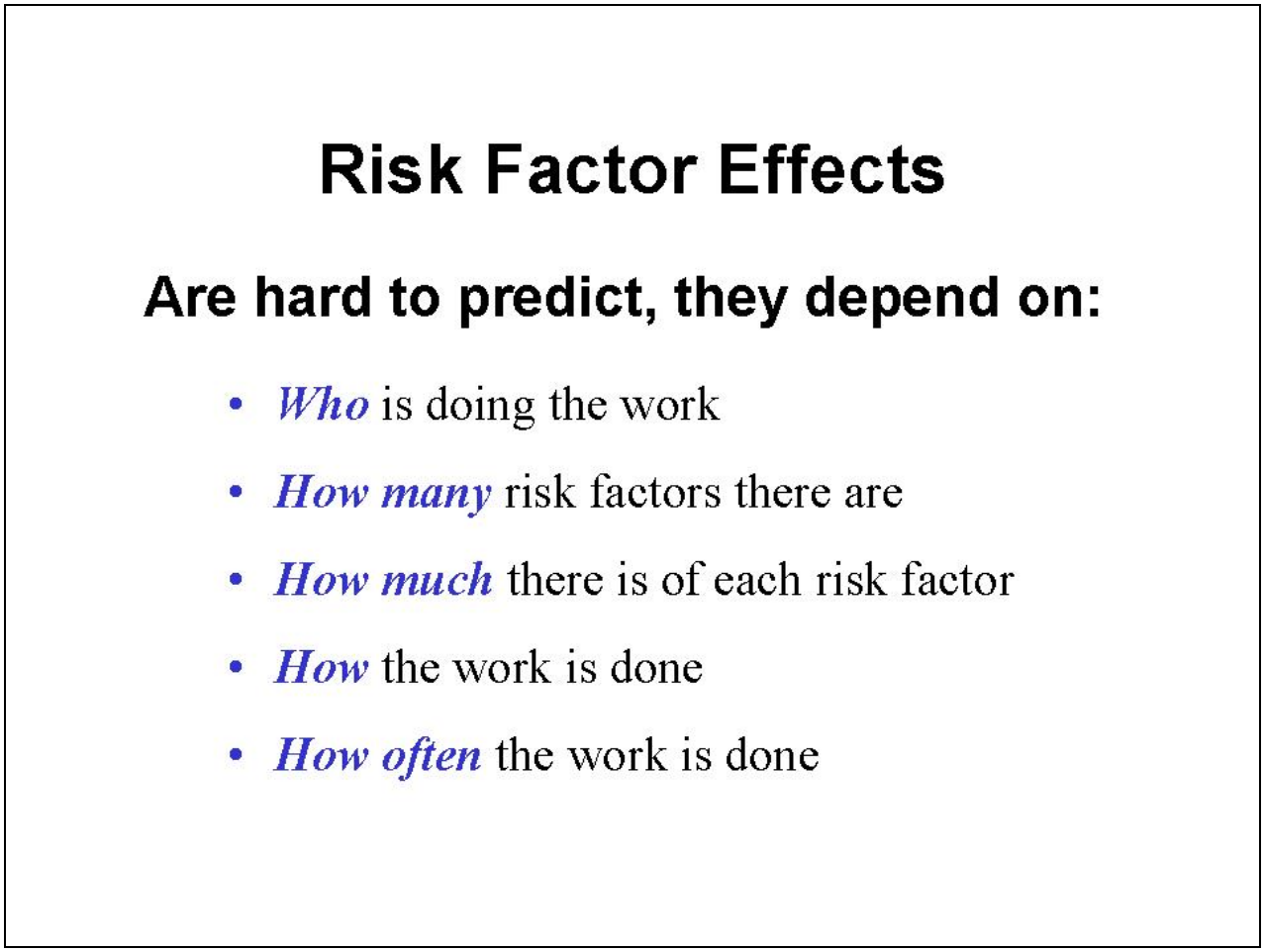
- Do not assume that fatigue or discomfort is just “part of the job.”
- It is important to learn to recognize early warning signals and take action.
- Discuss the reporting procedure used by your organization, i.e., report to supervisor, ergonomics committee, safety director, etc.

Demos / Stories / Examples:

Ask participants about the right procedure for their site.

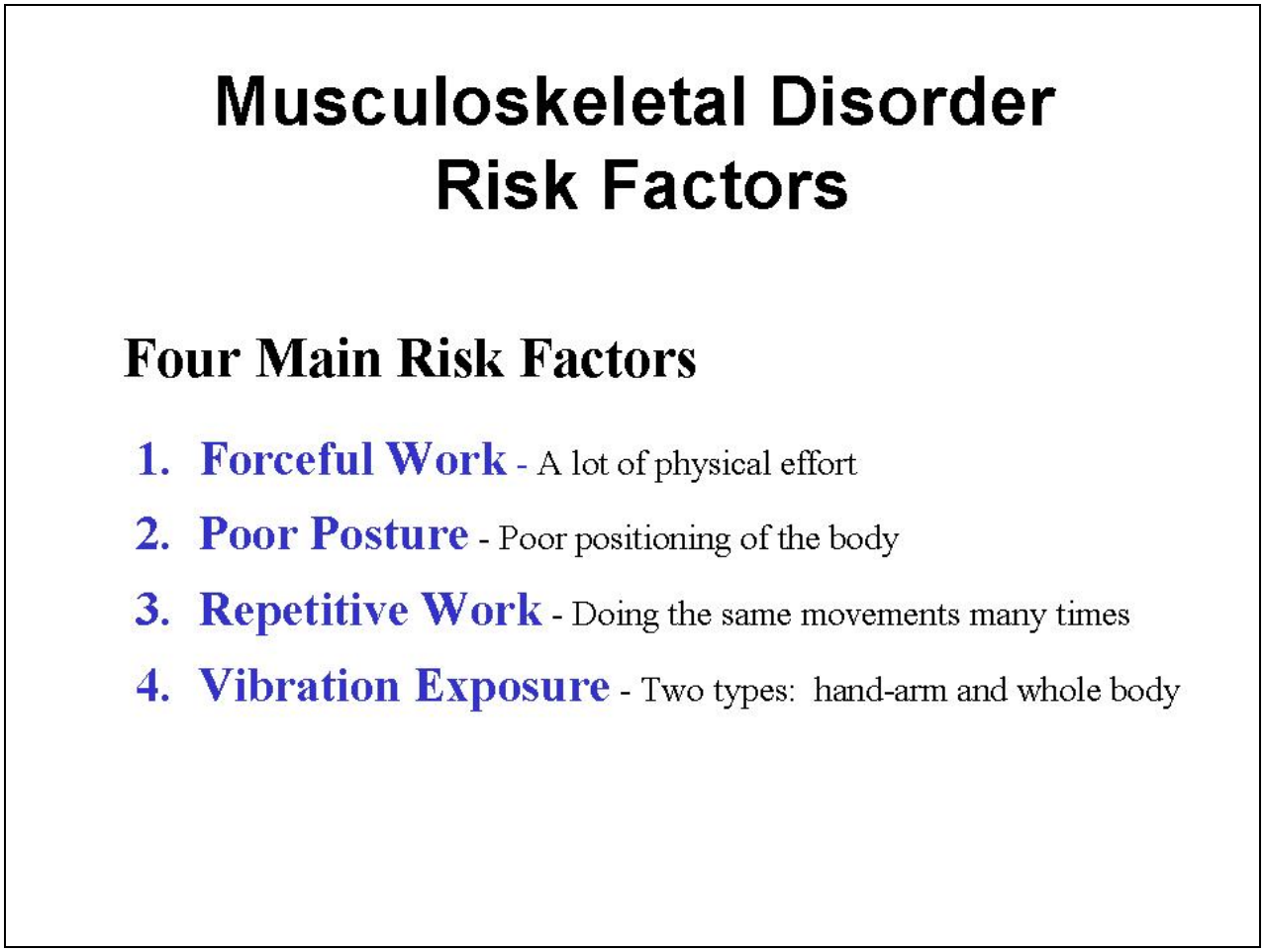
Suggested Discussion Points:

- Risk factor exposures may result in discomfort or an MSD.
- In addition to looking for and eliminating safety hazards, such as an unstable ladder or an oil spill on the floor, it is vital to identify and control risk factors.



Suggested Discussion Points:

- Exposure to risk factors may have some effect on workers.
- Effects of risk factors depend on:
  - Who?
  - How many?
  - How much of each risk factor?
  - How often the exposure occurs (days per week and times per day)?
  - How the work is done (tools, techniques used, or work station layout)?
- Early effects of risk factors are more likely if:
  - A worker is exposed to extreme levels.
  - Multiple risk factors are in play, e.g., bending and twisting while lifting.
  - A worker has a preexisting weakness due to heredity or a previous injury or illness.



Suggested Discussion Points:

- Much research has been done to identify risk factors that result in MSDs.
- The four main musculoskeletal injury risk factors that are found in mining environments are:
  - Force
  - Posture
  - Repetition
  - Vibration

Handouts / Tools / Reference Materials:

Canadian Centre for Occupational Health and Safety. Work-related musculoskeletal disorders (WMSDs): risk factors. http://www.ccohs.ca/oshanswers/ergonomics/risk.html

Examples of Forceful Work

- Heavy lifting
- Carrying heavy objects
- Forceful pushing or pulling
- Forceful gripping
- Shoveling damp or heavy materials

Suggested Discussion Points:

- Examples: Heavy lifting or carrying, forceful pushing or pulling, forceful gripping, and shoveling
- The actual force needed to do a job depends on many factors, such as: the task being performed, weight and shape of objects being handled, type of grip being used, and ability to get a good grip.
- Strength is a function of body position. The amount of force that one can produce by the body will depend on the body position and the specific muscles being used. For example, if you are lifting an object at knee height versus shoulder height, a person could lift a heavier object at their knees using the leg muscles than at their shoulders using the shoulder/arm muscles.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. A quality control technician is obtaining a sample from a railcar. This is done several times during the shift. Play the video and ask the participants to identify the risk factors they observe. The risk factors shown in this video include shoveling, forceful pulling, heavy lifting, and carrying.

Examples of Poor Posture

- Trunk bent over more than 20 degrees
- Twisting the trunk or head
- Elbows above shoulders
- Extended forward reaches
- Reaching behind the body
- Extreme wrist bending
- Pinch grips
- Kneeling or squatting
- Static position

Suggested Discussion Points:

- It is common for workers to use postures that put stress on their bodies.
- Elbows above shoulders, extended forward reaches, trunk bending, extreme wrist bending, pinch grips, and kneeling or squatting are poor postures often seen in the work environment.
- Because work is dynamic, several different safe postures should be used throughout the work shift.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This worker is welding. Awkward postures shown in the video include static posture, reaching with arm, and twisted and bent neck. This worker is wearing a powered air-purifying respirator.

Demonstrate examples of some of the poor postures (see pictures below demonstrating poor postures):

- Raise your hands and elbows above your shoulders and demonstrate using the power tool (screwdriver) from the earlier slide.
- Bend your wrist in extreme flexion and extension.
- Pick up a binder using a pinch grip.

Ask participants what they think is a safe posture. *A good rule of thumb is to work with your joints at about the midpoint of their range of motion*. Demonstrate a neutral posture for the wrist and arm.

- The wrist is straight—no wrinkles should be visible.
- The arm should be bent about 90° at the elbow.

Neutral posture:

Demonstration of the differences between pinch and power grip strengths: Ask for two volunteers. Obtain maximum strength levels for both types of grips using a dynamometer. Record results on a white board or flip chart. Ask for two more volunteers and obtain their maximum power and pinch grips. Record the results. Discuss the differences between power and pinch grips. The pinch grip should be around 20% of the power grip. Ask the participants: if they had a choice, which grip they would use? Tasks should be designed to use power grips and not pinch grips.

Two sources for dynamometers include:

The Human Solution
12417 River Bend, Suite 12
Austin, TX 78732
Phone: 1–800–531–3746
http://www.thehumansolution.com/dynamometers.html

Nexgen
6600 Trans Canada Highway
Suite 750
Pointe Claire (Montreal), Quebec
CANADA H9R 4S2
Phone: 514–685–8593
http://www.nexgenergo.com/medical/baseline1.html

Examples of Repetitive Work

- Using equipment controls
- Machine paced assembly tasks
- Packing or unpacking items
- Computer keyboarding
- Manning a store checkout line

Suggested Discussion Points:

- Highly repetitive motions are repeated every few seconds or minutes.
- Using equipment controls, machine-paced assembly tasks, packing or unpacking items, computer keyboarding, and working at a store checkout line are commonly repetitious jobs.
- Some parts of the body are more likely to be affected by repetitive motion than others, e.g., the wrist, elbow, and shoulder.
- Repetition is more critical as a risk factor when combined with another risk factor, such as force or awkward posture. An example would be using a sledgehammer. Using it once would not generally be a problem, but using it many times could result in fatigue and possibly an injury.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This worker is operating a surface drill. He manipulates the levers and switches throughout the shift. Also, note the awkward postures: forward reach and twisted neck.

Handouts / Tools / Reference Materials:

Ergonomics – high repetition.
http://www.osha.gov/SLTC/etools/poultry/general_hazards/ergo_repetition.html

Examples of Vibration Exposure

- Whole Body - Sitting or standing on vibrating surfaces (includes jolting and jarring)

- Hand-Arm - Using vibrating tools

Suggested Discussion Points:

- Hand-arm and whole-body vibration are the primary forms of vibration exposure.
- Commonly used power tools like sanders and drills have moderate hand-arm vibration levels.
- Tools like impact wrenches and jackhammers have high hand-arm vibration levels.
- Whole-body vibration is often caused from riding in mobile equipment like haul trucks or forklifts.

Short-term effects of too much hand-arm vibration are reduced blood flow and loss of ability to feel things that are cold, hot, rough, or sharp.

Exposure to whole-body vibration may also cause headaches, nausea, and back problems.

How can we protect ourselves from hand-arm vibration?

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This is a video of mechanic using a grinder. This is an example of moderate arm-hand vibration.

Also, you could ask how we could protect ourselves from hand-arm vibration. Answers may include antivibration gloves, properly setting the torque, and selecting the proper tool for the job.

Handouts / Tools / Reference Materials:

Canadian Centre for Occupational Health and Safety. Vibration.
http://www.ccohs.ca/oshanswers/phys_agents/vibration/vibration_intro.html

Other Risk Factors

- Environmental Factors - temperature/humidity/altitude
- Contact Stress – sharp edges
- Pressure Points
- Torque Reaction

Suggested Discussion Points:

There are other risk factors that occur at mining sites. They include:

- Pressure points
- Contact stress (sharp edges on desk/table tops)
- Environmental conditions: heat stress, cold stress, high humidity, altitude
- Restricted spaces: working under vehicles

This worker is working under a vehicle in a restricted working space.

Demos / Stories / Examples:

Ask the participants to identify the risk factors observed in the photo: restricted space, perhaps pressure points, lying on back.

Compounding Risk Factors

Higher Priority!

More than one risk factor present

Reducing *any one* of the risk factors *will significantly reduce* the probability of injury.

Suggested Discussion Points:

- An MSD is more likely to occur if the exposure involves multiple risk factors.
- Reducing the exposure to some of the risk factors will significantly reduce the chance of developing an MSD.

Demos / Stories / Examples:

Ask the participants for examples of multiple risk factor exposures they have seen.

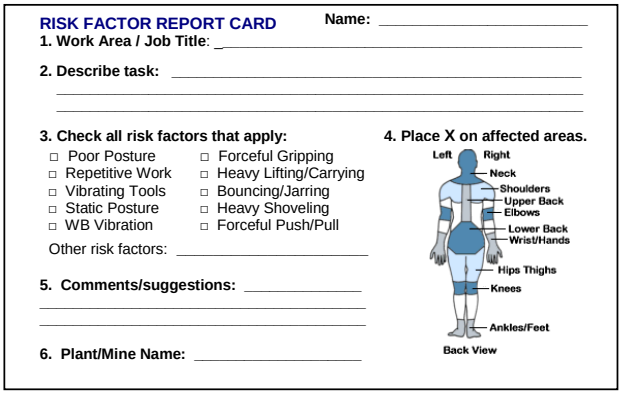
- Lifting and twisting the trunk of the body
- Operating a heavy power tool with a bent wrist
- Operating a joystick with a bent wrist
- Reaching above your head while holding a tool

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. Play the video and ask the participant to identify the risk factors observed.

These workers are rebuilding a crusher and need to remove the springs. Risk factors observed include forceful exertions, forceful gripping, impacts from the hammer, repetition, and working above shoulder level.

Homework

- **Identify tasks that you do or other workers do that have exposures to risk factors.**
- **Complete a concern card for each task - Describe the task and risk factors. Indicate if you have any discomfort.**
- **Try to complete at least 2 concern cards.**
- **Bring your cards to the next session.**



RISK FACTOR REPORT CARD **Name:** _____

1. Work Area / Job Title: _____

2. Describe task: _____

_____

_____

3. Check all risk factors that apply:

- ☐ Poor Posture
- ☐ Repetitive Work
- ☐ Vibrating Tools
- ☐ Static Posture
- ☐ WB Vibration
- ☐ Forceful Gripping
- ☐ Heavy Lifting/Carrying
- ☐ Bouncing/Jarring
- ☐ Heavy Shoveling
- ☐ Forceful Push/Pull

Other risk factors: _____

4. Place X on affected areas.

5. Comments/suggestions: _____

_____

_____

6. Plant/Mine Name: _____

Suggested Discussion Points:

- The homework gives the participants practice at identifying risk factors associated with their jobs.
- Discuss how to complete the card. Use an example of a completed card.

Handouts / Tools / Reference Materials:

- Risk Factor Report Card
- Example of a completed Risk Factor Report Card

If you choose not to do the homework assignment, delete this slide from the presentation.

Provide date and time for the second session.

Tell participants the topics that will be covered during the second session:

- Review risk factors
- Learn:
  - Why risk factors occur (root causes)
  - How to control risk factors
- Practice:
  - Identifying risk factors
  - Improving jobs

Ergonomics and Risk Factor Awareness

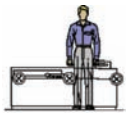
PART 1

Objectives

- To gain an understanding of:
  - **What is ergonomics**
  - **How cumulative trauma disorders develop**
  - **Ergonomic risk factors**
  - **Controlling risk factors**
- To gain an understanding of how ergonomics applies to your job

Ergonomics - What is it?

Most people look like this...



Some designers must think that people look like this...

Ergonomics is…

- Scientific study of human interaction with the work environment
- Considers physical and mental capabilities of workers as they interact with tools, equipment, work methods, tasks, and working environment
- Goal – to reduce work related injuries by adapting work to fit people

Ergonomics is …

not only the design of jobs,

tools and equipment, but

..how people use them

Is this a problem?

What one company did…

Taking the Work Out of Work

What are the Benefits?

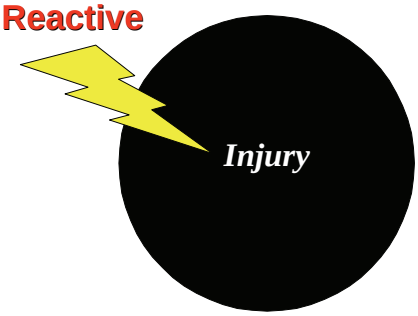
What are the Barriers?

Preventing Musculoskeletal Disorders

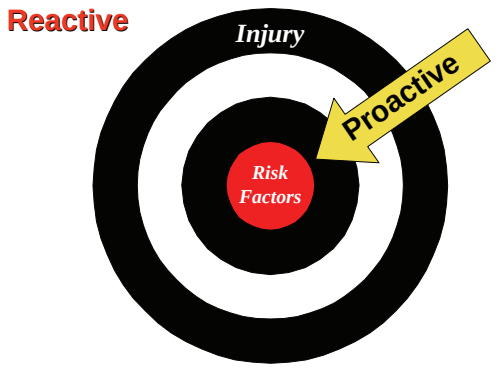
Cumulative Trauma Disorders (CTDs)
Musculoskeletal Injuries (MSIs)

Targeting Injuries

Reactive



Targeting Risk Factors



Work-Related Injuries

- ***Acute injuries*** –
  - Occur instantly
  - Examples: fractures, cuts, bruises
- ***Cumulative injuries*** –
  - Develop gradually
  - Examples: sprains/ strains, herniated discs, tendonitis, carpal tunnel syndrome

What type of injury?

Acute

or

Cumulative

??????????????????????????????????

Musculoskeletal Disorders

- **Median number of lost work days**
  - 5 days for all workers with injuries
  - 25 days for workers with MSDs
- **Average cost per injury**
  - $824 for all other cases
  - $8,070 for an MSD
- **MSDs tend to have**
  - Longer durations
  - Longer treatment time
  - Greater work disability

Case Study – Back Injuries Can be Serious

Supervisor suffered back injury helping a worker move sheet metal in January 1978

- Original injury - $1000 medical costs and no lost time
- Recurrence in 1992 cost ***$18,000***
- Surgery/comp in 1993 cost ***$81,000*** and resulted in permanent partial disability
- Additional costs of ***$55,000*** in 2001 alone

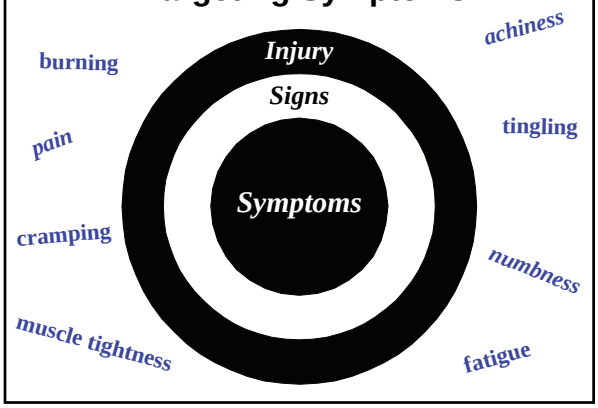
By 2002, this 1978 back injury cost over *$517,000*!

Original injury cost data did not appear to warrant investment . . . until you consider future costs.

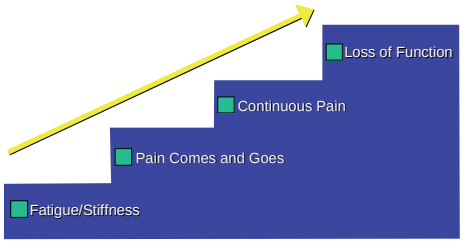
What about costs to the employee?

Targeting Signs

Targeting Symptoms

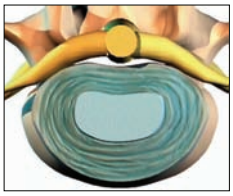


Cumulative Injury Progression

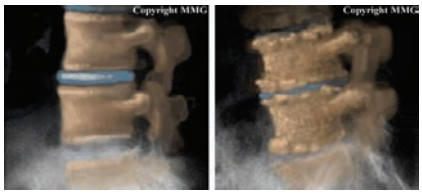


Spinal Movement

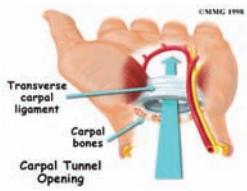
Herniated Disc



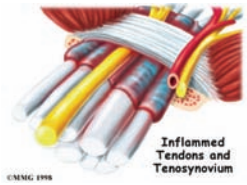
Spinal Degeneration



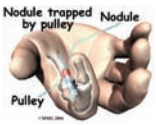
Wrist Anatomy



Tendon Movement



Trigger Finger



MSDs vs. Heart Disease

Disease (Injury)	Heart Disease	MSDs
Signs	Artery blockage	Loss of muscle function/decreased range of motion
Symptoms	Shortness of breath/chest pain/arm pain	Pain/numbness/fatigue/ tingling
Risk Factors	High blood pressure/ smoking/no physical activity/age/male/race /high cholesterol/high triglycerides	Excessive force/poor posture/repetition
Root Cause	Lifestyle/Genetics	Object weight /workstation design/ position of work piece

Address root causes to improve health!

Take Action!

As soon as you are aware of early warning signals

Report Your Concerns

Early action may prevent loss of function and serious injury!

Risk Factors

Actions or conditions found to contribute to worker discomfort or injury

Risk Factor Effects

Are hard to predict, they depend on:

- ***Who*** is doing the work
- ***How many*** risk factors there are
- ***How much*** there is of each risk factor
- ***How*** the work is done
- ***How often*** the work is done

Musculoskeletal Disorder Risk Factors

Four Main Risk Factors

1. **Forceful Work** - A lot of physical effort
2. **Poor Posture** - Poor positioning of the body
3. **Repetitive Work** - Doing the same movements many times
4. **Vibration Exposure** - Two types: hand-arm and whole body

Examples of Forceful Work

- Heavy lifting
- Carrying heavy objects
- Forceful pushing or pulling
- Forceful gripping
- Shoveling damp or heavy materials

Examples of Poor Posture

- Trunk bent over more than 20 degrees
- Twisting the trunk or head
- Elbows above shoulders
- Extended forward reaches
- Reaching behind the body
- Extreme wrist bending
- Pinch grips
- Kneeling or squatting
- Static position

Examples of Repetitive Work

- Using equipment controls
- Machine paced assembly tasks
- Packing or unpacking items
- Computer keyboarding
- Manning a store checkout line

Examples of Vibration Exposure

- Whole Body - Sitting or standing on vibrating surfaces (includes jolting and jarring)
- Hand-Arm - Using vibrating tools

Other Risk Factors

- Environmental Factors - temperature/humidity/altitude
- Contact Stress - sharp edges
- Pressure Points
- Torque Reaction

Compounding Risk Factors

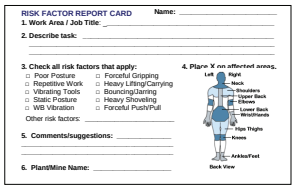
Higher Priority!

More than one risk factor present

Reducing *any one* of the risk factors *will significantly reduce* the probability of injury.

Homework

- **Identify tasks that you do or other workers do that have exposures to risk factors.**
- **Complete a concern card for each task - Describe the task and risk factors. Indicate if you have any discomfort.**
- **Try to complete at least 2 concern cards.**
- **Bring your cards to the next session.**



RISK FACTOR REPORT CARD Name: _____

1. Work Area / Job Title: _____

2. Describe task: _____

3. Check all risk factors that apply:

□ Poor Posture	□ Forceful Gripping
□ Repetitive Work	□ Heavy Lifting/Carrying
□ Vibrating Tools	□ Bouncing/Jarring
□ Static Posture	□ Heavy Shoveling
□ WB Vibration	□ Forceful Push/Pull

Other risk factors: _____

5. Comments/suggestions: _____

6. Plant/Mine Name: _____

4. Place X on affected areas.

Next Session

- **Risk Factors Review**
- **Root Causes**
- **Controlling Risk Factors**
- **Practice Exercises**

Ergonomics and Risk Factor Awareness

PART 2

PART 2

Risk Factors (Review)

Root Causes

Improving Jobs

Ergonomics and Risk Factor Awareness

PART 2

Suggested Discussion Points:

- Review why the participants are receiving this training.
- Review briefly what was covered during the first session.
- Discuss what will be covered during Part 2.

Suggested Discussion Points:

- Risk factor exposures may result in discomfort or an MSD.
- In addition to looking for and eliminating safety hazards, such as an unstable ladder or an oil spill on the floor, it is vital to identify and control MSD risk factors.
- The next few slides are a quick review of the risk factors we learned in Part 1 of the training.

Cumulative Injury Risk Factors

Four Main Risk Factors

1. **Forceful Work** - A lot of physical effort
2. **Poor Posture** - Poor positioning of the body
3. **Repetitive Work** - Doing the same movements many times
4. **Vibration Exposure** - Two types: hand-arm and whole body

Suggested Discussion Points:

- Much research has been done to identify risk factors that result in MSDs.
- The four main cumulative injury risk factors that are found in mining environments are:
  - Force
  - Posture
  - Repetition
  - Vibration

Examples of Forceful Work

- Heavy lifting
- Carrying heavy objects
- Forceful pushing or pulling
- Forceful gripping
- Shoveling damp or heavy materials

Suggested Discussion Points:

- Examples: Heavy lifting or carrying, forceful pushing or pulling, forceful gripping, and shoveling
- The actual force needed to do a job depends on many factors, such as the task being performed, the weight and shape of objects being handled, the type of grip being used, and the ability to get a good grip.
- Strength is a function of body position. The amount of force that one can produce will depend on the position relative to the object being lifted.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This video demonstrates forceful work when using a cheater bar to set torque levels.

Examples of Poor Posture

- Trunk bent over more than 20 degrees
- Twisting the trunk or head
- Elbows above shoulders
- Extended forward reaches
- Reaching behind body
- Extreme wrist bending
- Pinch grips
- Kneeling or squatting
- Static Position

Suggested Discussion Points:

- It is common for workers to use postures that put stress on their bodies.
- Elbows above shoulders, extended forward reaches, trunk bending, extreme wrist bending, pinch grips, and kneeling or squatting are poor postures often seen in the work environment.
- Because work is dynamic, several different safe postures should be used throughout the work shift.
- Avoid using a static posture, i.e., staying in the same position for prolonged periods.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This video demonstrates poor postures when operating water cannons.

Examples of Repetitive Work

- Using equipment controls
- Machine paced assembly tasks
- Packing or unpacking items
- Computer keyboarding
- Manning a store checkout line

Suggested Discussion Points:

- Highly repetitive motions are repeated every few seconds or minutes.
- Using equipment controls, machine-paced assembly tasks, packing or unpacking items, computer keyboarding, and working at a store checkout line are commonly repetitious jobs.
- Some parts of the body are more likely to be affected by repetitive motion than other parts, e.g., the wrist, elbow, and shoulder.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This worker is shoveling material from the walkway alongside of a conveyor. This task is done periodically throughout the shift every day.

Examples of Vibration Exposure

- Whole Body - Sitting or standing on vibrating surfaces (Includes jolting & jarring)
- Hand-Arm - Using vibrating tools

Suggested Discussion Points:

- Hand-arm and whole-body vibration are the primary forms of vibration exposure.
- Commonly used power tools like sanders and drills have moderate hand-arm vibration levels.
- Tools like impact wrenches and jackhammers have high hand-arm vibration levels.
- Whole-body vibration is often caused from riding in mobile equipment like haul trucks or forklifts.

Short-term effects of too much hand-arm vibration are reduced blood flow and loss of ability to feel things that are cold, hot, rough, or sharp.

Exposure to whole-body vibration may also cause headaches, nausea, and back problems.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This video demonstrates hand-arm vibration when using a chipping hammer.

Other Risk Factors

- Environmental Factors - temperature/humidity/altitude
- Contact Stress - sharp edges
- Pressure Points
- Torque Reaction

Suggested Discussion Points:

Other risk factors that occur at mining sites include:

- Environmental conditions: heat stress, cold stress, high humidity, altitude
- Contact stress (sharp edges on desk/table tops)
- Pressure points
- Torque reaction: hand/arm is jerked when tightening bolts with a pneumatic wrench

Compounding Risk Factors

Higher Priority!

More than one risk factor present

Reducing *any one* of the risk factors *will significantly reduce* the probability of injury.

Suggested Discussion Points:

- An MSD is more likely to occur if the exposure involves multiple risk factors.
- Reducing the exposure to some of the risk factors will significantly reduce the chance of developing a MSD.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This video demonstrates various compounding risk factors. The workers are rebuilding a crusher and need to remove the springs. Risk factors observed included forceful exertions, forceful gripping, impacts from the hammer, repetition, and working above shoulder level.

Stacking boxes

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This person is stacking boxes of potatoes, which weigh 50 pounds. He lifts the boxes off of the conveyor belt and places them on top of the other stacked boxes. This job is done for 12 hours/shift. It is a seasonal job lasting 6–8 weeks. Although the video only shows the worker stacking boxes above his shoulders, he also places the boxes on the pallets, which would entail lowering the boxes below his knees.

Participants might be able to relate this job task to something they might see in a receiving area, or stacking or moving materials used in a maintenance area.

It is important to redesign a lifting task that may cause injury instead of simply giving the worker a back belt. In the example, the worker is at risk whether he is wearing the back belt or not.

Questions to pose are:

1. What risk factors are present here?
2. What part of the body is affected?
3. What do you think about the back belt? (If this has not already been mentioned, discuss the use of back belts.)

Write participants' comments on a white board.

Props / Materials Needed:

- White board or flip chart
- Could use overhead to show and fill out Task Evaluation Form

Handouts / Tools / Reference Materials:

- UCLA ergonomics: tips for lifting safety. http://ergonomics.ucla.edu/Tips_Lifting.html

- NIOSH [1996]. Back belts: do they prevent injury? Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–127.

- NIOSH facts: back belts. http://www.cdc.gov/niosh/backfs.html

- Summary of NIOSH back belt studies (March 2002). http://www.cdc.gov/niosh/beltsumm.html

- Wassell JT, Gardner LI, Landsittel DP, Johnston JJ, Johnston JM [2000]. A prospective study of back belts for prevention of back pain and injury. JAMA *284*:2727–2732.

- Scientific Look at Back Belts (videotape – catalog No. VC 937). To order, contact:

  Mine Safety and Health Administration (MSHA)
  National Mine Health and Safety Academy
  Department of Instructional Materials
  Printing and Property Management Branch
  1301 Airport Rd.
  Beaver, WV 25813–9426
  Phone: 304–256–3257
  e-mail: MSHADistributionCenter@dol.gov

Task Evaluation

Task Name: Box Stacking

Risk Factors Observed

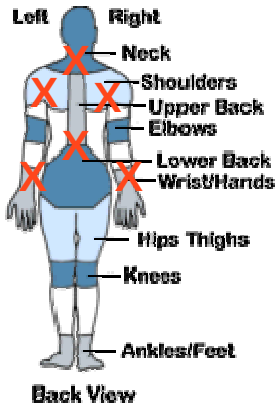
X Poor Posture	X Forceful Gripping
☐ Static Posture	X Heavy Lifting/Carrying
☐ Contact Stress	☐ Forceful Pushing/Pulling
☐ Pressure Points	☐ Heavy Shoveling
☐ Torque Reaction	☐ Vibrating Tools
X Repetitive Work	☐ Bouncing/Jarring
☐ Environment	☐ Whole Body Vibration

☐ Other (describe): _____

☐ Other (describe): _____

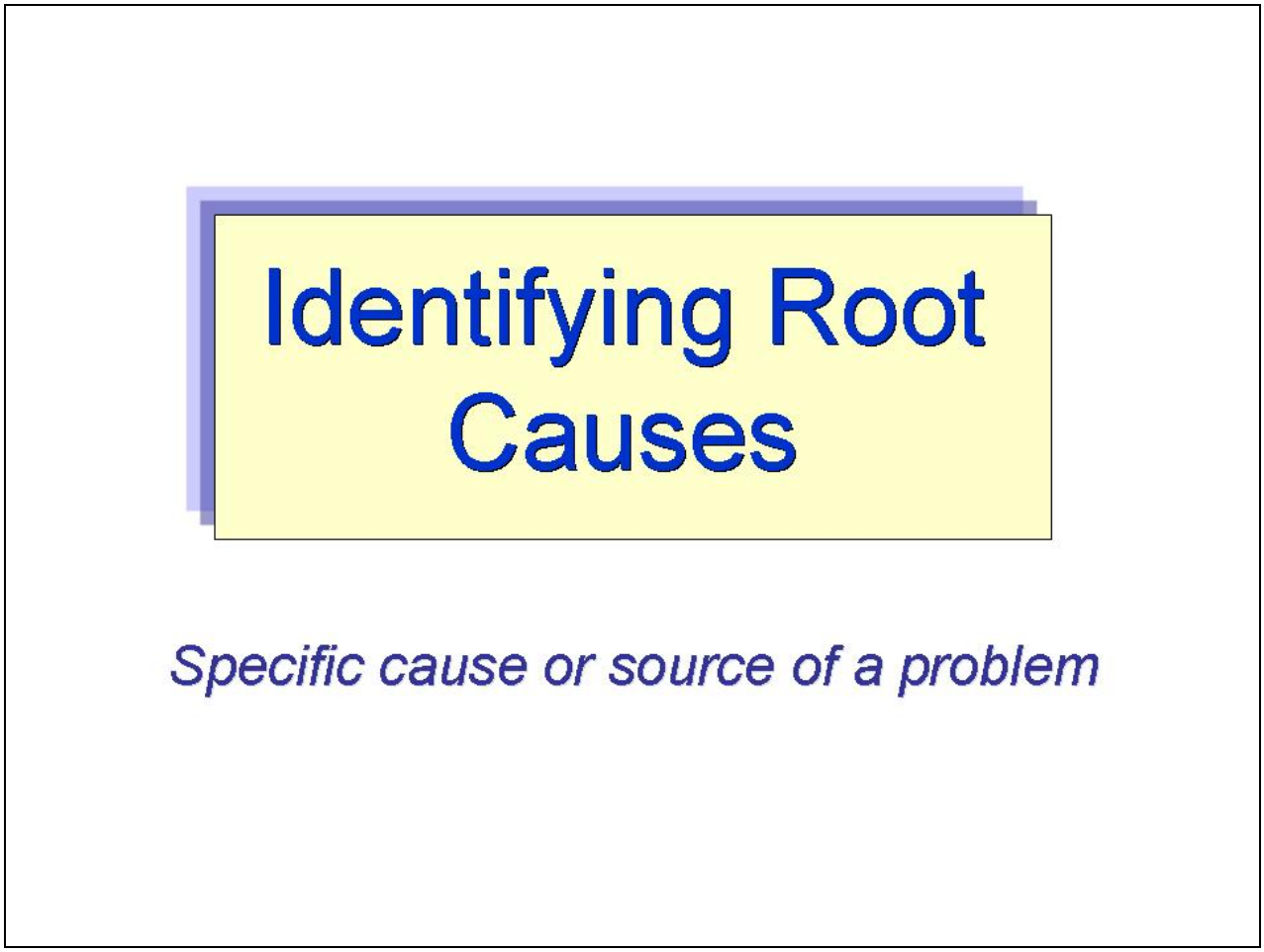
☐ Other (describe): _____

Body Parts Affected



Demos / Stories / Examples:

This is a completed form showing what an observer might identify for the box-stacking task. Comment on similarities and differences between what was identified by the participants and this form.



Suggested Discussion Points:

- A root cause contributes or creates an undesired outcome.
- A root cause is the specific cause or source of a problem.
- There may be more than one root cause resulting in exposures to risk factors.
- There are many different root causes for MSD risk factors.

In order to reduce the chance of an injury, we must eliminate the causes.

Risk Factor Root Causes

- ***Effort*** or strength required
- ***Location*** of parts, equipment, or tools
- ***Position*** of parts, equipment, or tools
- ***Design*** of parts, equipment, or tools
- ***Speed*** of work (cycle time)
- ***Frequency*** of work
- ***Duration*** of task
- ***Productivity*** levels

Suggested Discussion Points:

- Observations help us understand why jobs are done certain ways.
- Observations and measurements are essential to identifying root causes.
- Measurements can also determine how much there is of each risk factor. This will be useful to know if the changes that are made result in less exposure.

NOTE: Sometimes there is confusion as to the difference between location and position of parts. Location is where the part is placed—on the workbench, on the floor, suspended from a hoist, etc. Position is how the part is oriented relative to the worker—lying flat, placed upright on a side, tilted to one side, etc.

Speed is how fast a task is done or cycle time. Frequency is how often a task is done—the number of times during the day, number of days per week, or number of weeks per month or year. Duration is how long the same task is done during the work shift.

Root Causes – cont.

- ***Process*** used or required to do the task
- ***Training*** - skill development
- ***PPE*** - worn to do task
- ***Environment*** – restricted work space

Stacking Boxes

Suggested Discussion Points:

Identify root causes for the risk factors identified by the participants.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. Play the video and ask the participants to identify the root causes for the risk factors that they had identified earlier. Write their responses on the white board.

If participants are reluctant to provide answers to your question, give prompts such as:

- What determines the effort exerted by the worker in the video? *(weight of the boxes)*
- Where are the boxes stacked? *(stacked from the floor to above shoulder height)*
- How is the box lifted? *(worker grabs the side and bottom because there are no handles*)
- What determines how many boxes are lifted each minute? *(conveyor speed)*

If participants discuss the use of back belts, inform them that back belts do not help with lifting. The damage to the back is internal, and the back belt cannot stabilize these internal components. Refer to the reference material below for more information.

Props / Materials Needed:

White board or flip chart.

Handouts / Tools / Reference Materials:

- NIOSH [1996]. Back belts: do they prevent injury? Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–127.

Task Evaluation – Root Causes

Process used to do task	Box stacks start at floor level and go to above shoulder/manually lift and carry boxes
Effort/strength required	Boxes weigh 50 lbs
Location of parts, equipment or tools	Lower to floor level / Lift to shoulder level required
Position of parts, equipment or tools	Position of conveyor & pallets promotes twisting
Design of parts, equipment or tools	Box size/design makes it hard to carry
Speed of task	Conveyor sets speed
Frequency or repetition of task	Conveyor pace sets repetition
Duration of task	Task is done 12 hours per day
Productivity levels	Limited time to ship product
Environment	
Training	
PPE	Back belt ??

Demos / Stories / Examples:

This is a completed form showing the root causes identified by an observer for the box-stacking task. Comment on the similarities and differences between what the participants identified and the form.

Video Tape Examples

Three key questions:

1. What is the risk factor(s)?
2. What part(s) of the body is affected?
3. What is causing the risk factor(s)?

Demos / Stories / Examples:

In this exercise, the participants will watch someone performing a job and then decide which risk factors are present, identify the part of the body that is affected by the risk factors, and decide what might be causing the risk factors.

Format: This exercise can be done by each individual participant or as a team exercise. If a team format is used, divide the class into two or three teams and ask each team to answer the three questions. Record the answers on the job evaluation form. Give them about 10 minutes to do the exercise. After the exercise has been completed, ask the participants/teams to share their responses.

Handouts / Tools / Reference Materials:

- Summary page of common risk factors
- Job evaluation forms—enough for each participant/team for two exercises

Brake Repair

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. These two mechanics are performing a brake repair job for a haul truck. The mechanics work 12-hour shifts, 4 days/week. This task is one of many performed by the mechanics.

Task Evaluation

Task Name: Brake Repair

Risk Factors Observed

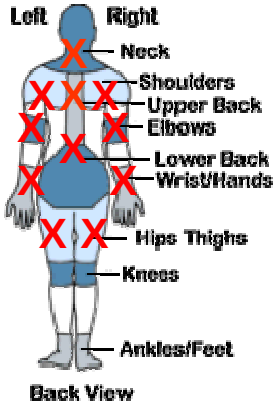
X Poor Posture	X Forceful Gripping
X Static Posture	X Heavy Lifting/Carrying
▫ Contact Stress	▫ Forceful Pushing/Pulling
X Pressure Points	▫ Heavy Shoveling
▫ Torque Reaction	X Vibrating Tools
▫ Repetitive Work	▫ Bouncing/Jarring
▫ Environment	▫ Whole Body Vibration

▫ Other (describe): _Cold Floor_____

▫ Other (describe): _____

▫ Other (describe): _____

Body Parts Affected



Demos / Stories / Examples:

This completed form shows the risk factors/body parts affected as identified by an observer for the brake repair task.

Comment on similarities and differences between what the participants identified and this form.

Task Evaluation - Root Causes

Process used to do task	Use power tool to remove bolts from brake assembly for haul truck
Effort/strength required	Hold tool (weight about 15 pounds)
Location of parts, equipment or tools	Brake assembly on floor
Position of parts, equipment or tools	Bolts about 20 inches above floor
Design of parts, equipment or tools	Vibration exposure from tool
Speed of task	
Frequency or repetition of task	
Duration of task	Must remove all bolts from assembly
Productivity levels	
Environment	Concrete floor
Training / PPE	No PPE provided

Demos / Stories / Examples:

This completed form shows the root causes identified by an observer for the brake repair task.

Comment on similarities and differences between what the participants identified and this form.

Hydraulic Pit Station Operator

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. This video shows two operators using two different hydraulic pit stations at a phosphate mine. They work in this pit station all day. They are responsible for mixing the phosphate with water so it can be piped to the processing plant.

Task Evaluation

Task Name: Hydraulic Pit Operation

Risk Factors Observed

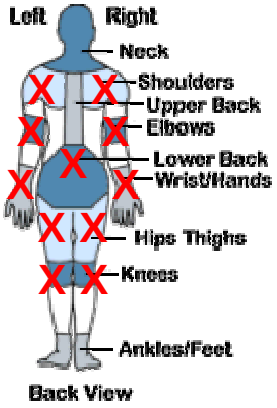
X Poor Posture	X Forceful Gripping
X Static Posture	☐ Heavy Lifting/Carrying
X Contact Stress	☐ Forceful Pushing/Pulling
X Pressure Points	☐ Heavy Shoveling
☐ Torque Reaction	☐ Vibrating Tools
X Repetitive Work	☐ Bouncing/Jarring
☐ Environment	X Whole Body Vibration

☐ Other (describe): _____

☐ Other (describe): _____

☐ Other (describe): _____

Body Parts Affected



Demos / Stories / Examples:

This completed form shows the risk factors/body parts affected as identified by an observer for the hydraulic pit station operator.

Comment on similarities and differences between what the participants identified and this form.

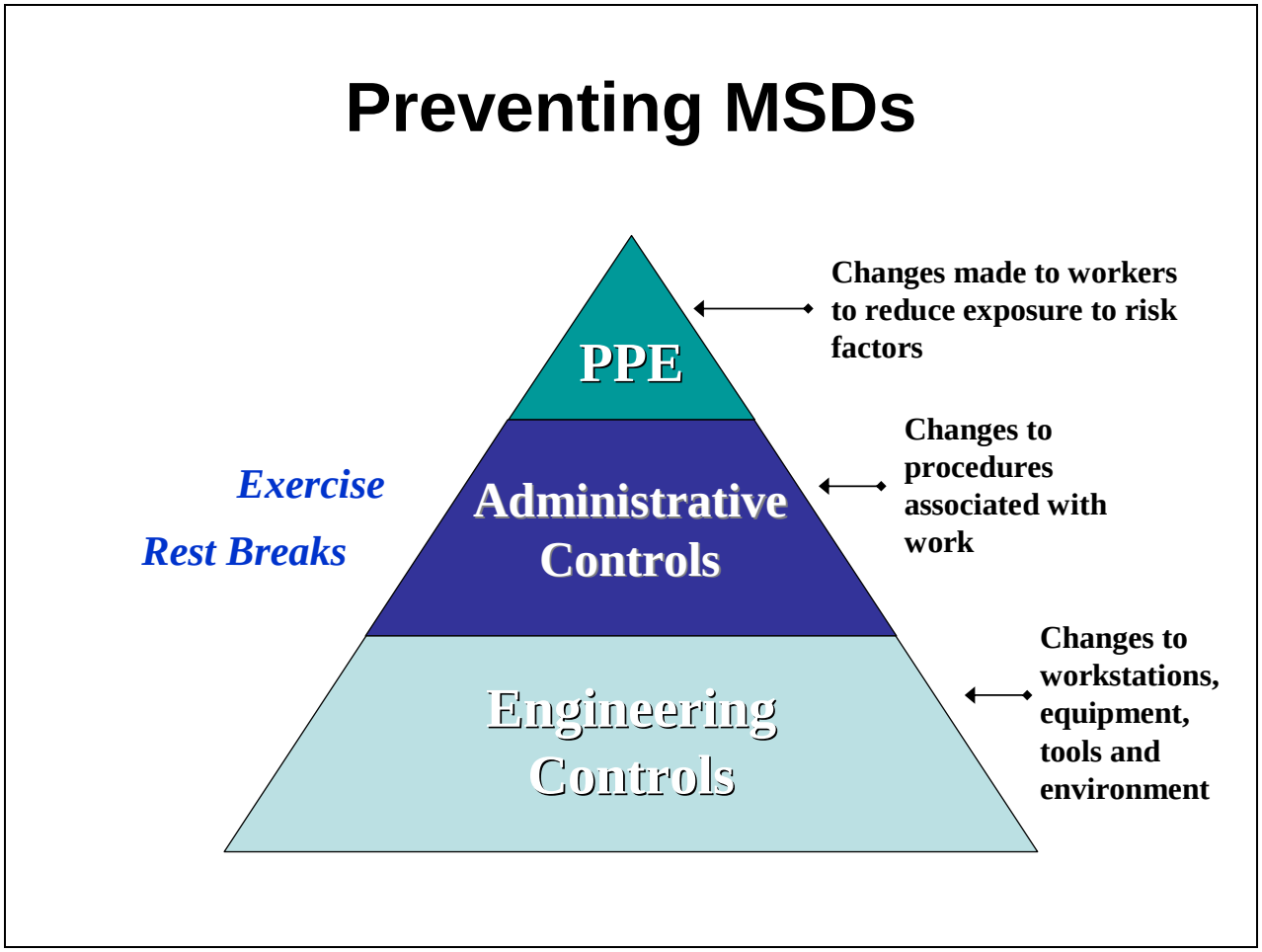
Task Evaluation - Root Causes

Process used to do task	
Effort/strength required	Use of quick, forceful gripping actions to position controls when moving tree stumps and logs
Location of parts, equipment or tools	Location of control causes leaning in and reaching
Position of parts, equipment or tools	Flat control table top increases reaches
Design of parts, equipment or tools	Sharp edge on control top causes contact stress; type of control causes frequent & exaggerated movements; poor seat – no arm rests/allows vibration exposure
Speed of task	Work pace controlled by dragline production
Frequency/repetition of task	Work pace controlled by dragline production
Duration of task	12 hour shift with few breaks
Productivity levels	
Environment	
Training / PPE	

Demos / Stories / Examples:

This completed form shows the root causes identified by an observer for the hydraulic pit station operator.

Comment on similarities and differences between what the participants identified and this form.



Suggested Discussion Points:

- The job improvement pyramid shows the three types of controls or job improvement categories that most changes fall into:
  - Engineering controls
  - Administrative controls
  - Personal protective equipment (PPE)
- The approaches used for preventing MSDs are the same as those used for preventing acute injuries and occupational diseases.

Engineering controls are the changes that we prefer to do, but are sometimes costly and take more time.

Administrative Controls are changes to work procedures. An example of this may be daily or weekly job rotation so that one person does not get excessive exposure to a particularly difficult job.

> *Exercise*, which is a change a person makes to himself/herself, can go a long way to improving an individual's health and safety, both on and off the job.
>
> *Rest breaks* fall into the category of changes to work practices. They should be scheduled into any procedure, especially ones that are physically demanding.

Personal protective equipment (PPE) is a “Band-Aid” fix to a larger problem. For instance, hearing protection is used when a machine or tool has high noise levels and protection is needed. If the noise were “engineered out” of the machine or tool, the “Band-Aid” would not be needed.

Demos / Stories / Examples:

Have the participants think of the food pyramid: the top of the pyramid represents something that is necessary, but should be kept in small amounts, like oils and fats. As you move toward the bottom of the pyramid, these are methods that you want to use for improving jobs. Engineering controls are recommended as the first course of action.

Engineering Controls

- Workstation / Workplace layout
- Equipment
- Tools
- Work environment
- Work methods

"Suspending your keyboard from the ceiling forces you to sit up straight, thus reducing fatigue."

Suggested Discussion Points:

- Engineering controls are the most effective type of controls because they remove or minimize the exposure to the risk factor.
- Engineering controls can be applied to every aspect of a task: equipment, tools, work station, layout, methods, and environment.
- There are many simple and inexpensive engineering controls.
- When engineering controls are used, it is important to evaluate the changes to ensure that other risk factors are not introduced.

Administrative Controls

- Job enlargement
- Job rotation
- Work pace and duration
- Work-rest cycles
- Training
- Shift schedule / overtime
- Exercises / stretches

Slide Pointers:

This slide is animated so that the content of the slide is hidden when it is first displayed on the screen. This will allow discussion by the participants. On the second click of the mouse, the list will appear.

Suggested Discussion Points:

- Administrative controls can take many forms.
- The success of administrative controls usually depends on effective monitoring by management and feedback from employees.
- Job enlargement and job rotation both seek to vary the exposures that a worker experiences. The objective of both is to limit exposures of a body part to a particular risk factor. Job enlargement occurs when multiple tasks are added to a job. Job rotation occurs when the number of tasks remains the same, but they are rotated throughout the work shift.

Demos / Stories / Examples:

Format: Ask participants to identify different types of administrative controls. A team format can also be used. Ask each team to make a list of administrative controls for preventing MSDs. Determine which team has the most correct responses. Instead of using teams, the format for the "Family Feud" TV game show can also be used for this slide.

Personal Protective Equipment

- Anti-Vibration gloves – reduce vibration transmission
- Knee pads – reduce pressure points
- Shoe inserts – reduce discomfort
- Cooling devices – reduce body temperature increases
- Cold weather clothing – prevents hypothermia/frost bite

Slide Pointers:

This slide is animated so that the content of the slide is hidden when it is first displayed on the screen. This will allow discussion by the participants. On the second click of the mouse, the list will appear. On the third click of the mouse, the graphics will appear.

Suggested Discussion Points:

- PPE to prevent MSDs and environmental stress: available PPE is limited.
- PPE is only a barrier between the employee and the risk factor.
- How well PPE protects employees depends on several factors, such as using it as intended and the quality of PPE.
- PPE can be expensive, e.g., periodically replaced, cleaning issues, maintenance issues.

Demos / Stories / Examples:

Format: Ask participants to identify different types of PPE. A team format can also be used. Ask each team to make a list of PPE for preventing MSDs and environmental disorders. Determine which team has the most correct responses. Instead of using teams, the format for the “Family Feud” TV game show can also be used for this slide.

If you have examples of the PPE shown in this slide, the PPE can be shown to the participants.

Lifting with your legs is not always the answer to preventing injury!

Suggested Discussion Points:

Lesson to be learned: You can try to train things out, but that is only trying to make up for a very poor design, which must be constantly monitored for proper performance. Engineering controls require workers to do the task while removing or reducing the exposures.

Job Improvement Exercise

- What can be done to reduce the risk factor(s)?
- What category do the changes fall under?
  - Engineering control
  - Administrative control
  - Personal protective equipment

Suggested Discussion Points:

Encourage identifying controls that fall within the different categories.

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance. The brake repair and hydraulic pit station operators will be shown again. This time, ask the participants to identify solutions to reduce the risk factors. Talk about what type of improvement can be made, i.e., is it an engineering control, administrative control, or PPE? Remind them that reducing the risk factors is a proactive step to reducing symptoms and signs, which will, of course, reduce or even eliminate injuries.

Format: This exercise can be done by each individual participant or as a team exercise. If a team format is used, divide the class into two or three teams and ask each team to determine potential controls. Record the answers on the job evaluation form. Give them about 10 minutes to do the exercise. After the exercise has been completed, ask the participants/teams to share their responses.

Brake Repair

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance.

If participants are not able to identify controls, examples of controls include:

- Engineering:
  - Place pedestal on an adjustable-height table.
  - Position part so nuts are on the side and not bottom.
- Administrative:
  - Reduce shift to 8 hours.
  - Rotate tasks with improved postures.
- PPE:
  - Antivibration glove
  - Cushion to place on the floor

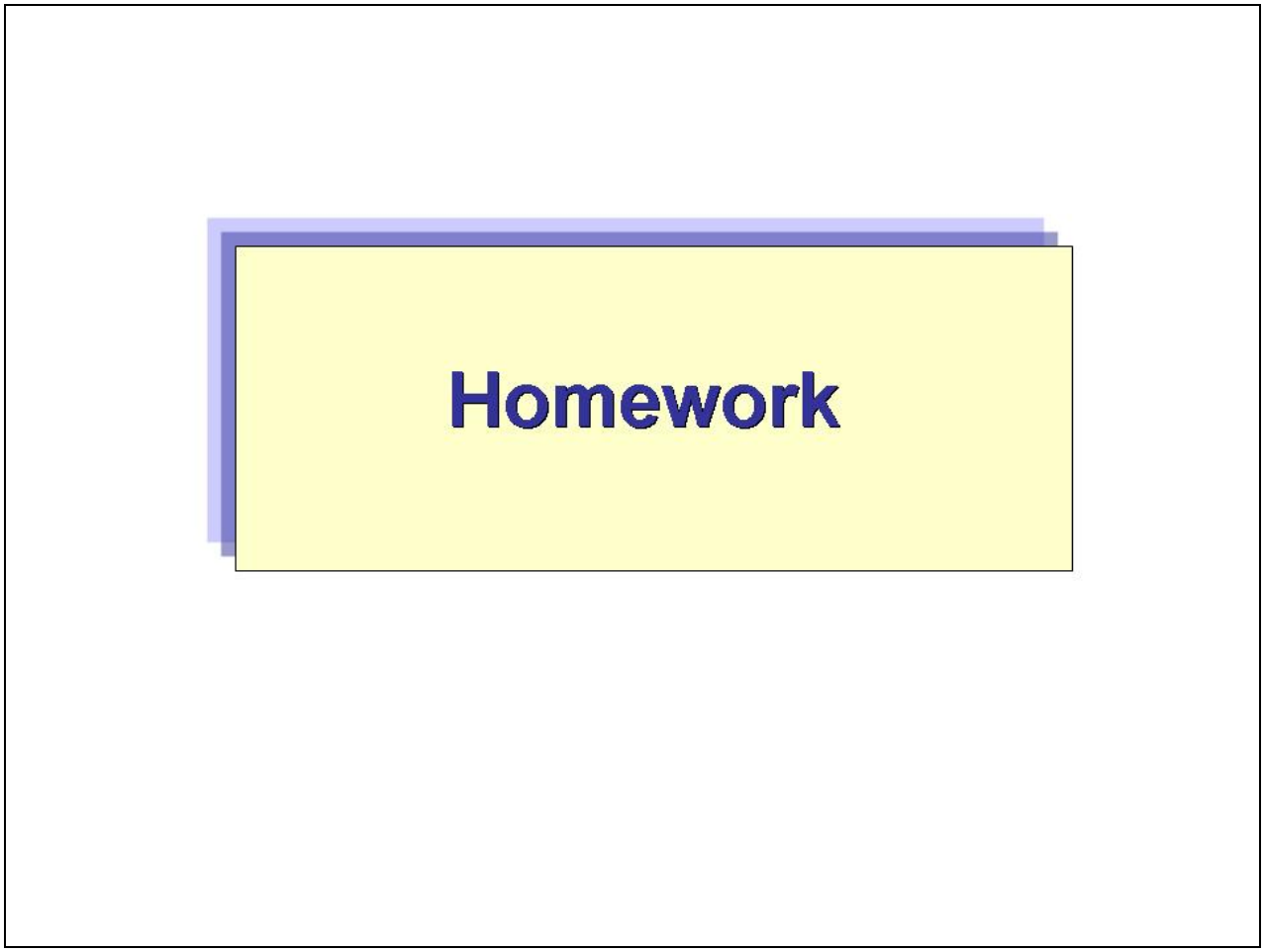
Hydraulic Pit Station Operator

Demos / Stories / Examples:

Video: Click on the picture to start the video, and then click it again to stop the video when you are done. To move to the next slide, make sure your pointer is no longer on the picture. This will allow the presentation to advance.

If participants are not able to identify controls, examples of controls include:

- Engineering:
  - Rearrange controls so operator can see feeder without looking to the side.
  - Pad the window seal to eliminate sharp edge.
  - Provide chair so operator does not have to stand.
  - Provide antifatigue mat when standing to operate controls.
- Administrative:
  - Reduce length of shift.
  - Rotate to a different task—not operating equipment with joysticks
- Personal protective equipment:
  - Forearm pad



Suggested Discussion Points:

Risk factors observed by the workers and tasks associated with observed risk factors

Demos / Stories / Examples:

Ask participants to provide information obtained for their homework. Make a list of the tasks and the risk factor observed.

If the participants are not able to identify risk factors, give them some simple examples.

- Mechanics use pneumatic wrenches: What is the risk factor exposure? *(vibration)*
- Welders use chipping hammers: What is the risk factor exposure? *(vibration)*
- Mechanics work under vehicles: What is the risk factor exposure? *(restricted spaces, awkward postures)*
- Heavy equipment operator turns a steering wheel when driving a bulldozer: What is the risk factor exposure? *(repetition)*

If the participants are able to identify risk factors, comment on the need to apply ergonomic principles to their jobs (find root causes and generate solutions that follow ergonomic principles).

Props / Materials Needed:

White board or flip chart

If the homework assignment was not done, delete this slide from the training.

Suggested Discussion Points:

- Zero in on the risk factors in order to reduce injuries at work and at home proactively.
- Avoid waiting for injuries to occur.
- Even signs and symptoms are reactive.

Risk Factor Report Card

RISK FACTOR REPORT CARD **Name:** _____

1. Work Area / Job Title: _____

2. Describe task: _____

_____

_____

3. Check all risk factors that apply:

□ Poor Posture	□ Forceful Gripping
□ Repetitive Work	□ Heavy Lifting/Carrying
□ Vibrating Tools	□ Bouncing/Jarring
□ Static Posture	□ Heavy Shoveling
□ WB Vibration	□ Forceful Push/Pull

Other risk factors: _____

4. Place X on affected areas.

5. Comments/suggestions: _____

_____

_____

6. Plant/Mine Name: _____

Suggested Discussion Points:

- Example of a form that can be used to report concerns about participants' jobs
- Similar to what they have done during the exercises and homework

Demos / Stories / Examples:

Encourage participants to take an active role in identifying risk factors associated with their jobs and deciding how to improve their jobs to reduce risk factors. At this time, give a card to each employee and ask him/her to complete it if he/she has not completed one for the homework. Instruct the participants to return the completed cards to you.

Handouts / Tools / Reference Materials:

- Concern cards—enough for each participant
- Pens/pencils

If you choose to use a different reporting system, replace this slide with your system.

Take Action!

As soon as you are aware of risk factors,

Report Your Concerns

Early action may prevent loss of function and serious injury!

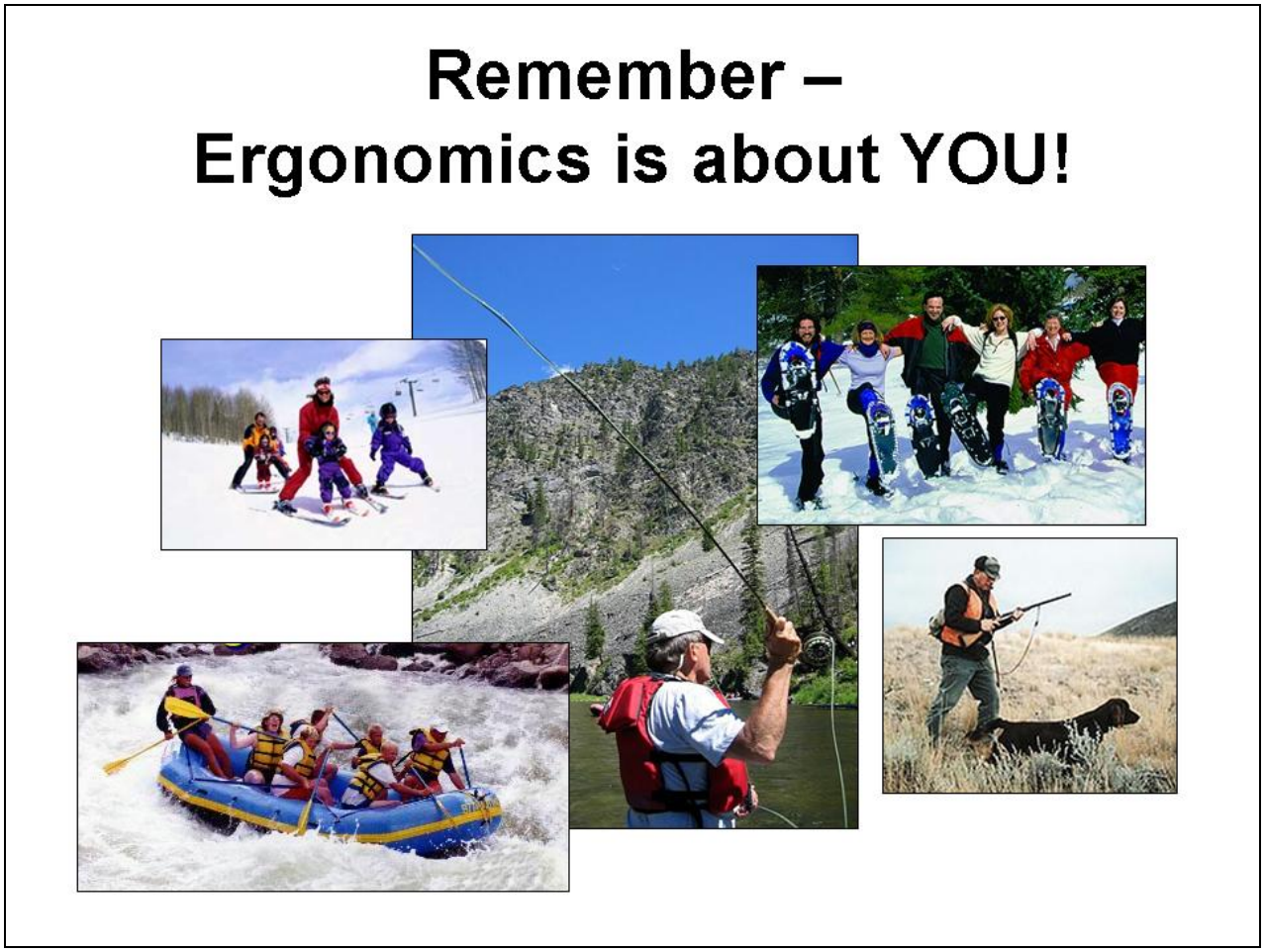
Suggested Discussion Points:

- Participants should be able to recognize risk factors and early warning signs.
- Take action by reporting your concerns.
- It is important not to assume that fatigue, discomfort, or difficult working conditions are just "part of the job."
- Role of the supervisor, safety manager, ergonomics coordinator

Demos / Stories / Examples:

At this time, it may be appropriate to discuss the role of the supervisor in the ergonomics process. Potential roles may include:

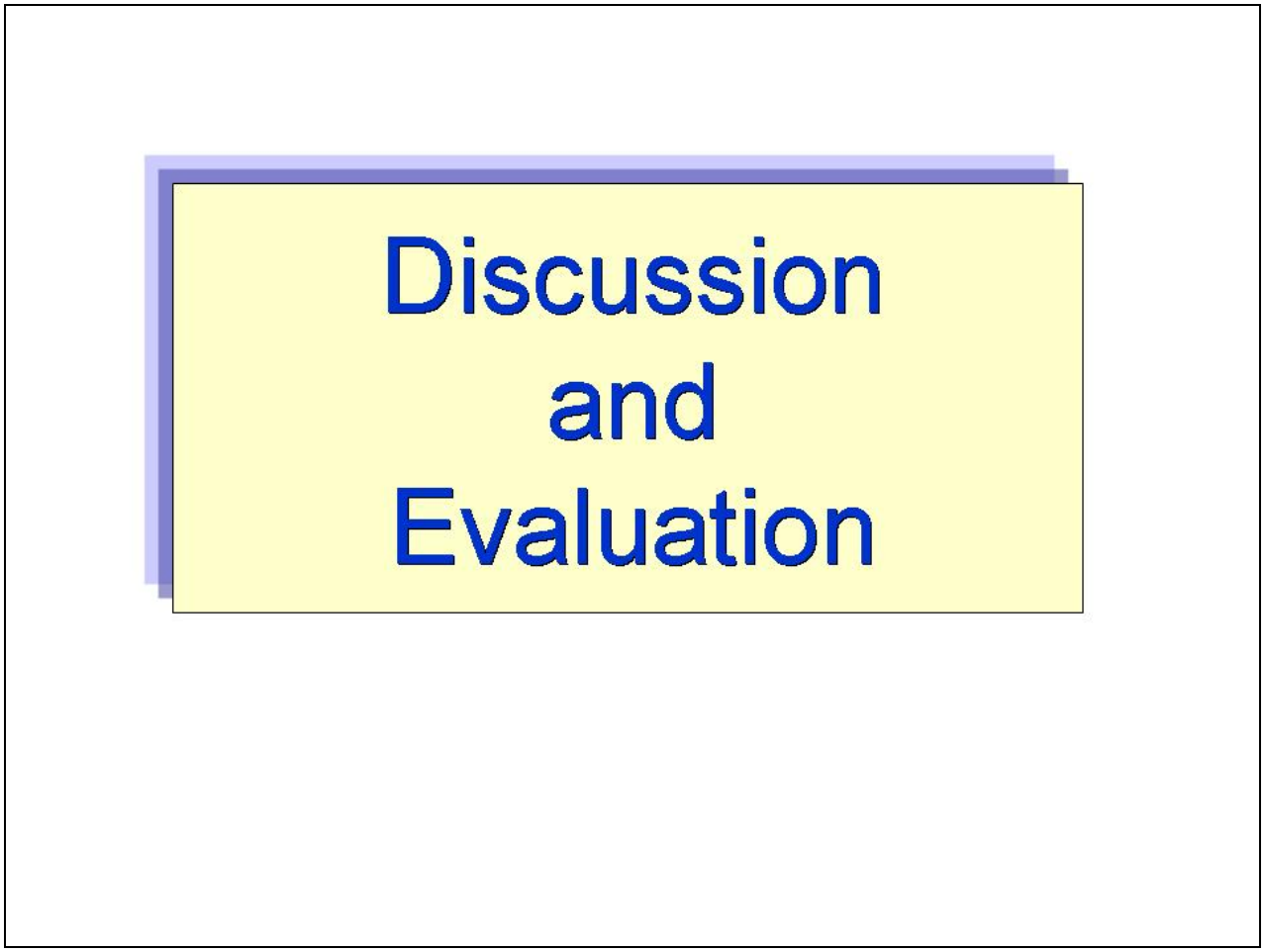
- Being an advocate for the ergonomics process
- Encouraging employees to report concerns
- Participating in improving jobs
- Providing necessary resources
- Serving as a communication link between employees and the ergonomics coordinator/ champion (safety and health representative for the company)



Suggested Discussion Points:

Remind participants that ergonomics will be a benefit to them. Applying ergonomics can lead to many benefits for the employee, including:

- Staying healthy as you get older
- Enjoying leisure time activities
- Reducing discomfort
- Reducing fatigue
- Enhancing quality of life
- Making job safer
- Designing jobs for the next generation of workers—your children
- Improving quality of work
- Increasing efficiency by working smarter
- Preventing musculoskeletal disorders



Suggested Discussion Points:

- Answer any questions the participants may have.
- Encourage employees to participate in the process, reporting concerns and helping to resolve concerns as part of a team. Anyone can give suggestions at any time.
- Ask participants to complete the course evaluation form. Encourage them to take the time to give honest and direct feedback.

Handouts / Tools / Reference Materials:

- Course evaluation form
- Ergonomics glossary

Ergonomics and Risk Factor Awareness

PART 2

Identifying Risk Factors

Remember –

Risk factors are actions or conditions found to contribute to worker discomfort or injury

Cumulative Injury Risk Factors

Four Main Risk Factors

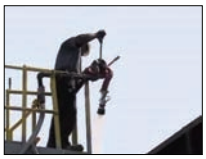
1. **Forceful Work** - A lot of physical effort
2. **Poor Posture** - Poor positioning of the body
3. **Repetitive Work** - Doing the same movements many times
4. **Vibration Exposure** - Two types: hand-arm and whole body

Examples of Forceful Work

- Heavy lifting
- Carrying heavy objects
- Forceful pushing or pulling
- Forceful gripping
- Shoveling damp or heavy materials

Examples of Poor Posture

- Trunk bent over more than 20 degrees
- Twisting the trunk or head
- Elbows above shoulders
- Extended forward reaches
- Reaching behind body
- Extreme wrist bending
- Pinch grips
- Kneeling or squatting
- Static Position



Examples of Repetitive Work

- Using equipment controls
- Machine paced assembly tasks
- Packing or unpacking items
- Computer keyboarding
- Manning a store checkout line

Examples of Vibration Exposure

- Whole Body - Sitting or standing on vibrating surfaces (Includes jolting & jarring)
- Hand-Arm - Using vibrating tools

Other Risk Factors

- Environmental Factors - temperature/humidity/altitude
- Contact Stress – sharp edges
- Pressure Points
- Torque Reaction

Compounding Risk Factors

Higher Priority!

More than one risk factor present

Reducing *any one* of the risk factors *will significantly reduce* the probability of injury.

Stacking boxes

Task Evaluation

Task Name: Box Stacking

Risk Factors Observed

X Poor Posture	X Forceful Gripping
▫ Static Posture	X Heavy Lifting/Carrying
▫ Contact Stress	▫ Forceful Pushing/Pulling
▫ Pressure Points	▫ Heavy Shoveling
▫ Torque Reaction	▫ Vibrating Tools
X Repetitive Work	▫ Bouncing/Jarring
▫ Environment	▫ Whole Body Vibration

▫ Other (describe): _____
▫ Other (describe): _____
▫ Other (describe): _____

Body Parts Affected

Identifying Root Causes

Specific cause or source of a problem

Risk Factor Root Causes

- ***Effort*** or strength required
- ***Location*** of parts, equipment, or tools
- ***Position*** of parts, equipment, or tools
- ***Design*** of parts, equipment, or tools
- ***Speed*** of work (cycle time)
- ***Frequency*** of work
- ***Duration*** of task
- ***Productivity*** levels

Root Causes – cont.

- ***Process*** used or required to do the task
- ***Training*** - skill development
- ***PPE*** - worn to do task
- ***Environment*** – restricted work space

Stacking Boxes

Task Evaluation – Root Causes

Process used to do task	Box stacks start at floor level and go to above shoulder/manually lift and carry boxes
Effort/strength required	Boxes weigh 50 lbs
Location of parts, equipment or tools	Lower to floor level / Lift to shoulder level required
Position of parts, equipment or tools	Position of conveyor & pallets promotes twisting
Design of parts, equipment or tools	Box size/design makes it hard to carry
Speed of task	Conveyor sets speed
Frequency or repetition of task	Conveyor pace sets repetition
Duration of task	Task is done 12 hours per day
Productivity levels	Limited time to ship product
Environment	
Training	
PPE	Back belt ??

Video Tape Examples

Three key questions:

1. What is the risk factor(s)?
2. What part(s) of the body is affected?
3. What is causing the risk factor(s)?

Brake Repair

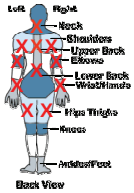
Task Evaluation

Task Name: Brake Repair

Risk Factors Observed

- X Poor Posture
- X Static Posture
- ▫ Contact Stress
- X Pressure Points
- ▫ Torque Reaction
- ▫ Repetitive Work
- ▫ Environment
- ▫ Other (describe): Cold Floor
- ▫ Other (describe): _____
- ▫ Other (describe): _____
- X Forceful Gripping
- X Heavy Lifting/Carrying
- ▫ Forceful Pushing/Pulling
- ▫ Heavy Shoveling
- X Vibrating Tools
- ▫ Bouncing/Jarring
- ▫ Whole Body Vibration

Body Parts Affected



Task Evaluation - Root Causes

Process used to do task	Use power tool to remove bolts from brake assembly for haul truck
Effort/strength required	Hold tool (weight about 15 pounds)
Location of parts, equipment or tools	Brake assembly on floor
Position of parts, equipment or tools	Bolts about 20 inches above floor
Design of parts, equipment or tools	Vibration exposure from tool
Speed of task	
Frequency or repetition of task	
Duration of task	Must remove all bolts from assembly
Productivity levels	
Environment	Concrete floor
Training / PPE	No PPE provided

Hydraulic Pit Station Operator

Task Evaluation

Task Name: Hydraulic Pit Operation

Risk Factors Observed

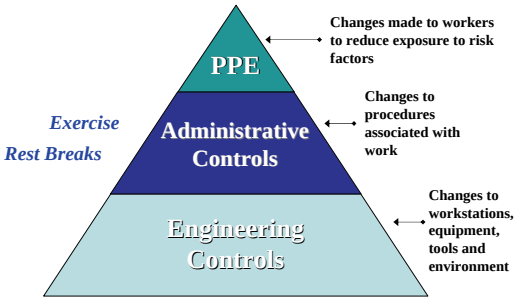
- X Poor Posture
- X Static Posture
- X Contact Stress
- X Pressure Points
- ▫ Torque Reaction
- X Repetitive Work
- ▫ Environment
- ▫ Other (describe): _____
- ▫ Other (describe): _____
- ▫ Other (describe): _____
- X Forceful Gripping
- ▫ Heavy Lifting/Carrying
- ▫ Forceful Pushing/Pulling
- ▫ Heavy Shoveling
- ▫ Vibrating Tools
- ▫ Bouncing/Jarring
- X Whole Body Vibration

Body Parts Affected

Task Evaluation - Root Causes

Process used to do task	
Effort/strength required	Use of quick, forceful gripping actions to position controls when moving tree stumps and logs
Location of parts, equipment or tools	Location of control causes leaning in and reaching
Position of parts, equipment or tools	Flat control table top increases reaches
Design of parts, equipment or tools	Sharp edge on control top causes contact stress; type of control causes frequent & exaggerated movements; poor seat – no arm rests/allows vibration exposure
Speed of task	Work pace controlled by dragline production
Frequency/repetition of task	Work pace controlled by dragline production
Duration of task	12 hour shift with few breaks
Productivity levels	
Environment	
Training / PPE	

Preventing MSDs



Engineering Controls

- Workstation / Workplace layout
- Equipment
- Tools
- Work environment
- Work methods

Administrative Controls

- Job enlargement
- Job rotation
- Work pace and duration
- Work-rest cycles
- Training
- Shift schedule / overtime
- Exercises / stretches

Personal Protective Equipment

- Anti-Vibration gloves – reduce vibration transmission
- Knee pads – reduce pressure points
- Shoe inserts – reduce discomfort
- Cooling devices – reduce body temperature increases
- Cold weather clothing – prevents hypothermia/frost bite

Lifting with your legs is not always the answer to preventing injury!

Job Improvement Exercise

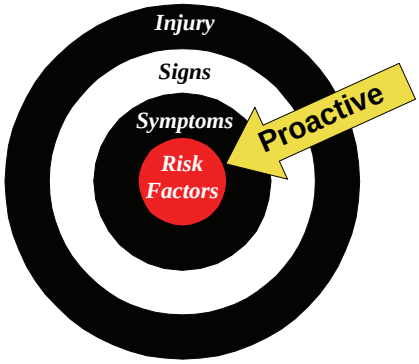
- What can be done to reduce the risk factor(s)?
- What category do the changes fall under?
  - Engineering control
  - Administrative control
  - Personal protective equipment

Brake Repair

Hydraulic Pit Station Operator

Homework

Targeting Risk Factors



Risk Factor Report Card

RISK FACTOR REPORT CARD **Name:** _____

1. Work Area / Job Title: _____

2. Describe task: _____

_____

_____

3. Check all risk factors that apply:

- ☐ Poor Posture
- ☐ Repetitive Work
- ☐ Vibrating Tools
- ☐ Static Posture
- ☐ WB Vibration
- ☐ Forceful Gripping
- ☐ Heavy Lifting/Carrying
- ☐ Bouncing/Jarring
- ☐ Heavy Shoveling
- ☐ Forceful Push/Pull

Other risk factors: _____

4. Place X on affected areas.

5. Comments/suggestions: _____

_____

_____

6. Plant/Mine Name: _____

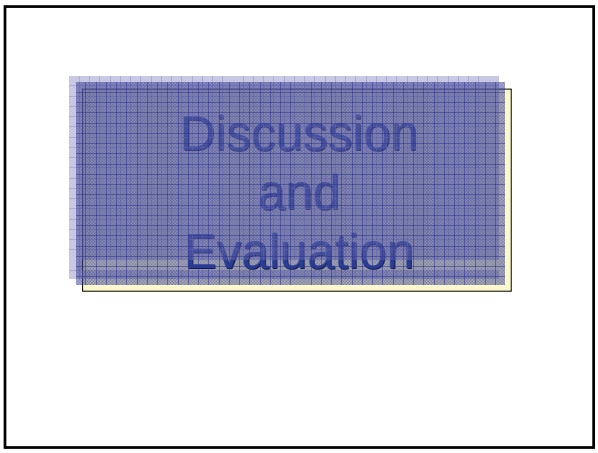
Take Action!

As soon as you are aware of risk factors,

Report Your Concerns

Early action may prevent loss of function and serious injury!

Remember – Ergonomics is about YOU!


Discussion
and
Evaluation

RISK FACTOR REPORT CARD **Name:** _____

1. Work Area/Job Title: _____

2. Describe task: _____

_____

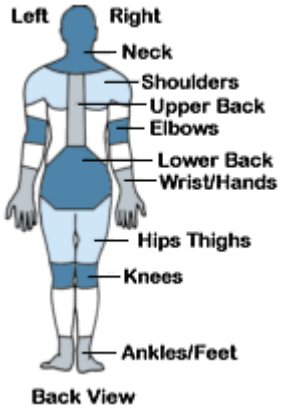
_____

3. Check all risk factors that apply:

- ☐ Poor Posture
- ☐ Repetitive Work
- ☐ Vibrating Tools
- ☐ Static Posture
- ☐ WB Vibration
- ☐ Forceful Gripping
- ☐ Heavy Lifting/Carrying
- ☐ Bouncing/Jarring
- ☐ Heavy Shoveling
- ☐ Forceful Push/Pull

Other risk factors: _____

4. Place X on affected areas:



Back View

5. Comments/Suggestions: _____

_____

_____

6. Plant/Mine Name: _____

WHAT TYPE OF INJURY?

Acute = sudden release of energy (accident)
Cumulative = occurs over a longer period of time

1. An employee was climbing down the boarding ladder of a water truck, reached the bottom of the ladder, extended his right leg down, and hopped from the ladder. The landing twisted his right knee, straining the knee and possibly tearing a ligament in the knee.

2. An employee was separating plies on a piece of conveyor belt when the knife slipped, cutting her forearm.

3. A technician was diagnosed with carpal tunnel syndrome caused by repetitive use of his hands in gripping-type motions while performing electrical wiring and other electrical work, which also required surgery prior to experiencing carpal tunnel syndrome.

4. An employee was attempting to remove seven roof screens from a bundle of screens leaning against the rib when the entire bundle tipped over, striking her in the left leg.

5. An employee was stacking 50-pound bags in the bagging area when he began to experience lower-back pain. The employee had been stacking bags for 1 hour when he was injured. The employee's job requires him to stack bags for 3–4 hours every workday.

6. While putting keeper bolts on cutting edges of a Cat 16–G, an employee twisted, causing pain in his back. The edges were already being held in place. The employee has a previous history of back injury. He has seen a chiropractor on and off for 6 years. The employee was released to return to work with no restrictions.

7. An employee was pulling on motor grader cutting edges while in a twisted position. He felt lower-back pain.

8. An employee was dismounting a rubber-tired dozer. Her feet slipped on the ladder (lowest rung) and she landed hard on the ground, straining her knee.

9. An employee placed his left hand on the drill mast, reached up with right hand, and grasped the drill steel to remove it from the hole. During this action, the left middle finger was smashed or caught between unknown objects, lacerating and crushing the distal phalange of the left middle finger.

10. An employee was operating a bulldozer, performing a backfilling operation. During normal operations, the employee was turning and twisting while operating dozer. He started to experience back pains and swelling of muscles in the lower back.

11. An employee bent down to pick up a bucket weighing approximately 10 pounds, felt a pop and experienced pain in the right groin area, resulting in a hernia.

12. An employee was carrying 5-gallon buckets of oil to the top of the silo. He had pain in the right knee; an MRI revealed a small tear.

Ergonomics and Risk Factor Awareness Training – Part 1

Date _____ Age _____ Mine _____ Company _____

Years of experience within your industry _____ Job title _____

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
The videos helped me understand risk factors.	1	2	3	4	5	6
I understand the differences between acute and cumulative injuries.	1	2	3	4	5	6
I would like to apply what I learned to my job.	1	2	3	4	5	6
I would recommend this training to others.	1	2	3	4	5	6
There was too much information given during this training.	1	2	3	4	5	6
I believe I can identify risk factors from what I learned today.	1	2	3	4	5	6

How much experience do you have in applying "ergonomics" in your work place?

None **A Lot**

1 2 3 4 5

Did this training teach you how to apply the skills presented to your work setting?

None **A Lot**

1 2 3 4 5

How much of the information presented during this training could be applied to mining jobs?

None **A Lot**

1 2 3 4 5

How much do you think you will be able to apply to your job?

None **A Lot**

1 2 3 4 5

Would you change the number of sessions used to offer this training? Yes No

If yes, circle the number of sessions you would recommend: 2 3 4 Other _____

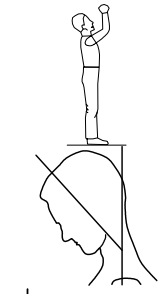
What was the most important thing you learned? Why was that important?

What suggestions do you have for improving this training? (If needed, please use the back of this form).

General Risk Factors

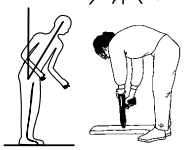
A risk factor exists when the movements, postures, or conditions described on this card are a regular and expected part of the job, occur more than *one day per week*, and more frequently than *one week per year.*

1. Poor Posture



Working with the hand(s) above the head, or the elbow(s) above the shoulders more than 2 hours total per day.

Working with the neck bent more than 30 degrees (without support) more than 2 hours total per day.



Working with the back bent more than 20 degrees (without support) more than 2 hours total per day.

Kneeling or squatting more than 2 hours total per day.

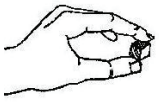
2. Heavy or Frequent Lifting

Lifting object weighing more than 75 pounds once per day or more than 55 pounds more than 10 times per day.

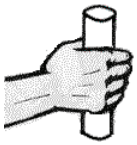
Lifting object weighing more than 25 pounds above the shoulders, below the knees or at arms length more than 25 times per day.

Lifting object weighing more than 10 pounds if done *more than twice per minute*, more than **2 hours** total per day.

3. Forceful Gripping



Pinching an unsupported object weighing 2 or more pounds, or pinching with a force of 4 or more pounds per hand, more than **2 hours** per day (comparable to pinching half a ream of paper).



Gripping an unsupported object(s) weighing 10 or more pounds per hand, or gripping with a force of 10 or more pounds per hand, more than **2 hours** per day.

General Risk Factors

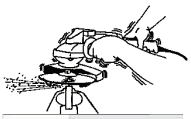
A risk factor exists when the movements, postures, or conditions described on this card are a regular and expected part of the job, occur more than *one day per week*, and more frequently than *one week per year.*

4. Highly Repetitive Work

Repeating the same motion with the neck, shoulders, elbows, wrists or hands (excluding keying activities) with little or no variation every few seconds, more than **2 hours** total per day.

Performing intensive keying more than **4 hours** total per day.

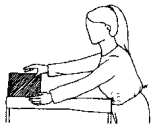
5. Vibrating Tools (Hand/Arm Vibration)



Using grinders, sanders, jig saws or other hand tools that typically have moderate vibration levels more than **2 hours** total per day.

Using impact wrenches, carpet strippers, chain saws, percussive tools (jack hammers, scalers, chipping hammers) or other tools that typically have high vibration levels, more than **30 minutes** total per day.

6. Contact or Impact Stress



Contacting hard or sharp objects like work surface edges or narrow tool handles, more than **2 hours** total per day.

7. Bouncing or Jarring

Traveling in mobile equipment over rough ground or flooring, more than **2 hours** total per day.

Task Evaluation

Job Name: _____ Task: _____ Date: _____

1. Brief Description of Task:

_____

_____

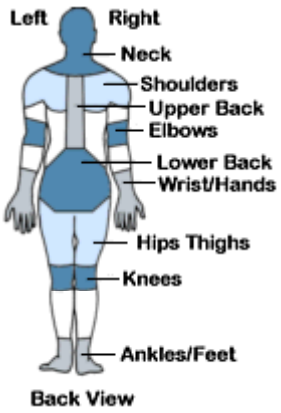
_____

2. Check all risk factors that apply:

__ Poor Posture
__ Static Posture
__ Contact Stress
__ Pressure Points
__ Torque Reaction
__ Repetitive Work
__ Environment
__ Other (describe): _____
__ Other (describe): _____
__ Other (describe): _____

__ Forceful Gripping
__ Heavy Lifting/Carrying
__ Forceful Pushing/Pulling
__ Heavy Shoveling
__ Vibrating Tools
__ Bouncing/Jarring
__ Whole Body Vibration

3. Mark areas affected with an X



4. Describe all root causes that apply:

Process used to do the task:
Effort or strength required:
Location of parts, equipment or tools:
Position of parts, equipment or tools:
Design of parts, equipment or tools:
Speed of work (cycle time):
Frequency or repetition of tasks:
Duration of tasks:
Productivity levels:
Training:
PPE:
Environment factors (restricted work space...):
Other:

Task Evaluation

Job Name: _____ Task: _____ Date: _____

5. Brainstorm for task improvement ideas:

Engineering Changes

Administrative Changes

Personal Protective Equipment

Ergonomics and Risk Factor Awareness Training – Part 2

Date _____ Age _____ Mine _____ Company _____

Years of experience within your industry _____ Job title _____

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
The videos helped me understand risk factors.	1	2	3	4	5	6
The video exercises helped me understand how to reduce injury risk.	1	2	3	4	5	6
I would like to apply what I learned to my job.	1	2	3	4	5	6
I would recommend this training to others.	1	2	3	4	5	6
There was too much information given during this training.	1	2	3	4	5	6
The homework assignment helped me understand risk factors.	1	2	3	4	5	6

How much experience do you have in applying "ergonomics" in your work place?

None **A Lot**

1 2 3 4 5

Did this training teach you how to apply the skills presented to your work setting?

None **A Lot**

1 2 3 4 5

How much of the information presented during this training could be applied to mining jobs?

None **A Lot**

1 2 3 4 5

How much do you think you will be able to apply to your job?

None **A Lot**

1 2 3 4 5

Would you change the number of sessions used to offer this training? Yes No

If yes, circle the number of sessions you would recommend: 2 3 4 Other _____

What was the most important thing you learned? Why was that important?

What suggestions do you have for improving this training? (If needed, please use the back of this form).

Ergonomics Glossary

Administrative controls

Procedures used to reduce the duration, frequency, or severity of exposure to a hazard. They may include training, job rotation, and gradual introduction to work. Administrative controls are part of hazard prevention and control strategy.

Awkward posture

If a job task looks uncomfortable, it probably is, and this increases the chances for injury. Whenever possible, arrange the work station or work processes to allow employees to work from a comfortable, neutral posture. Excessive torso bending, reaching away from the body, bending the neck, or reaching above shoulder height are examples of awkward postures.

Discomfort

Mental or physical distress. Examples of physical distress include aches and pains your body is experiencing. Examples of mental distress include loss of a loved one, pressure to perform at work, or lack of sleep.

Engineering controls

A method of controlling and preventing worker exposure to risk factors or hazards by redesigning equipment, tools, and work stations.

Ergonomics

Ergonomics is the field of study that seeks to match the physical and cognitive requirements of the job to the abilities of the worker. This is achieved by designing workplaces, environments, job tasks, equipment, and processes to suit the worker's abilities. Ergonomics is the scientific study of people at work.

Ergonomics program

A systematic method (similar to an accident prevention or quality improvement program) used to evaluate, prevent, and manage work-related musculoskeletal disorders. The four elements of a typical ergonomics program are worksite analysis, hazard prevention and control, medical management, and training and education. To implement an ergonomics program, some companies use an ergonomics team or committee. This team would be responsible for identifying and correcting musculoskeletal hazards in the workplace.

Fatigue

A condition that results when the body cannot provide enough energy for the muscles to perform a task. It results in an incapacity to continue to perform work at the same rate.

Force

The amount of physical effort a person uses to do a task.

Hand-arm vibration

Vibration (generally from a hand tool) that goes through the hand, then travels through the rest of the body.

Hazard prevention and control

Eliminating or minimizing the hazards identified in the worksite analysis. It involves changing the jobs, work stations, tools, or environment to fit the worker. Hazard prevention and control is an element of the ergonomics program.

Injury incident rate

Represents the number of injuries and/or illnesses per 100 full-time workers, calculated as follows: (N/EH) × 200,000, where N = number of injuries and/or illnesses, EH = total hours worked by all employees during the calendar year, and 200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

Mechanical contact stress

The contact of the body with a hard surface or edge that results in the compression of tissue. Can also result when using a part of the body as a hammer or striking instrument.

Musculoskeletal disorders (MSDs)

Illnesses and injuries that affect one or more parts of the soft tissue and bones in the body. The parts of the musculoskeletal system are bones, muscles, tendons, ligaments, cartilage, and their associated nerves and blood vessels.

Neutral posture

Comfortable working posture that reduces the risk of musculoskeletal disorders. An ideal posture for the upper body would be: arms at your sides, elbows bent, wrists straight, and eyes looking straight ahead.

Personal protective equipment (PPE)

Gloves, kneepads, and other equipment that may help reduce hazards until other controls can be implemented or that supplement existing controls.

Repetitiveness

Performing the same motions repeatedly. The severity of risk depends on the frequency of repetition, speed of the movement or action, the number of muscle groups involved, and the required force.

Risk factors

An aspect of a job that increases the worker’s chance of getting a work-related musculoskeletal disorder.

Severity rate

The cost in terms of lost workdays (or dollars) of new injuries and illnesses. It is calculated as the number of lost workdays per total number of hours worked by all employees during a specified time period.

Static loading (or sustained exertions)

Physical effort or posture that is held without movement and requires muscle contraction for more than a short time. As muscles remain contracted, the blood flow to the muscles is reduced.

Worksite analysis

A safety and health review that addresses work-related musculoskeletal disorders. It is a structured way of identifying jobs and work stations that may contain musculoskeletal hazards, risk factors that pose the hazards, and causes of the risk factors.

Medical Terms for Musculoskeletal Disorders

Carpal tunnel syndrome
A compression of the median nerve as it passes through the carpal tunnel in the wrist.

Chronic low-back pain
General soreness and fatigue of the low back. Pain is usually constant, and it accompanies most activities.

Constriction
Binding, squeezing, or shrinking blood vessels so that circulation is reduced.

Cubital tunnel syndrome
Compression of the ulnar nerve as it passes through the notch of the elbow.

Cumulative trauma disorders
Injuries and illnesses that generally occur as a result of exposure to repeated stresses over a period of time. They affect one or more parts of the soft tissues and bones of the musculoskeletal system and/or nerves and blood vessels servicing the musculoskeletal system.

Degenerative disc disease
Wear and tear of the discs that separate the vertebrae of the spine.

DeQuervain's Disease
An inflammation of the tendon and/or its sheath at the base of the thumb.

Digital neuritis
Compression of the nerves along the sides of the fingers or thumbs, resulting in tingling and numbness.

Epicondylitis
An inflammation of the tendons at the elbow. Also called tennis elbow (lateral or outside part of the elbow) or golfer's elbow (medial or inside part of the elbow).

Ganglionic cyst
Swelling of the tendon sheath due to the buildup of synovial fluid inside the sheath. The cyst usually causes a bump under the skin.

Nonspecific backache
General soreness and fatigue of the low back.

Osteoarthritis

Most common type of arthritis, especially among older people, sometimes called degenerative joint disease or "wear-and-tear" arthritis. Unlike other types of arthritis, it only affects the joints, not internal organs. It causes persistent stiffness and swelling of the joints.

Raynaud's Phenomenon

A constriction of the blood vessels in the hands and fingers. Also called "white finger."

Rotator cuff tendonitis

Inflammation of one or more tendons at the shoulder. Also called "pitcher's shoulder."

Sprain

Overstretching or overexertion of a ligament that results in a tear or rupture of the ligament.

Strain

Overstretching or overexertion of a muscle or tendon.

Tendonitis

Inflammation of the tendon.

Tenosynovitis

Inflammation of the sheath around the tendon.

Thoracic outlet syndrome

Compression of the nerves and blood vessels between the neck and shoulder often associated with prolonged overhead work.

Trigger finger

A common term for tendonitis or tenosynovitis that causes painful locking of the finger(s) while flexing.

Ulnar nerve entrapment

Compression of the ulnar nerve as it passes through the wrist, often associated with prolonged flexion and extension of the wrist and pressure on the palm.

Guide to Intervention Ideas

Elimination/Substitution

- Increase the weight of the container/item and move with a mechanical assist (handle in bulk).
- Have materials delivered to a different area.
- Have the supplier perform part of the task.
- Do not act upon the input (ship as is).
- Ensure that current specifications are necessary.
- Install a feeder mechanism.
- Install overhead gantry, boom, or fixed hoist.
- Place collection ports lower to use gravity.
- Use a small electric portable lifting device.
- Use a conveyor belt.
- Use a forklift.
- Use a lever-type device.
- Use a rolling lever or portable rollers.
- Use a two-pole suspension system (stretcher).
- Use a vacuum tube conveyor system.
- Use an overhead suction lifting device.
- Use an overhead tube-fed dispenser system.
- Add a motor drive to carts.

Force/Exertion

- Decrease the size of the container/item.
- Decrease the weight of the container/item.
- Change the composition of raw materials to something lighter in weight.
- Alter the properties of the materials (malleability, heat conductivity, etc.).
- Alter environmental conditions that affect material properties.
- Change the container or packaging that contains the materials.
- Add wheels.
- Change to bigger wheels.
- Bevel work surface edges.
- Install permanent handles.
- Place ramps over thresholds.
- Place rollers at edge of table.
- Use lighter trays or bins.
- Use lubricants to reduce friction.
- Use slip sheeting.
- Use special jack attachment.
- Use customized/redesigned hand trucks.
- Use special-applications dolly.

- Install a vice.
- Use a customized or stock jig.
- Use a handtool.
- Anchor tool to resist its force.
- Install tool balancer.
- Provide a guide attached to tool to hold work.
- Place recess in tables to support arms.
- Provide a chest support for forward leaning.
- Attach adjustable armrests to work surface.
- Place sleeves or extenders on levers or controls.
- Change handle design by adding padding or slip resistance.
- Alter tool size, diameter, weight, or length.
- Make tools electric-, air-, or battery-operated.
- Provide the appropriate tool.

Posture

- Modify the position of the container/item.
- Change the container or packaging that contains the materials.
- Change the final placement location or position.
- Stop using the currently used storage space.
- Adjust chair height, angle, depth, or armrest.
- Replace current chairs with adjustable models.
- Place the worker on a platform.
- Place worker in trough or sunken floor.
- Change or install handles on carts.
- Use pallets to raise worker or work.
- Provide adjustable floor height.
- Place a second elevated work surface on top of work station.
- Split work-surface heights.
- Place something (such as wooden supports) under work station legs.
- Attach work station surface to wall to change working height.
- Cut two or four legs or bottom of work station.
- Sink floor or place work station in trough.
- Use a spring-loaded double-bottom cart.
- Install adjustable work station.
- Install lazy Susan (turntable).
- Add third hand or document holder.
- Cut out work surface.
- Angle bins toward the worker.
- Alter doorway/porthole to decrease awkward posturing.
- Modify trays on conveyor devices.
- Interchange shelves, bins, trays, and drawers.
- Make controls remote.
- Use a tool or reaching device.

- Properly space rungs on ladders.
- Provide step stools.
- Relocate meters, visual displays, or other input devices.
- Install lighting fixtures that can adjust direction of lighting.
- Provide headphones for audio input.
- Provide lighted magnifying glass.
- Provide glare screen or reposition monitor.
- Increase size of dials or visual display equipment.
- Allow adjustability in location and display features.
- Make control handles or buttons larger.
- Make foot or hand controls movable.
- Move all overhead controls down.
- Place controls inset into table.
- Change tool handle design by altering angle.
- Change handle by altering tool shape.
- Store tools in most convenient position.
- Provide a lumbar roll or supportive cushion.

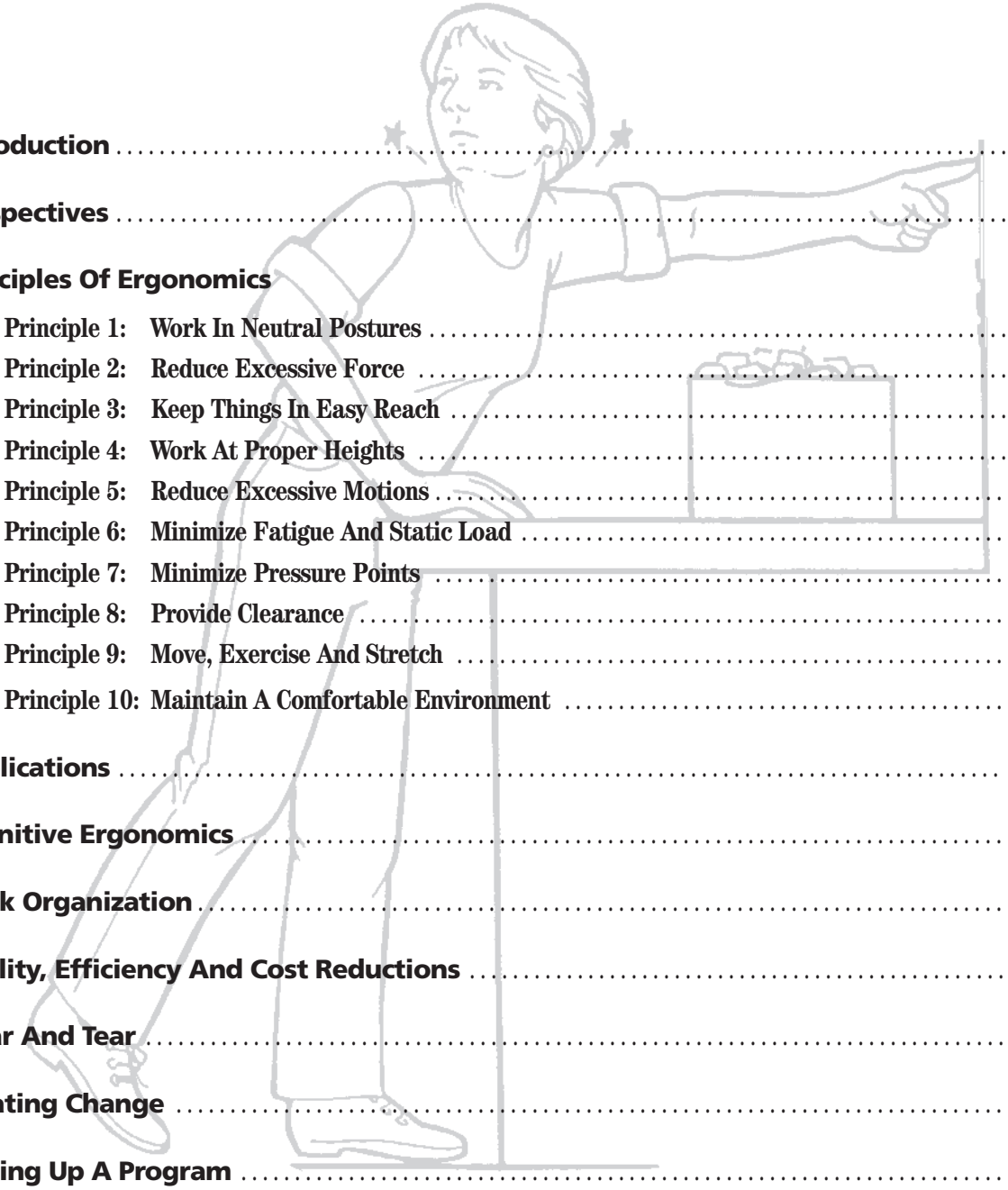
Repetition and Duration

- Decrease the number of different pieces to be handled.
- Order parts preassembled.
- Change the output rate.
- Increase or decrease the number of steps each worker performs.
- Enlarge job by having worker pack or put away whatever he or she processes.
- Provide sit/stand seating.
- Use several fixed tools rather than one adjustable one.
- Change work organization: spread similar work throughout different shifts.
- Allowances for breaks—work organization—how and when you do activities.

Vibration

- Roadway maintenance.
- Improved vehicle seating: suspension system, seat padding, seat.
- Reduce vehicle speed.
- Use low-vibration tools.
- Apply dampening materials to tool handles.

The Ergonomics Manual



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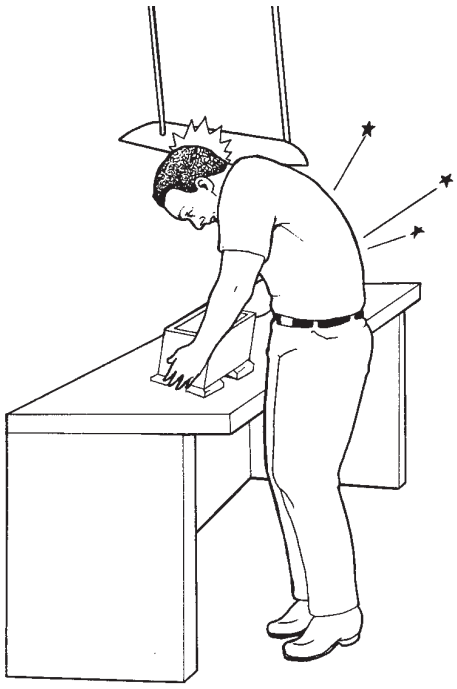
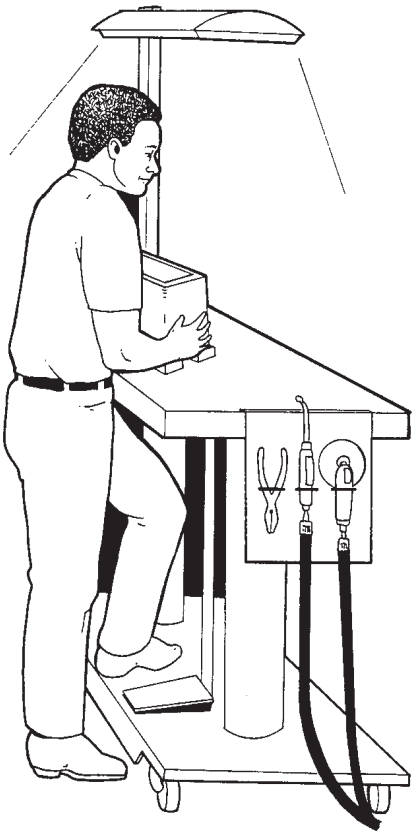
Introduction

Ergonomics *is a wide-ranging field that seeks to design tools, equipment and tasks to optimize human capabilities. Several catchphrases are described below that serve as good definitions. As you will see, in many ways, ergonomics is not really anything new. It amounts to seeing everyday things from a new perspective — that is, putting on your "ergonomics glasses." Much of ergonomics is common sense, once you think about it. The field can be summarized in a set of basic principles, which form the core of this booklet.*

Fit the task to the person — Probably the best phrase to describe the field of ergonomics is "Fit the task to the person, not the person to the task." Whenever we set up a piece of equipment, we need to ask, "How does the human fit in?" When designing a tool or planning a task, we need to consider human strengths and imitations.





Work smarter, not harder — A time-worn phrase that many people aspire to is "Work smarter, not harder." Normally, how one actually goes about doing so is left unstated. But ergonomics remedies that by providing *methods* for finding smarter ways of working. It prescribes the principles and techniques by which people can improve ways to work.

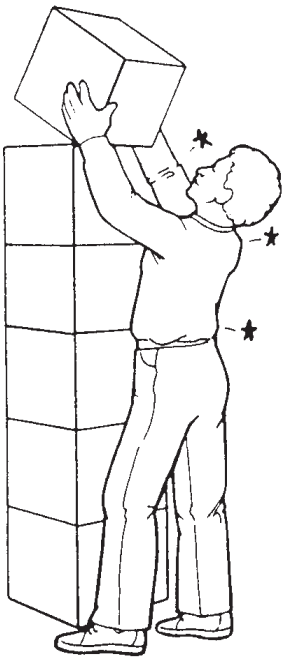
The rules of work — The term *ergonomics* was coined from the Greek words *ergon* (meaning "work") and *nomos* (meaning "rules"); so the literal meaning is "the rules of work," which is a handy concept to think about and then apply.

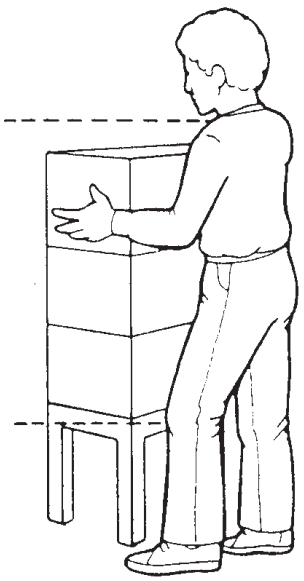
Targets for ergonomic improvement are divided into two broad categories:

(1) physical issues, such as reaches and exertion

(2) cognitive issues, such as mental overload and confusing displays

User friendliness — The term *user friendly* is synonymous with *ergonomics.* Anything that can be described as user friendly can also be said to be ergonomic; unfriendly items are not ergonomic. Being user friendly means that things are easy to understand and apply, that mistakes are reduced, and that the human is treated well in the process. The concept applies to both *physical* issues as well as mental, or *cognitive,* ones.





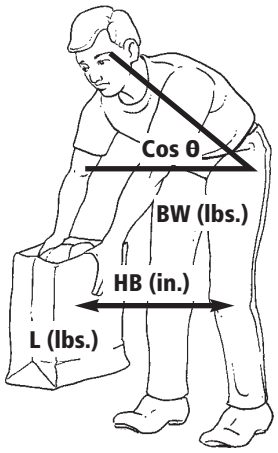
Formal Definition

Ergonomics is an interdisciplinary field of study that seeks to design tools, equipment and tasks to optimize human capabilities. In this context, tools, equipment and tasks are broadly defined. A *tool* might range from a simple hand tool, to a written set of directions, to an entire organizational system. *Equipment* includes factory production lines, household appliances and sports paraphernalia. A *task* could be either a physical or a mental activity, and it could be done as a job, a household chore or a leisure-time pursuit.

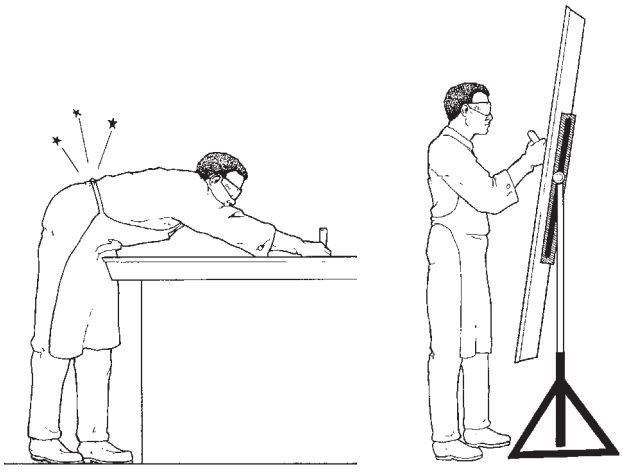
Ergonomics seeks to improve the interrelationship between the human and a system, whether a simple hand tool or an entire production line. Whenever one designs a more effective interface between a human and a tool or task, that is ergonomics.

Perspectives

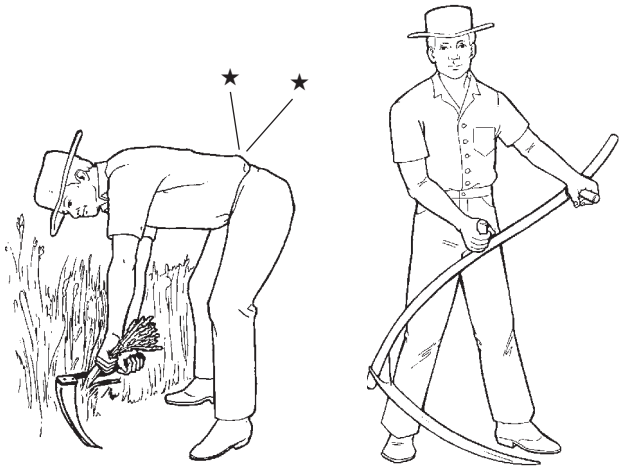
It's not just for work — Ergonomics can be applied to any human activity, including home chores and leisure activities.



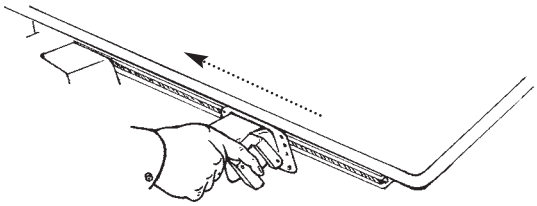
It doesn't have to be hard — Although some technical aspects of ergonomics are difficult, practical application at work doesn't have to be hard. Anyone can have a good idea.



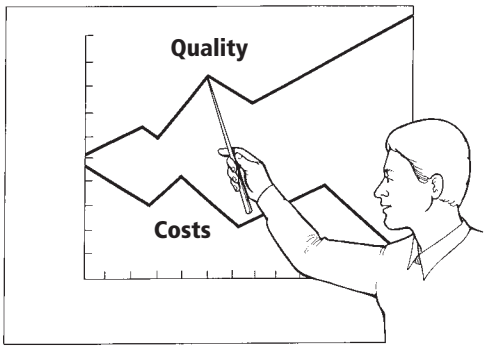
It's about quality and effectiveness — People who are fatigued, uncomfortable or hurting are in no position to do their jobs right the first time, every time. Good ergonomics can put people in a better position to do the jobs they're capable of.



It's not necessarily new — The term *ergonomics* might be new, but the concepts have been around since the earliest humans. A good example is a famous ergonomic device invented in the nineteenth century — the two-handed scythe.

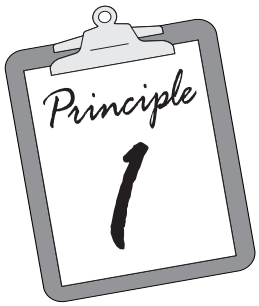


It doesn't have to be expensive — On some occasions, improvements take capital investment, but often enough, the best solutions are inexpensive or even free. It just takes some creativity and thinking. A common example is simply relocating control buttons to be within better reach.

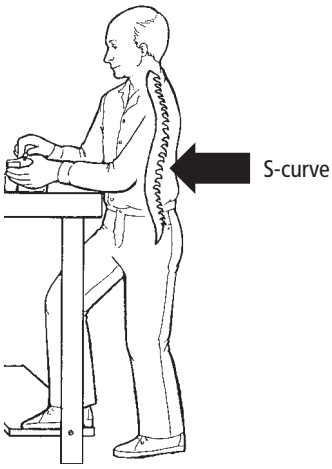


It's good for business — The focus of ergonomics is people. But when properly applied, ergonomics can reduce many costs for business, including workers' compensation costs, turnover, absenteeism and a variety of inefficiencies.

Work In Neutral Postures

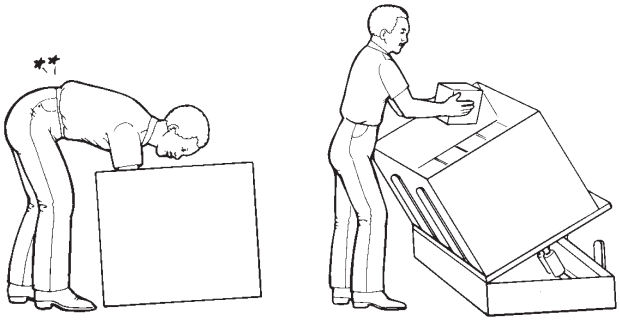


Working in awkward, contorted postures and positions increases physical stress on the body and reduces its strength, thereby making it more difficult to do a task. The optimal neutral posture is the one in which the muscles surrounding a joint are equally balanced — the posture that provides the most strength, the most control over movements and the least physical stress on the joint and surrounding tissue. Note that none of these postures are at right angles, even though tools and equipment are generally built that way.

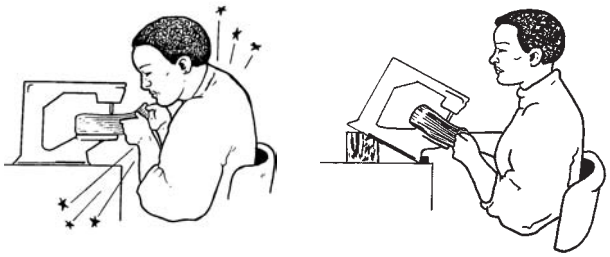


Keep the S-curve — Whether sitting or standing, it is important to maintain the natural S-curve of the back, which essentially means keeping a slight "sway back."

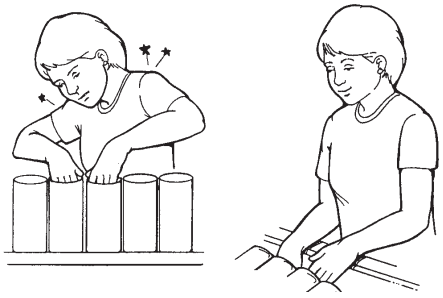
Good lumbar support is important, especially to help prevent an injury-producing "C-curve."



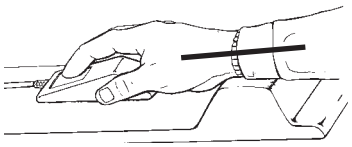
The "inverted V-curve" is a serious injury-producing posture; it can be avoided with use of a tilter. Twisting motions, especially with a heavy load, can also cause injury.



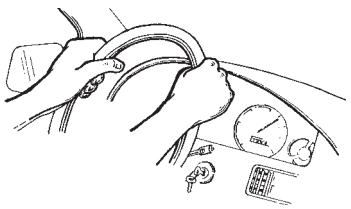
Keep the neck aligned — Adjusting the heights of or tilting the equipment or the worksurface often helps.



Keep the elbows in and the shoulders relaxed — Here, changing the orientation of the product allows the elbows to hang naturally at the sides.

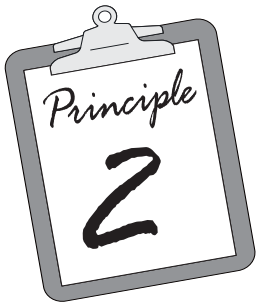


Keep the wrists in neutral — The hands and wrists should be in the same plane as the forearms.

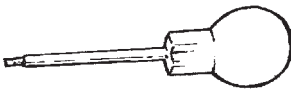


Ideally, the hands should also be slanted slightly in and forward — the position your hands are in when you hold a steering wheel at the 10 and 2 o'clock positions. You can check this posture for yourself by dangling your arms at your sides while standing and noting the position of your wrists.

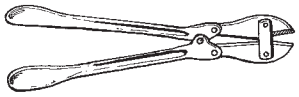
Reduce Excessive Force



Countless tools and machines through the ages have served to reduce exertion. The search for even more ways is one of the defining areas of contemporary workplace ergonomics. Excessive force can overload the muscles, creating fatigue and the potential for injury. Furthermore, applying excessive force to perform a task can slow down the effort and interfere with the ability to perform the task well. Consequently, almost anything that minimizes the exertion required for the task will make it easier and typically faster to perform — and with less effort.

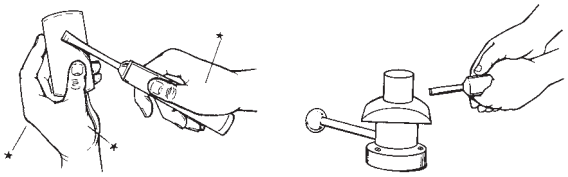


Increase leverage — Levers are usually thought of in terms of lifting large, heavy objects, but they can be applied in virtually any circumstance, such as increasing the diameter of a screwdriver handle. There are many opportunities in industry to use levers to reduce forces on the hands and fingers.

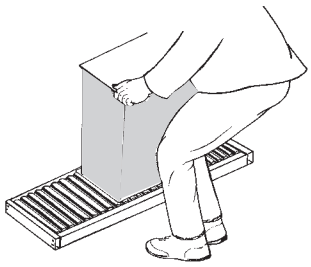


A particularly neglected type of lever is the compound lever, such as in this bolt cutter. It yields tremendous mechanical advantage even with short grips and even when incorporated into small tools used to squeeze tiny parts.

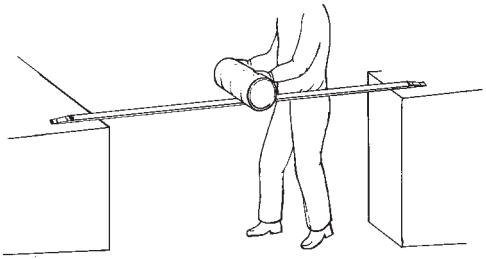
Improve layouts — Poor layout (especially uneven heights, reaches and distances that items need to be moved) often causes forceful, wasted motions.



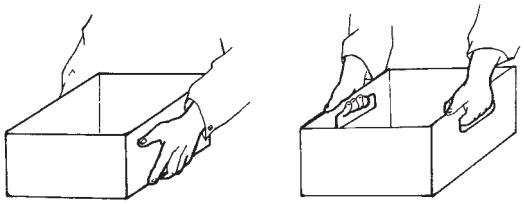
Use fixtures — Using the hand as a fixture increases exertion and wastes effort. If you simply hold the object in a fixture, it becomes much easier to work on. Furthermore, the fixture frees up both hands to do the actual work, rather than simply holding onto the object.



Use conveyors — Creative uses include floor mounted, adjustable height, flex (or "snake"), short lengths, ball and omni-directional versions.

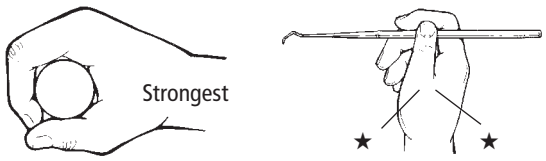


Use skids — Skid bars are an inexpensive way to reduce the amount of lifting and carrying. Even a skid as short as a few inches can be helpful.

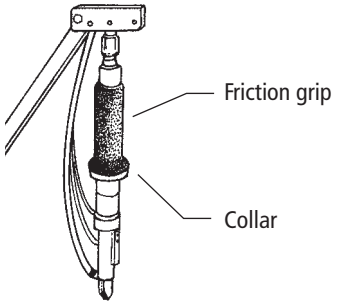


Use power grips — You can exert more force with a full hand grip (a *power grip*) than with the fingers alone (a *pinch grip*). A good example is carrying a box or tote — boxes with handholds take less exertion to carry. Consequently, with a good grip, you can accomplish the same task with less effort.

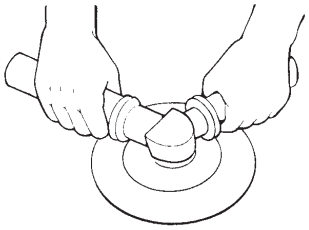
Heat malleable products — If plastic or a similar product needs to be manipulated or fitted, it's often helpful to heat the material to make it more malleable. Heat lamps and hand-held heat guns can be used for this purpose.



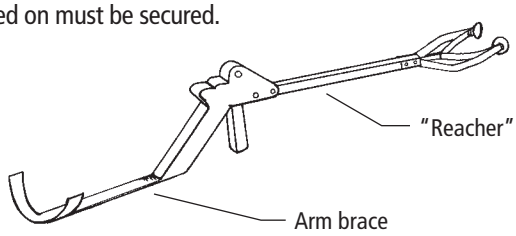
Use appropriate grip size — The optimal size for a power grip is roughly that which permits the thumb and the forefinger to overlap slightly. If the grip is significantly larger or smaller, then more force is needed to accomplish the same work.



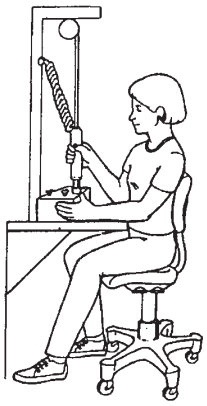
Increase contact friction or use a collar — If a grip is slippery, you must squeeze harder to accomplish the same task. One common improvement is to cover the grip with a material that provides higher friction. In cases where the force applied is coaxial to the grip, providing a collar or stop on the grip can reduce grasping force.



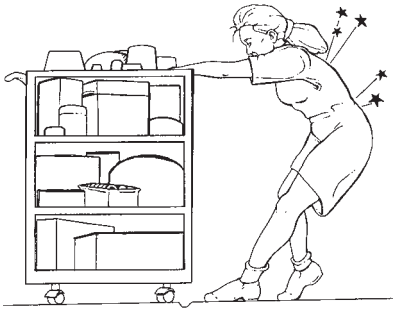
Use two-handed tools — Adding a second handle to a tool can halve the exertion required when one hand alone holds a tool. Having two handles also permits greater control and more accuracy in using the tool. "Tommy gun" grips are a version of this concept used for pressure hoses. Note that a prerequisite for a two-handled tool is that the product being worked on must be secured.



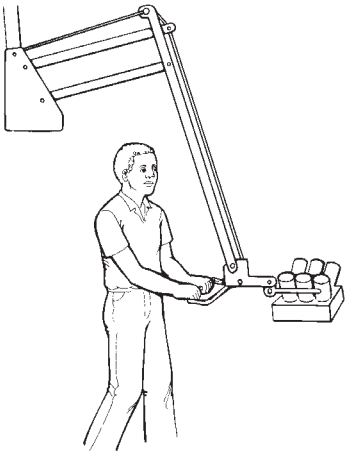
Use arm braces — If a tool or its load is especially heavy, then it may be possible to add a forearm brace. The classic examples are (a) the "reachers" used in old-time grocery stores and (b) high-powered slingshots.



Use counterbalances — Many loads that are held by the arms can be counterbalanced to make them virtually weightless. Techniques include overhead spring suspension, self-closing cylinders (like on doors or car hoods), a weight in combination with a pulley or some type of lever and fulcrum.

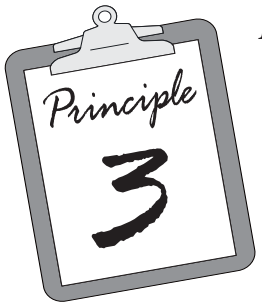


Use good carts — Heavily loaded carts often require high force to be moved. Improvements include increasing wheel size, adding handles and providing better flooring. Power tuggers may be needed in some circumstances.

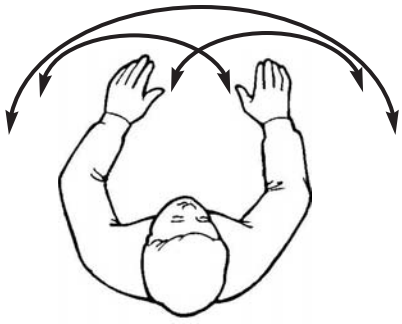


Use power tools, machines and cylinders — Perhaps the most obvious way to reduce force is to completely mechanize the activity. Air and hydraulic cylinders are particularly useful when moderate force is needed.

Keep Things In Easy Reach

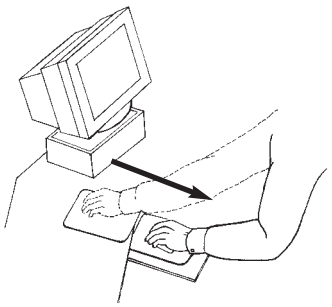


Make your work more user friendly by keeping within easy reach all the parts and tools that you need frequently. Long reaches often cause you to twist, bend and strain, making work more difficult. This principle goes along with that of keeping good posture. If the posture is OK, then the reaches will usually be OK. However, in the case of reaches, one evaluates the equipment and workstations themselves, whereas with posture, all the signs of problems come directly from observing individuals. Thus, evaluating both reaches and postures is needed to double-check using different perspectives.



Think "reach envelope" — The basic ideas are to (a) keep frequently used materials within the reach envelope of the *entire arms* and (b) keep constantly used things within the reach envelope of the *forearms.* Note that this envelope is a semicircle, not the rectangle typically used in fabricating work surfaces.

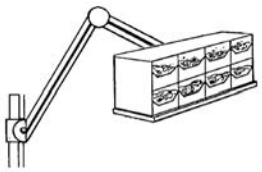
Design for the short person — In general, make sure that shorter-statured people can reach everything. If they can reach, so can everyone else. (There is an opposite rule later regarding clearance.)



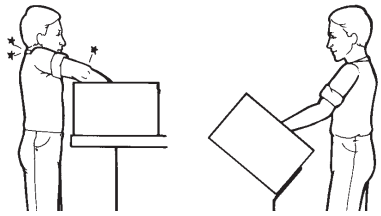
Rearrange — The point behind keeping things in easy reach is not a hard concept to grasp. What *is* difficult is having the presence of mind to notice the reaching. Typically, long reaches are so habitual that you're unaware that you're reaching or that you could easily move items closer.

Reduce work surface size — All too often, the work surface is much bigger than needed. By cutting down its size, you can eliminate long reaches plus increase floor space.

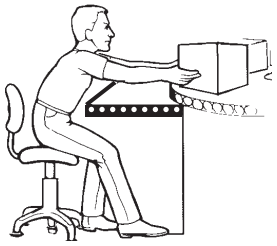
Make cutouts — An increasingly common approach is to make a cutout in the work surface. Cutouts reduce reaches yet still allow large workspaces.



Use swing arms — Another way to bring items closer yet spare workspace is to use swing arms.

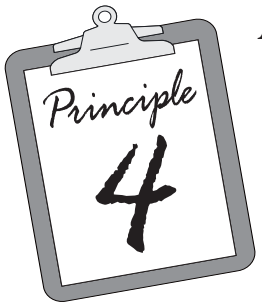


Tilt — When working out of boxes, it's possible to use tilt tables or stands or even to prop up the box on one end. Tilted box stands can easily be fitted with hinges, cylinders and rollers to enable easy transfer to carts and conveyors.

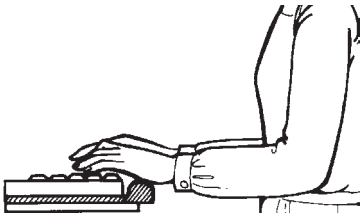


Remove barriers — Many reaches are caused by barriers that can be eliminated or relocated.

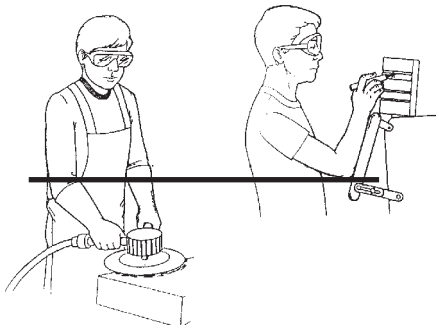
Work At Proper Heights



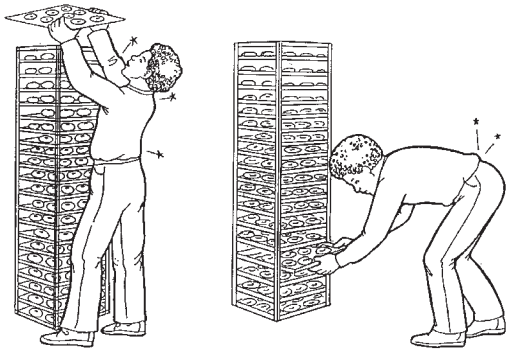
A common workplace problem is a mismatch in heights between people and the work that they're doing. This mismatch leads to poor postures and related fatigue, discomfort and potential damage to soft tissue ***plus*** *unnecessarily harder work and reduced ability to perform the task correctly. Proper height depends on the nature of the task. Once again, this principle is often correlated with posture: If the postures are correct, then generally the heights will be correct. However, there are exceptions.*



Design for elbow height — Generally, work is best done at about elbow height, whether sitting or standing. This is true for keyboarding as well as other kinds of work in manufacturing and assembly. Note that it is *the work itself* that should be at elbow height, not necessarily *the work surface.*

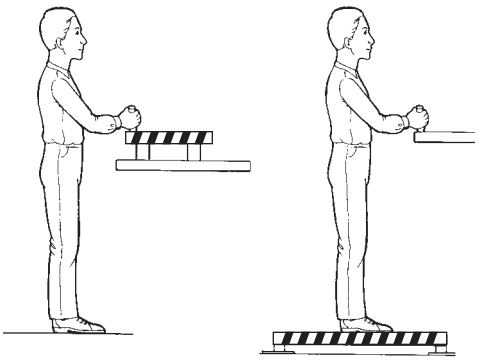


Consider the exceptions — The nature of the work also affects the proper height. Heavier work, requiring upper-body strength, should be lower than elbow height. Lighter work, such as precision work and inspection tasks, should be higher.



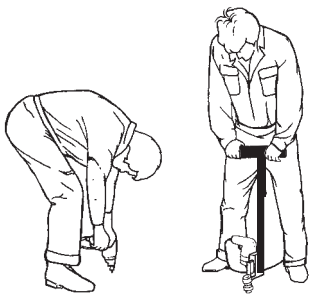
Avoid extremes — When it isn't possible to make every height ideal, it may be feasible to avoid the extremes; that is, avoid working below knee level or above shoulder level.

Provide adjustable heights — Because people vary in height, good design often involves making height adjustments in work surfaces. There are a variety of ways to do so:



1. *Change the work surface* — The best approach is to adjust the height of the work surface itself. This is easiest with only one person per workstation, which can then be adjusted once for that person — for example, by lengthening or shortening the legs of a workbench. It is harder if several people use the same workstation. Placing a simple riser or work surface platform can sometimes accommodate taller people. More elaborate is a crank-up or push-button adjustable surface.

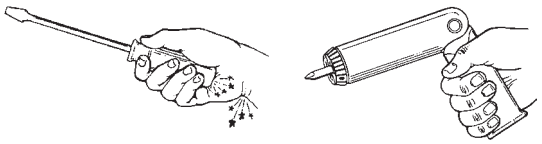
2. *Stand on a platform* — It usually is impossible to raise or lower assembly lines or large pieces of equipment. The alternative, then, is to provide platforms. While they may create congestion and possible tripping hazards, they have worked well in many facilities.



Use tool extenders — The floor is an extremely awkward height from which to work. Long handles and tool extenders provide ways to improve the height.

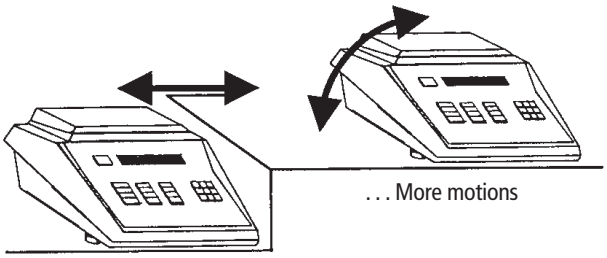
Reduce Excessive Motions

Minimizing the number of motions required to do a task can lessen the wear and tear on your body and also improve efficiency. Repetitive motions are, in many ways, time wasters, and many of the techniques to reduce excessive motions amount to old-fashioned ***methods engineering*** *— ideas that have perhaps been neglected in an era of high technology. Motion efficiency can be readily applied in many workplace ergonomics activities.*



Let the tool do the work — One of the best ways to reduce repetition is to allow machines and tools to do the work. Machines are good at performing repetitive tasks endlessly, so they should be exploited.

Improve technique — It's not uncommon to see two people working side by side on the same task, one working smoothly and the other with hectic, exaggerated and wasted motions. It's important to help employees learn to use the most efficient, least injurious methods. Sometimes, this might take some study and comparisons. The video camera offers an excellent tool to help find the best method. You can videotape various individuals and then watch the tapes during group meetings to identify good techniques.



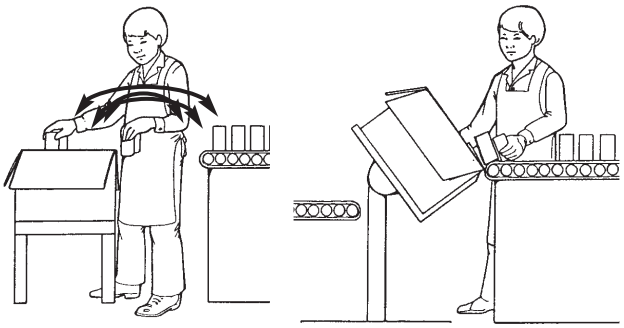
. . . More motions

Fewer motions . . .

Improve layouts — Workstation changes to improve the heights, reaches, locations and orientations of materials can eliminate many unnecessary hand and arm motions.

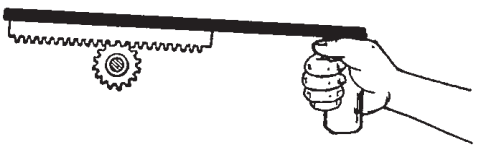
Reduce the range of the motion — There is a distinction between a small, insignificant motion and a large, sweeping one. Thus, even if a motion cannot be eliminated altogether, it might be reduced.

Watch for double-handling — Double-handling is basically doing the same work twice — picking up and replacing an object only to have to pick it up and handle it again.



Slide rather than pick and place — It's usually better to slide items, rather than pick them up one at a time and place them in their locations. Although motions are still required, the total number is usually reduced. Try these techniques:

- Move equipment closer together, equalize heights and tilt boxes and containers.
- Cut holes in work surfaces to permit items or scrap to drop directly into containers or onto conveyors.



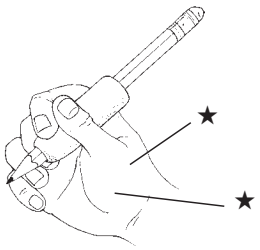
Motion-saving mechanisms — A number of mechanical devices can be applied:

- Gearing — One turn yields multiple turns.
- Rack and pinion — One motion yields multiple turns.
- Old-fashioned sewing machine pedal — One stroke yields multiple reciprocal motions.
- Yankee screwdriver — One push yields multiple turns.
- Ratchet — Eliminates repetitive grasping and regrasping.
- Hoppers — Instead of using scoops to handle granular materials, hoppers reduce motions and save time.

Keep materials oriented — Feeding parts and materials in the correct orientation to a workstation can reduce motions. Furthermore, *parts should never be allowed to become jumbled* because extra work and more motions will be needed to straighten them out again.

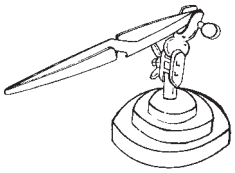
Minimize Fatigue And Static Load

*Overloading people's physical and mental capabilities can contribute to accidents, poor quality, lost productivity and wear-and-tear-type injuries. A particularly common source of fatigue is known as **static load**, which is holding the same position for a period of time (**static** means "not moving," as in **stationary**). Static load is especially stressful in combination with high force and awkward posture, but the primary concern is the amount of **time** that the muscles are contracted. Even if a muscle is only lightly tensed, over an extended time, pain and fatigue can result.*



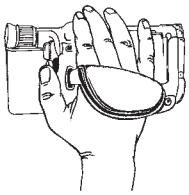
Reduce force and duration — A common example of static load is writer's cramp. You don't need to hold onto a pencil very hard, just for long periods, for your muscles to tire and begin to hurt. To prevent writer's cramp, (1) stop occasionally to stretch and (2) use a pencil grip, which makes it easier to hold. (It reduces slipperiness plus increases size.)

Self-closing tool mounted on a fixture



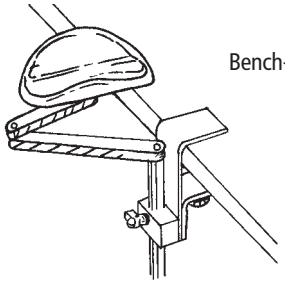
Use fixtures — It's crucial to use fixtures, clamps and other ways to prevent static grasping of items, whether parts, tools or both, if possible. *Don't use your hands as fixtures.*

Use self-closing tools — Tweezers and clamping tools squeeze to open up the tool and then let go to hold it in place. This eliminates the need to grasp continually. Locking pliers provide a different version of the same concept, as do locking triggers on power tools.

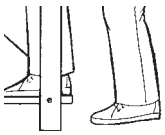


Use straps — Tools held for long periods can be fitted with straps to offload the muscles, as is common with hand-held video cameras.

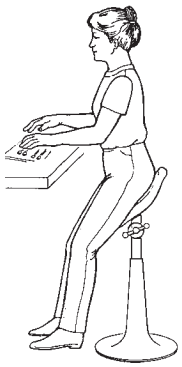
Bench-mounted armrest



Use armrests — Armrests eliminate static load on the shoulders in tasks that require outstretched arms. New types of armrests can be attached to workbenches and machines.



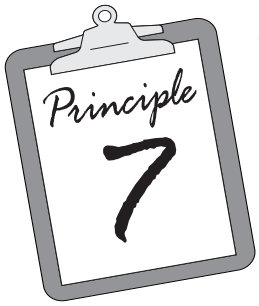
Use footrests — For standing jobs, having a footrest available provides a chance to alternate postures occasionally.



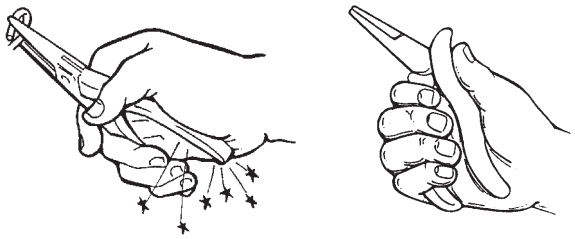
Use lean stands — Lean stands can relieve the static load on leg muscles. You wouldn't want to remain on a lean stand for a long period, but from time to time, it provides relief from constant standing. Furthermore, unlike a chair or stool, which can take some effort to get into and out of, a lean stand enables you to revert instantaneously to a standing position for immediate attention to a machine or other work process.

Provide mobility — *Staying in the same posture* is fatiguing. Good design provides ways to change position yet not interrupt work. (*Fatigue* interrupts work; good design doesn't.)

Minimize Pressure Points

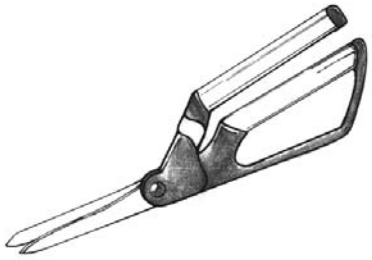


*Direct pressure against the body, or **contact stress,** is a common issue in many workstations. In addition to being uncomfortable and interfering with your ability to work, contact stress can inhibit nerve function and bloodflow. For example, the hand is particularly sensitive because there are (a) a large number of nerves throughout the hand and fingers, which are typical points of contact, and (b) blood vessels in the fleshy part of the palm, where hand tools normally press.*

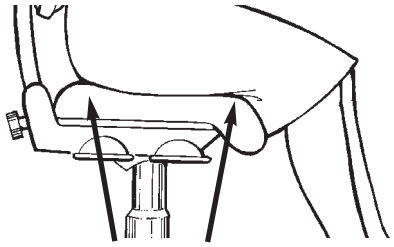


Contour and pad — Many tools and pieces of equipment can be improved with these techniques:

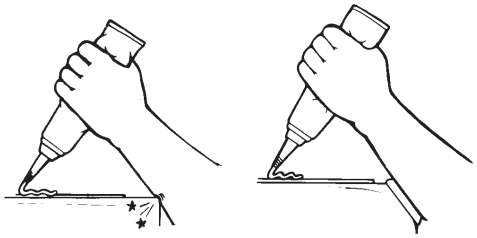
- Contour the item to fit the shape of the body.
- Provide padding to soften the pressure.
- Distribute the pressure over a larger surface area.



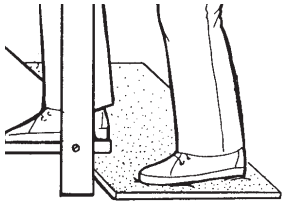
Use whole-hand loops — Rather than using finger loops for tools such as scissors, providing whole-hand loops for heavily used tools eliminates rubbing on the fingers.



Provide good chairs and shop stools — Contact stress from sitting on hard surfaces, which is the epitome of discomfort from pressure points, can be lessened with cushioning and contouring. Proper seat height greatly affects pressure points on the legs. If the seat is too high and the legs dangle, the pressure behind the knees can be excessive. If the seat is too low, the weight of the body concentrates on the buttocks, again creating discomfort.

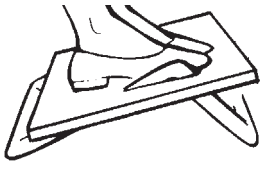


Provide arm cushions — A common example of contact stress is having to lean your forearms against a hard edge. To make improvements, add padding and/or round out the edge.



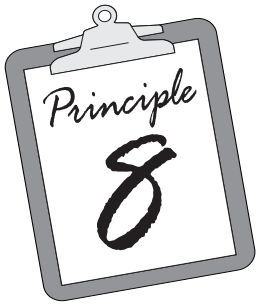
Provide floor cushioning — Standing for long periods of time on hard surfaces (especially concrete floors) can damage tissue in the heels, contribute to other leg disorders and increase fatigue. Options include:

- **Antifatigue mats** are the usual choice in production facilities where employees stand at single workstations. A variety of types are available for an assortment of conditions, ranging from oily areas in machine shops to clean-room conditions in pharmaceutical labs.
- **Cushioned insoles or heel cups** for mobile staff — such as maintenance, engineers and supervisors — should be used where mats are not feasible. Viscoelastic, shock-absorbing materials typically work best.



Use flat footrests — Foot rings and rails are common on stools and workstations, and they're better than nothing. However, the narrow dimension can create a pressure point on the bottom of the foot. It's better to use a flat surface.

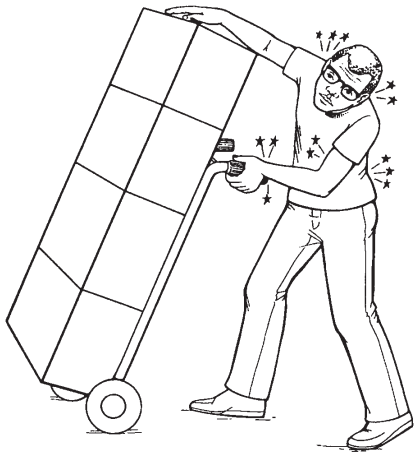
Provide Clearance



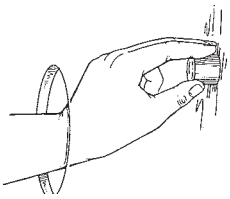
You should have both adequate workspace and easy access to everything you need, with no barriers in the way. Lack of clearance can create bumping hazards or force you to work in contorted postures. It also can increase long reaches, especially if there is inadequate space for the knees or feet. Insufficient knee space is a common problem in the industrial workplace, although every part of the body can be affected — the head, torso, feet and hands.

Design for tall people — In general, the goal is to make sure that tall people have enough clearance, that is, room for the head, knees, elbows and feet. If tall people can fit, then so can everyone else. To improve access:

- Reorganize equipment, shelves and the like.
- Increase the sizes of openings.
- Eliminate obstructions between the person and the items needed to accomplish the task.



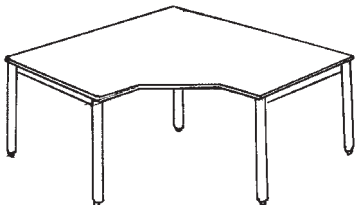
Provide visual access — A related issue is the ability to see what you're doing or to see dials and displays. A common problem is being unable to see when moving a cart or lift truck. Equally common is the difficulty of working at a machine or workstation where gauges are too far from the operator's position.



Clearance for maintenance

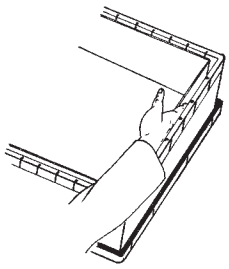
Build in maintainability — Probably the single biggest ergonomics problem for maintenance personnel is lack of clearance. Many activities would be simple to perform if the worker could only reach an item and work on it with easy access. Unfortunately, too often the items to be fixed are buried within machines. The remedy is designing equipment with access in mind:

- Provide removable panels.
- Provide quick disconnects.
- Relocate frequently accessed equipment.



Provide knee space — As noted earlier, a common problem is the lack of knee or thigh clearance under desks, workbenches and other types of equipment where people sit. Improvements include:

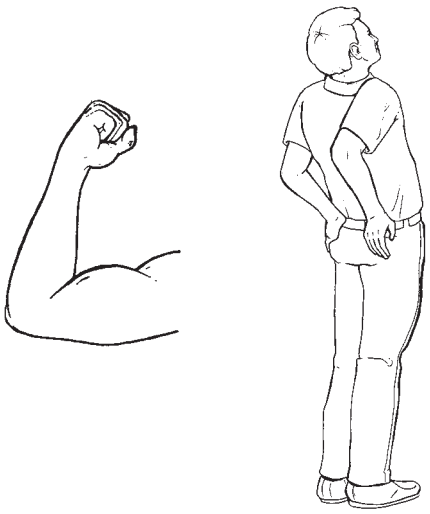
- Thin surfaces, with no hindering drawers
- Removal of obstacles



Provide hand clearance — Equally important is having sufficient space for the hands in order to avoid "knuckle-buster" injuries and simply to get the job done effectively.

Move, Exercise And Stretch

The human body needs to exercise and stretch. You shouldn't conclude after reading all the preceding information that you're best off just lying around, pushing buttons. To be healthy, you need to stretch each joint to the full range of motion periodically throughout the day. Your heartrate needs to rise for a period of time every day. Your muscles need to be loaded on occasion. Unfortunately, most jobs don't promote these activities, and where there is movement or exertion, it's often too much of the wrong type.



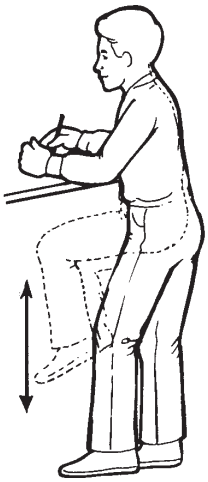
Keep fit — Staying in shape is important; some employers provide fitness centers onsite to help promote good fitness.

Do warm-ups — People who perform heavy tasks should warm up beforehand. Experience in sports has shown the value of warming up to prevent injuries.

Take energy breaks — People doing sedentary tasks should stop and stretch from time to time. Aerobic activity can also provide benefits and reduce fatigue.

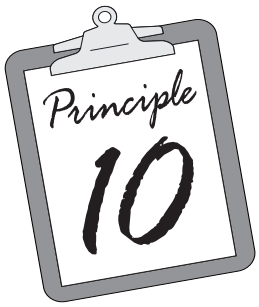
Change chair positioning — For those who sit for long periods, it's important to adjust chairs. Shift, move and change positions often.

Allow for alternate postures — No one correct posture is best for an entire workday. It's important to be able to change and move. Adjustable furniture and equipment can facilitate such movement, but even without them, you can change positions often. And if you have adjustable equipment, take advantage of it.

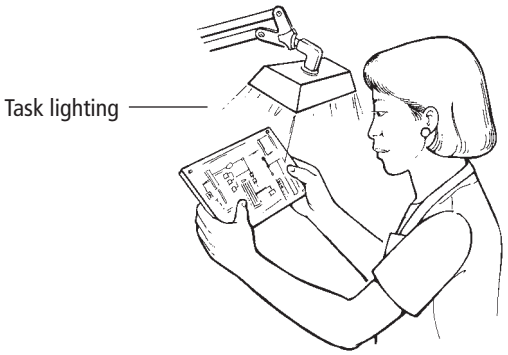


Design for sit-stand —Alternate back and forth between sitting and standing. The most basic approach is to design the workstation for a standing posture and then use a tall stool to sit on as needed. Stand until you get fatigued from standing; then sit and vice versa.

Maintain A Comfortable Environment



We humans don't perform well in less-than-ideal environments. Excessive heat and humidity slow us down; excessive cold hinders our ability to do effective work. Toxic chemicals can damage our health; vibration can injure sensitive tissue. This principle is more or less a catch-all category in ergonomics. Some topics are often addressed in other specialties — for instance, toxic chemicals in the field of industrial hygiene. Other issues, such as lighting, have gained attention with the interest in workplace ergonomics.

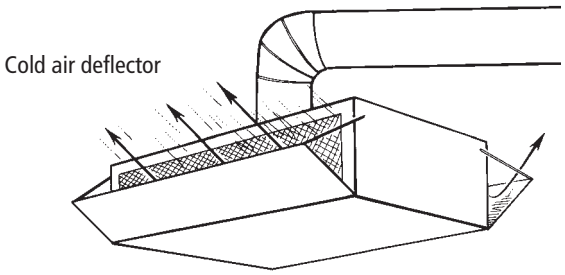


Provide appropriate lighting — The quantity and quality of light at your workstation will either serve to enhance or obscure the details of your work. Common problems include:

- Glare that shines in your eyes
- Shadows that hide details
- Poor contrast between your work and the background

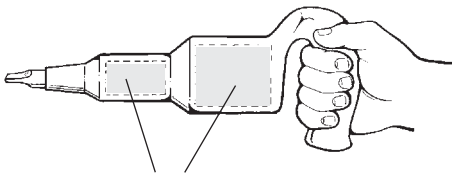
To make improvements, provide:

- Task lighting or indirect lighting
- Diffusers or shields to minimize glare
- Better placement of lights



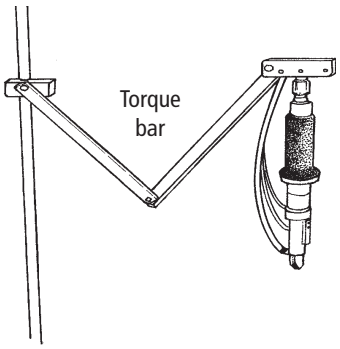
Avoid temperature extremes — Being excessively hot or cold while performing a task can cause discomfort and may contribute to health problems. In many cases, the source of the problem is inherent — for instance, laying shingles on a hot day or moving meat in a cold storage locker. However, steps can be taken to avoid specific problems:

- Use ventilation defusers or deflectors to keep cold air from blowing directly on people.
- Add heat shields around furnaces and other heat sources.



Dampen vibration and shock — Working with tools and equipment that create shock or vibration can cause injury. To isolate vibration:

- Use vibration-dampening materials in or on tools.
- Perform routine maintenance.
- Mount equipment on vibration-dampening pads.
- Use cushioned floormats for standing operations.
- Change equipment speeds and feeds.



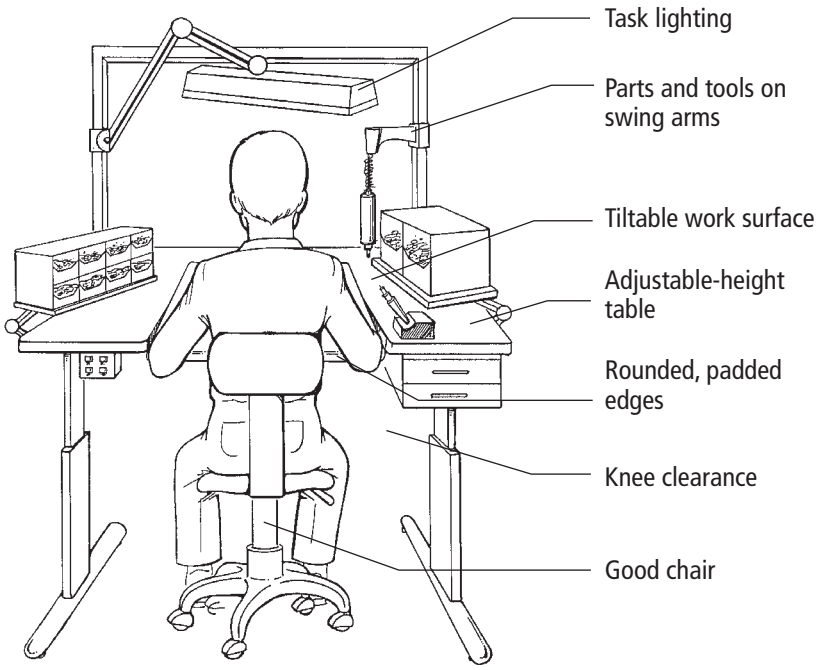
Use torque bars — In operations where power screwdrivers and nutrunners are used, it's important to use torque bars and make other modifications to prevent shock from being transferred to the wrists.

Noise control — This is another often neglected topic that fits in this category. Multitudes of techniques are available to dampen noise, including isolation mounts, flexible connectors, mufflers and streamlined air and fluid-handling systems.

Colors — Colors can affect tasks in a number of important ways. Small parts on a traditional white assembly table can be difficult to see; contrasting work surface colors can make them visible. Matte colors can reduce glare and eyestrain. Color on walls and the good use of art can enhance work areas.

Applications

SITTING WORKSTATIONS



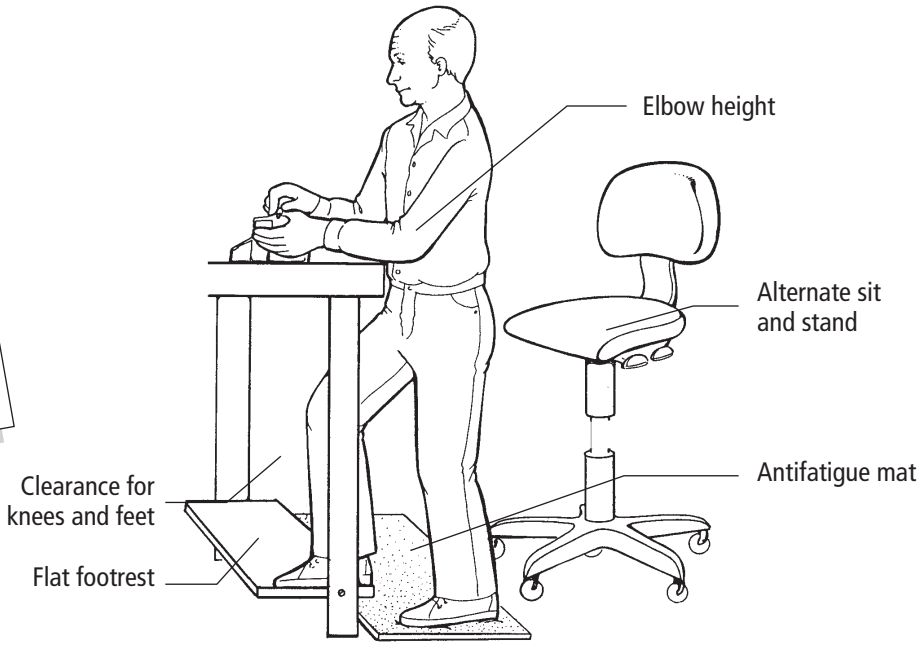
Common Issues

- Work surfaces not at good heights
- Long reaches for materials
- Work surfaces with hard edges
- Poor clearance for thighs and knees
- Poor work area to perform all tasks
- Shadows or glare

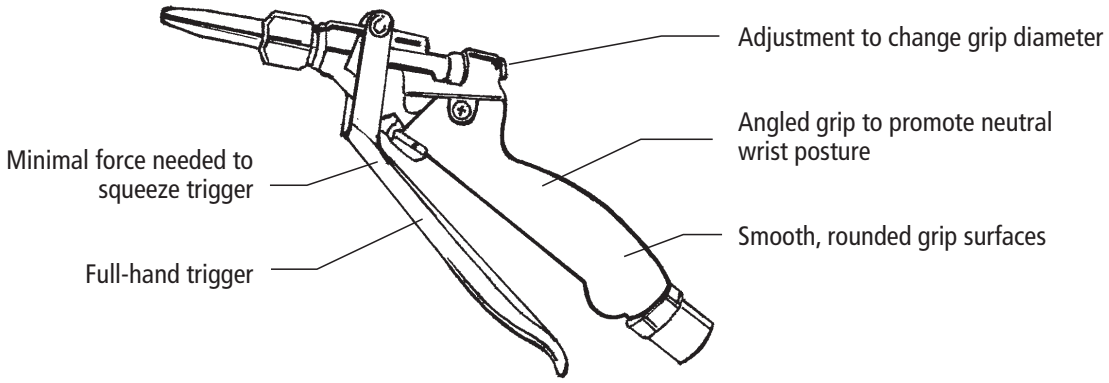
STANDING TASKS

Common Issues

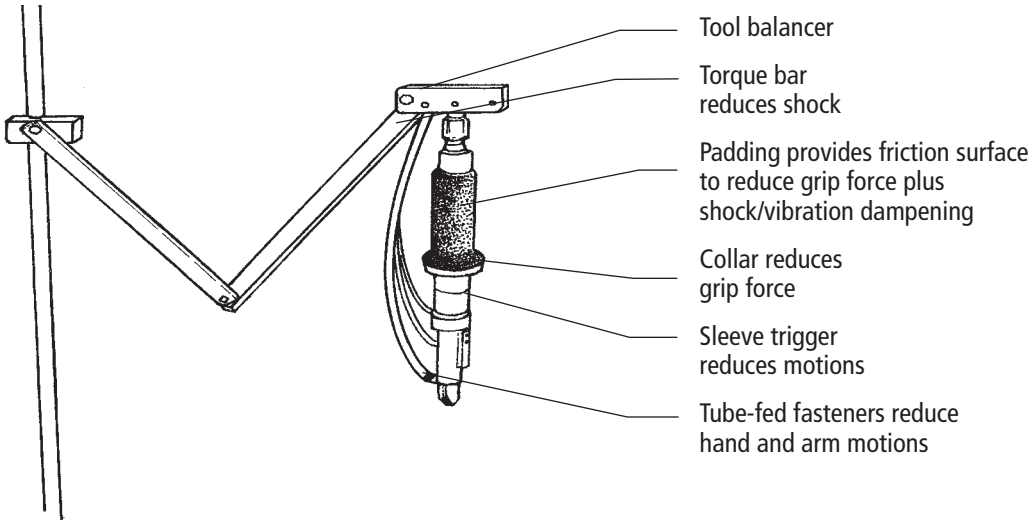
- Static load on legs
- Awkward back posture, bending
- Pressure points from hard floor
- Awkward heights



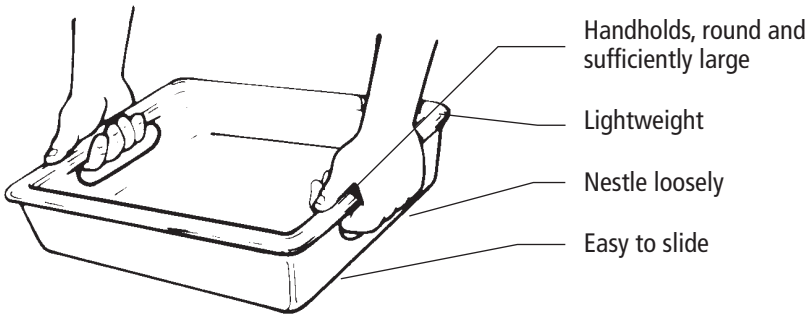
HAND TOOLS



POWER DRIVERS



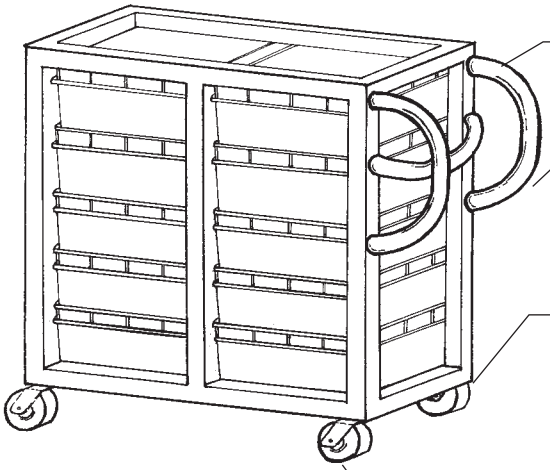
TOTES/BASKETS/PANS



CARTS

Use A Cart Appropriate To The Task

- Hundreds of types on the market
- Multiple styles may be needed
- Adjustable height can be helpful
- Consider custom carts for special needs



Common Issues

- Repetitive lifting, bending, twisting and reaching heavy loads

PALLETIZING AND MATERIAL HANDLING

Options For Improvement

Scissors Lifts

- Powered lift tables
- Spring-loaded lift tables
- Zero-clearance lift tables
- Lift tables with Lazy Susans
- Lift tables with roller conveyors
- Lift tables that also tilt
- Automatic palletizing systems

Stretch Wrappers

- No-bend manual stretch wrappers
- Automatic stretch wrappers

Conveyor Systems

- Skids and slides
- Roller or belt conveyors
- Screw (or auger) conveyors
- Ball conveyors
- Flex conveyors
- Air tube conveyors

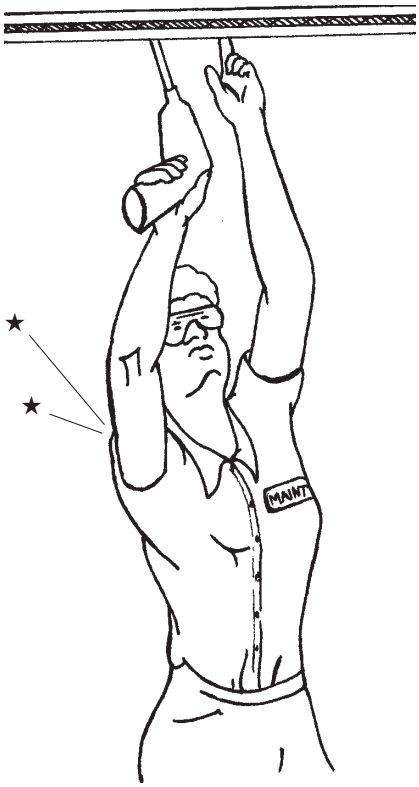
Mechanical Assists

- Powered, articulated arms
- Miscellaneous cranes and hoists
- Vacuum hoists

Alternative Methods

- Hoppers
- Chutes
- Guides and funnels
- Dollies and carts
- Gurneys
- Runways
- Pumps
- Overhead monorail systems
- Cell production (to reduce handling)
- Layout optimization (to reduce handling)
- Pressurized air (hovercraft concept)
- Bulk handling
- Lift trucks with custom grabbers

MAINTENANCE



Good ergonomics can eliminate some of the awkward tasks associated with maintenance and repair. Moreover, these same considerations can reduce down time for repairs, improve inspection of critical components and reduce failure-related accidents.

Improvements can be made by applying all the basic principles and concepts as needed but in particular, *Principle 8 — Provide Clearance*.

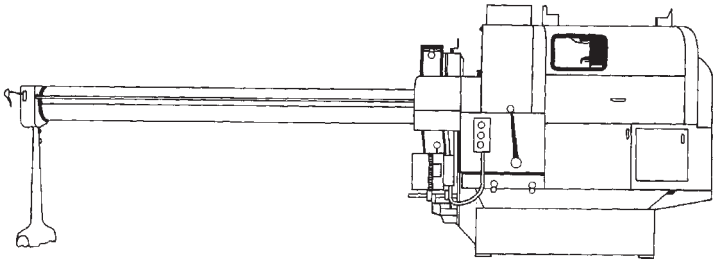
Common Issues

- Heavy handling of equipment
- Repetitive motions of arms and shoulders
- Awkward postures
- Static postures
- Static gripping
- Variety of hand tool issues
- Poor access and clearance
- Reaching and awkward heights
- Pressure points
- Environmental issues such as vibration and heat/cold

MACHINING

Common Issues

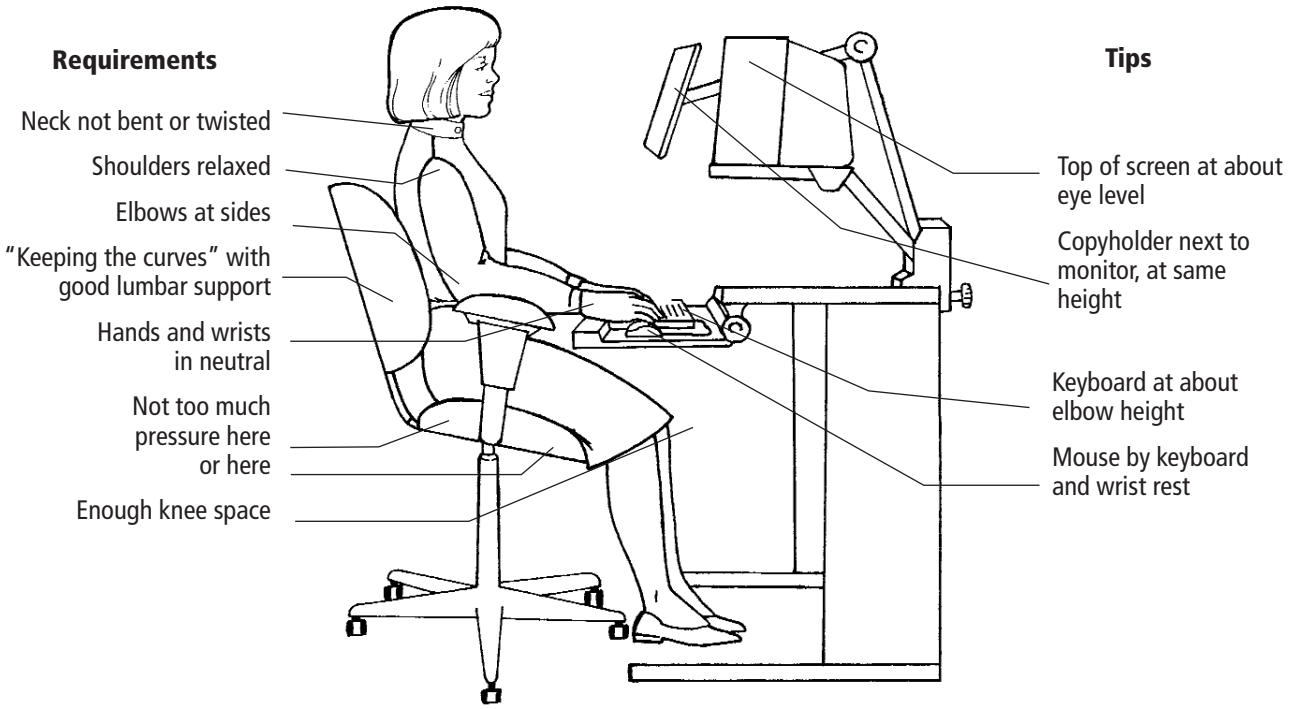
- Heavy lifting and exertion to load stock
- Heavy exertion to change tooling
- Long reaches to access tooling and handle parts
- Long reaches to make adjustments
- Lifting of heavy totes and baskets
- Repetitive hand and arm motions to load and unload parts
- Repetitive hand motions to deburr
- Continuous standing on hard floors



Options For Improvement

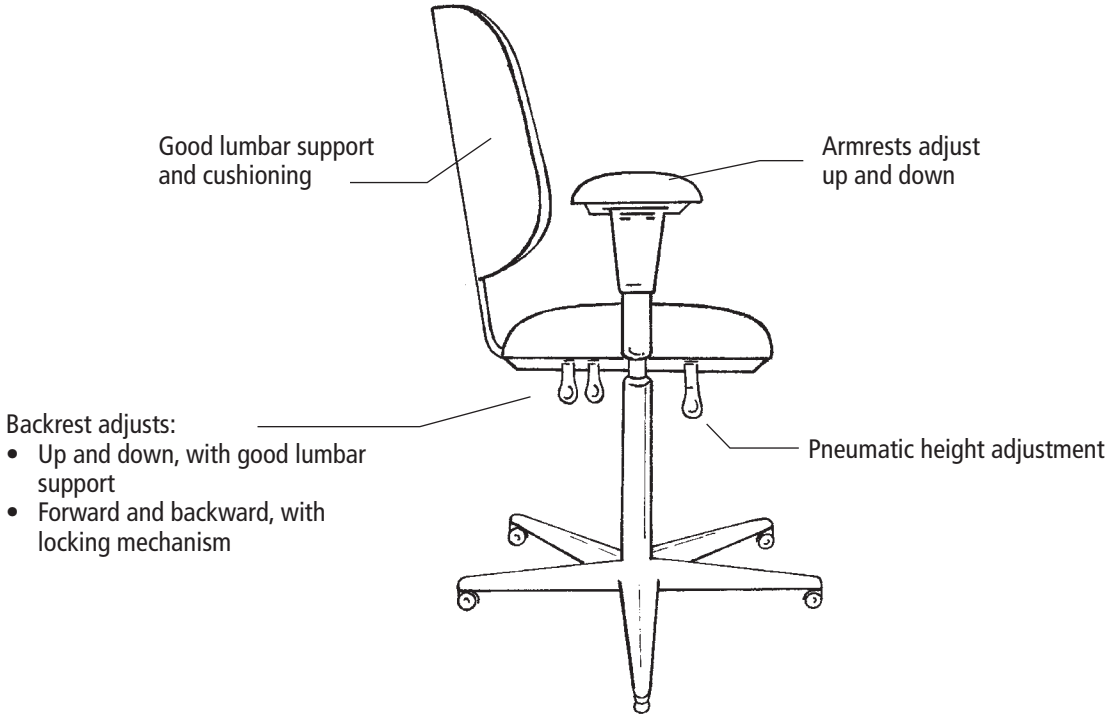
- Shuttles to load parts
- Equalize work surface heights to permit sliding of materials
- Skid bars and guides to support loads while putting in and removing from machine
- Skid bars, conveyors with gates or flex conveyors to handle totes
- Air or hydraulic cylinders to do heavy pushing
- Lift tables and tilted parts stands
- Lean stands and footrests

COMPUTER WORKSTATIONS



Remember: It's better for your spine to lean back slightly, as if you're sitting in your carseat. Even so, no one posture is correct for an entire 8-hour day. You must change positions periodically.

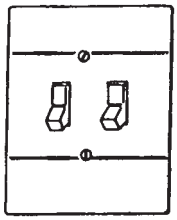
CHAIRS AND WORK STOOLS



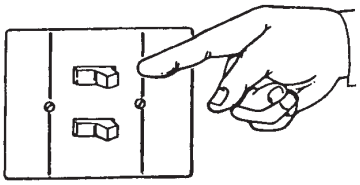
Cognitive Ergonomics

*Almost everything in this booklet deals with **physical ergonomics**. It is helpful, however, to mention other major aspects of the field. **Cognitive ergonomics** addresses how we conceive information, process it mentally and decide on correct responses. By designing displays and controls — and, in fact, every type of information that we handle mentally — to take into account human perceptions and expectations, it's possible to reduce errors and improve performance.*

Design For Expectations

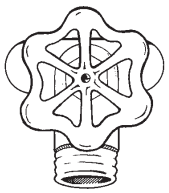


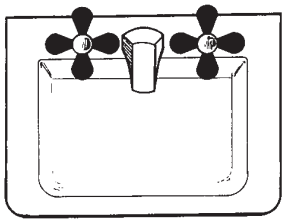
Most people would expect to flip up the switch to turn the lights on.



So horizontal switches violate our expectations and provide no hint of correct operation. We don't know automatically which way to flip the switch. By studying issues like this, we can reduce mistakes and confusion.

Standardize





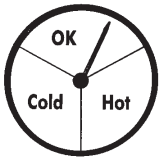
Which way would you turn these faucets to turn the water on?

Many errors are caused by inconsistencies in how things are supposed to work. To prevent mistakes, a general rule is to ensure that similar devices work the same way.

The operation of single faucets (such as outdoor spigots for garden hoses, above left) have been fairly standardized and follow the popular rule for activation: "Righty-tighty, lefty-loosey." Double faucets (like a sink, above right), on the other hand, are not standardized.

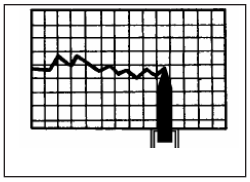
Use Appropriate Displays

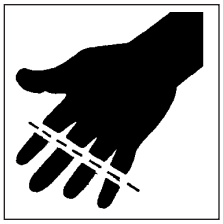
Digital



Analog

Often, the type of display used will help provide the user with the easiest and most accurate way to gain necessary information. Digital displays are usually best when precise information is needed. However, analog gauges tend to be faster and clearer for general indication.

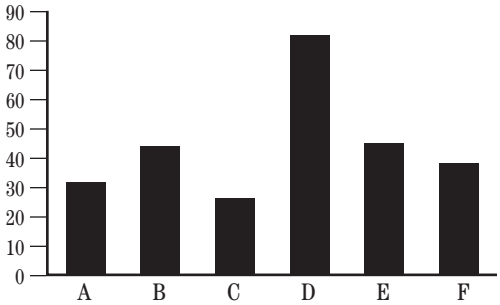




Moving pointers and trend graphs are better for presenting relative information. But icons convey information quickly, particularly for warning signs.

Use Patterns

A: 32
B: 43
C: 28
D: 82
E: 45
F: 38



Which is easier to interpret — the list of numbers at the left or the graph above?

Humans are good at recognizing patterns quickly and accurately. That's why graphs are much easier to read and interpret than columns of numbers. Bar graphs are especially good for comparing numbers, and line graphs are good for showing trends.

Work Organization

A final general area of ergonomics has to do with the underlying design of work and related issues:

- **Task allocation** — How should tasks be divided and assigned to accomplish goals? Is it better to have many people equally capable of doing many tasks? Or is it better to have a narrow division of labor, so that individuals are highly qualified at specific tasks?
- **Assembly lines versus work cells** — Should the technology and equipment of the workplace be designed so that tasks are narrowly defined? Or should the physical layout promote team activities?
- **Shift work** — Should there be more than one shift in a given workplace? And, if so, should employees be assigned to just one shift (thus prohibiting some people from enjoying normal evening family and social activities)? Or should they be rotated between shifts every couple of weeks (thus forcing everyone to disrupt their biological time clocks)?
- **Reward system** — How should people be compensated for their activities? What actions should be rewarded? Should people be compensated for how much they put into a task (hours and effort) or how much they put out (quality and quantity of product)?
- **Structure** — How many vertical layers should there be in an organization? What degree of horizontal segmentation? What amount of centralization?
- **Decision making** — What kinds of decisions should be made at what levels of the organization? Should the strategic issues be left to just top managers? Or should rank-and-file employees be allowed — or required — to take part in decision making?

These are huge topics, and other fields of study have clearly addressed them in more detail. Even so, ergonomics adds a certain perspective. In particular, ergonomics focuses on the point at which the technological and human sides of production mesh. There are many ways to approach these topics, but one helpful way is by considering *occupational stress.*

OCCUPATIONAL STRESS

An important topic in this category is how to reduce stress:

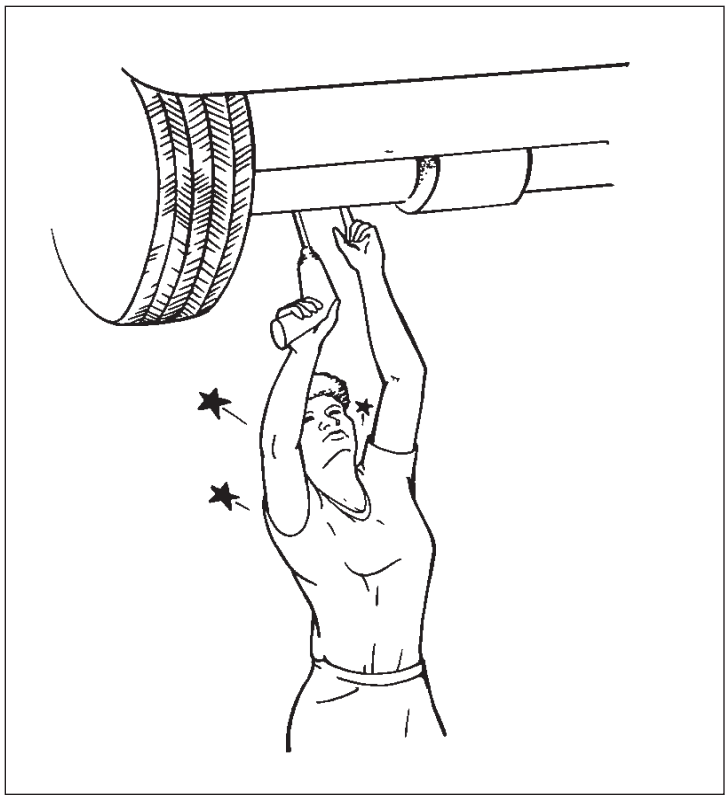
- **Plan** — Anticipate, think ahead and prepare. Think of ways to avoid the stress of hurry-up-and-wait situations. Balance the flow of work.
- **Communicate** — Think of how to share information, coordinate and help plan. Dedicate time so you can discuss issues and be kept up to date.
- **Empower** — Give people the ability to control the events of their daily work lives.
- **Be involved** — Encourage participation in the daily events of work life. Everyone's ideas and input are important.
- **Promote teams** — The team concept helps promote a sense of belonging, being valued and having a say.

Quality, Efficiency And Cost Reductions

Poor ergonomics can inhibit people from doing their jobs well:

- People who are working in awkward and uncomfortable postures — or maybe even hurting — are in no position to do their jobs right the first time, every time.
- Fatigue is directly linked with lower productivity.
- Manual tasks that are hard on people are often bottlenecks in production or, even worse, non-value-added steps.
- Working in awkward postures reduces strength and affects fine motor control, which can lead to errors.

Fortunately, by putting on your "ergonomics glasses," you can start to identify ways of working that are simply better all around. Experience shows that productivity goes up with good ergonomics, not by making anyone work harder or faster but by finding smarter ways of working. The number of defects and errors can drop for the same reasons. By systematically evaluating all tasks from one end of the workplace to the other, it's possible to find innovative ways to improve jobs from almost every perspective.



Ergonomics is a people-based concept, and the prime motivator is improving human well-being. However, it's also important to recognize the cost savings from doing so:

- **Workers' compensation** — Most workers' compensation costs are related to back injuries, strains and other types of human wear and tear. These are exactly the types of problems that can be solved with ergonomics.
- **Turnover and absenteeism** — One of the reasons people quit jobs or don't show up every day is that they don't like working in awkward and uncomfortable positions or are unnecessarily fatigued from work. In the current era of low unemployment, improved ergonomics can make many jobs more attractive.
- **Morale** — An unsatisfactory work environment can reduce morale. Estimating the cost of poor morale is difficult, but everyone knows there is a cost associated with it. Systematically improving jobs using principles of ergonomics can improve morale, in terms of both the end results and the process of getting there.

Wear And Tear

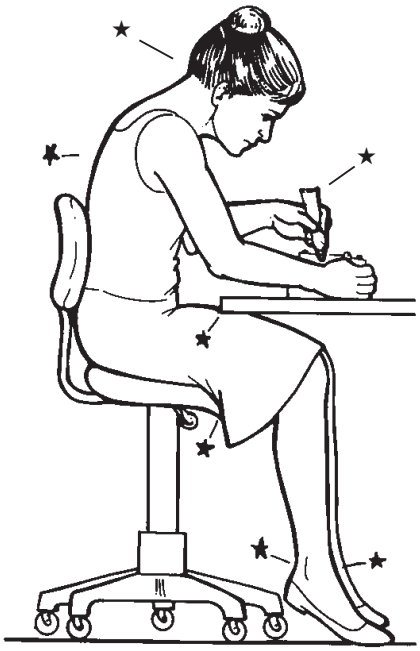
*There is a group of physical disorders that basically amount to **wear and tear** on the tissues surrounding the joints. General terms for these disorders include Cumulative Trauma Disorders (CTDs), Musculoskeletal Disorders (MSDs) and Repetitive Strain Injuries (RSIs). Most people experience disorders like these during their lives, often sports related or lower-back pain from everyday life. Usually, the symptoms are mild and disappear with rest, but sometimes, they can become disabling.*

Symptoms

- Soreness, pain or discomfort
- Burning or tingling ("pins and needles" sensation)
- Numbness, weakness and clumsiness
- Limited range of motion
- Popping and cracking in the joints
- Redness, swelling and local skin warmth

Get it checked out

If you are having any problems of this sort, it's important to get a medical evaluation using the normal procedures in your workplace. With early recognition, emerging disorders can be successfully and simply treated with aspirin and ice packs. Waiting too long might require surgery, which involves higher costs and less chance of complete recovery.



Risk factors

Several factors can increase the risk of wear-and-tear problems, whether of the lower back, wrist, elbow or shoulder. The more factors involved and the greater the exposure to each, the higher the chance of developing a disorder:

- Awkward postures — Body positions that deviate from neutral
- Static load — Using the same muscles for a period of time without change
- Pressure points — Direct pressure against any vulnerable part of the body
- Force — The exertion required to make these motions
- Repetition — The number of motions made per day by a particular body part
- Environment — Extreme heat or cold; vibration and shock

Personal issues

- Physical condition — Poor personal fitness can play a role in the development of some types of disorders.
- Diseases and conditions — There are also several diseases (for example, diabetes) and conditions (pregnancy) that can increase the risk for certain types of disorders.

Prevention

The approach to prevention is based in applying the concepts outlined in this manual.

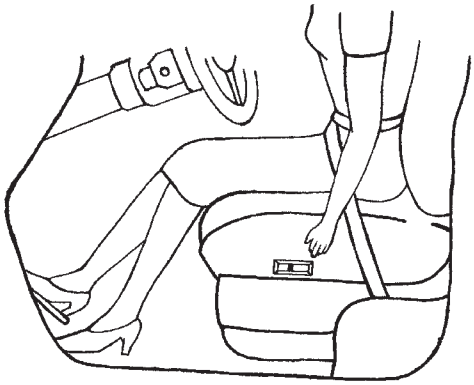
Creating Change

Improving ergonomics often involves change, and at one point or another, you may need to serve as a "change agent." Change must occur at two levels: (1) making sure the organizational climate is favorable and (2) on occasion, getting people to change habits.

Atmosphere Of Innovation

Much of what it takes to change organizational culture depends on the actions of top management, but everyone has a role. It helps to do these things:

- **Adopt a set of rules**
  - Everyone is expected come up with ideas for improvement.
  - The best ideas are often discovered in group settings. Two heads are better than one, and twelve heads are better than two.
  - Brainstorming and even raising "hare-brained" ideas are required.
  - Only a few of the ideas raised will actually be feasible. Consequently, (a) it's crucial to raise a lot of ideas to increase the likelihood that you will find a good one, and (b) no one should feel discouraged if his or her idea doesn't work.
  - Often, the only way to know if something is going to work is to try it.
  - Few ideas ever work from the start. It takes time — and usually a bit of trial and error — to get something to work right.
  - There is a difference between (a) a roadblock, which can be overcome, and (b) a fatal flaw, which totally kills an idea. Most problems are only roadblocks (but there may be many of these).
  - Failure should be expected. In the real world, not every good idea works.
- **Communicate** — Explaining plans and keeping everyone updated is crucial.
- **Involve people** — Participation creates ownership of ideas and helps people buy into the process, rather than have it dictated from above.



We're in the habit of adjusting our car seats. We need to do the same with equipment at work.

Individual Change

Sometimes, new methods involve changing ingrained habits, which everyone knows can be difficult and frustrating. To help make change easier, try to do the following:

- **Train, involve and empower** — Explain what, why and how. For example, with adjustable equipment, people need to be told *how* it is adjusted, *what* goals they are trying to accomplish, and *why* this is important.
- **Provide practice** — Getting instructions is not enough. People must practice a technique for it to become a habit.
- **Try it; you'll like it** — Sometimes, people simply have to be talked into trying the new method for awhile. The length of trial must be long enough to overcome old habits.
- **Change everything** — On occasion, individuals have done certain tasks for so long that any change feels awkward, even if it is clearly better. "Muscle memory" plays a strong role here. It may be easier to disrupt everything, so that everything is new and the task has to be learned all over again from scratch.

Setting Up A Program

Establishing an initial, focused program is often necessary to set in motion an ongoing process. Several basic elements of such a program are outlined below, and every employer should adopt them in one form or another. Despite differences between types of industries and sizes of businesses, the following framework provides an approach for integrating ergonomics into the day-to-day worklife.

PROGRAM ELEMENTS

- **Organization** — A plan for getting organized, assigning responsibility and involving people
- **Training** — An effort to provide training in ergonomics to personnel at all levels of the organization
- **Communication** — Systems for describing activities and progress
- **Task Analysis** — A systematic way to review all work areas for needed improvements
- **Making Improvements** — The key part of the process: making improvements whenever feasible
- **Medical Management** — Procedures and protocols for identifying and treating employees with symptoms of CTDs
- **Monitoring Progress** — Ways to measure and evaluate the program

*The step of **problem solving** is commonly left out of most descriptions of ergonomic task analysis. One useful approach follows these steps:*

- Use a good checklist to review the task, preferably in a group of two or three members of an ergonomics team.
- Discuss issues with employees and supervisors.
- Videotape the job.
- Review video and checklist results with a team in a conference room.
- Brainstorm options for improvement.
- Plan actions for change.
- Implement the changes.
- Evaluate the results.

Ergonomics Task Evaluation Worksheet

(Make sure to explain your purpose to the people at the task you are evaluating)

Area _____ Date of Evaluation _____

Task _____ Shift 1_____ 2_____ 3_____

Steps of the Task

_____ _____ _____

_____ _____ _____

_____ _____ _____

Ergonomics Issue	Ideas for Improvement or Comments
1. AWKWARD POSTURES?	
Bent wrists	
Elbows from body	
Bent/twisted back	
Bent neck	
2. EXCESSIVE FORCES?	
Grasping or pinching forces	
Push/pull arm forces	
Loads on back	
3. ANYTHING NOT IN EASY REACH?	
Reach envelope: • full arm • fore arm	
4. NOT AT RIGHT HEIGHT?	
Over shoulders/below knees	
Elbow height	
Equipment height relationships	
5. EXCESSIVE MOTIONS?	
Hands	
Arms	
Back	

Ergonomics Issue	Ideas for Improvement or Comments

6. UNNECESSARILY FATIGUING?

Static loads:
- grip
- arm

7. PRESSURE POINTS?

Tool grip

Hard edges/surfaces

Hard floor

8. POOR CLEARANCE AND ACCESS?

Bump/not fit

Can't see

9. FREEDOM TO MOVE & STRETCH?

Constant sitting

Stand in one place

10. UNCOMFORTABLE ENVIRONMENT?

Vibration

Temperature extremes

Glare, shadows, too bright or dark

ADDITIONAL INFORMATION

What suggestions and feedback do employees/supervisors have?

Brainstorming Questions:
- What alternative work methods are possible?
- What improved types of tools are possible?
- What types of mechanical assists might be used?
- What changes in layout would help?
- Would changes in the material-handling system help?
- Would changes in the work process help?
- Is there a completely different way of doing the job?

Evaluator(s) _____ _____ Date _____

Development and Evaluation

Ergonomics and Risk Factor Awareness Training

In 2001, the first version of the Ergonomics and Risk Factor Awareness Training for employees was developed to assist Mine A with the implementation of its ergonomics process. Although there were many commercially available training courses that could have been used for this application, none was specific to the mining industry. The training developed for Mine A emphasized the need for employees to identify and report exposures to ergonomic risk factors prior to the occurrence of a musculoskeletal disorder. Interactive exercises included tasks that were specific to mining and in some cases included tasks performed at Mine A. Twenty-one training sessions were given to 280 employees, who submitted approximately 28 concern cards indicating potential risk factor exposures.

Following this initial effort, the Ergonomics and Risk Factor Awareness Training was provided to approximately 800 people from several organizations/events (United Mine Workers of America, NIOSH Safety Seminar for Underground Stone Mines, Small Mines Conference, Industrial Minerals Association, and TRAM West) and four companies. When offering this training to these organizations, it was modified when possible to provide examples pertinent to their specific type of mining and tasks performed at their mines. In some cases, the companies provided short videos of tasks performed at their sites. The training was also modified to fit the time allowed for the training, usually 60–90 minutes.

Additionally, this training was given to 77 employees at Mine B, also as part of its effort to implement an ergonomics process. Evaluation responses provided by Mine B employees are shown in Tables 1 and 2. Most of the employees thought the interactive exercises were easy to follow and helped them to understand ergonomic risk factors and how to control them. In addition, most of the employees would like to apply what they learned and thought they would be able to do so. Forty-nine percent of the employees agreed that they were overwhelmed by the amount of information presented. At the request of Mine B, additional information about back stresses associated with lifting was presented. Consequently, the Mine B training took approximately 145 minutes (versus 90 minutes for the Mine A training) and may have been too long. Two employees commented that the training was too long or to make it shorter; two other employees thought the course should be more interactive. However, most of the employees would recommend this training to others.

Table 1.—Mine B employee responses for questions 1 through 7 (n=77)

Question	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1. The video exercise was easy to follow.	1	1		5	54	15
2. The video exercise helped me understand risk factors.	1			4	51	20
3. The video exercise helped me understand how injury risk can be reduced.	1	1		2	54	18
4. The instructor gave good explanations.	1		1	4	48	23
5. I would like to apply what I learned to my job.	1			3	48	25
6. I would recommend this training to others.	1		1	6	43	25
7. I was overwhelmed by the amount of information given during this training.	11	21	7	12	20	6

NOTE.—Some of the row totals do not equal 77 because one employee responded to only some of the questions. Except for the last question, only 3 employees responded as "disagreeing" with any of the other questions.

Table 2.—Mine B employee responses for questions 8 through 10 (n=77)

Question	None/Not at all				A lot
	1	2	3	4	5
8. After receiving this training, could you apply the skills presented in this workshop to your work setting?	0	1	16	45	15
9. How much of this course content was new to you?	1	24	30	17	5
10. How much experience do you have in implementing ergonomics in the workplace?	2	14	38	22	1

Because the demand for this training far exceeds NIOSH resources available to provide this training, it was decided to develop a train-the-trainer package. This required the development of supporting materials for the trainer to use for giving the employee course, as well as a stand-alone course for the trainer to become knowledgeable in basic ergonomics.

In August 2005, a focus group with members from the mining industry, the Mine Safety and Health Administration, and NIOSH was convened to discuss changes needed to the employee course and development of an instructor's manual. The result from this focus group included separating the training into two sessions and adding more interactive exercises and demonstrations. The format and content of the instructor's guide was considered suitable.

In February 2006, NIOSH researchers presented the train-the-trainer course to safety and health representatives from Mine C. Input was received from these participants regarding further improvements to the employee course and instructor's manual, which included:

- Adding a homework assignment after the first session
- Adding an example of an intervention specific to the mine receiving the training
- Using the same form in the interactive exercises as employees will use to report risk factor exposures
- Modifying the acute-cumulative-both injury exercise to allow only two choices (acute or cumulative)
- Presenting "musculoskeletal disorders," "musculoskeletal injuries," and "cumulative trauma disorders" as equivalent terms
- Highlighting the benefits of ergonomics for the employee and the impact of musculoskeletal disorders on employees
- Providing vendor information for some demonstration materials and making minor formatting changes

Within 6 weeks of receiving the train-the-trainer course, four of the six attendees presented parts of the employee training, which had been modified based on their input. The training was given at two sites during two sessions, 1 week apart. Twenty-two employees attended the training at one site, and 25 employees attended the training at the other site. The four trainers completed an evaluation following the second session of the employee training. The results of the evaluations are shown in Tables 3–4. Overall, the instructors felt comfortable presenting the four topics included in the employee training, but needed both the information presented in the train-the-trainer workshop and the instructor's manual to present the four topics. Additionally, when asked the following question:

> Did attending the "train the trainer" workshop make you more comfortable with the subject matter?
>
> **NOT AT ALL** **A Lot**
>
> 1 2 3 4 5

two instructors circled "5", one circled "4", and one circled "3" and "4".

Three of the four instructors responded that the instructor's manual was easy to read and felt comfortable doing the demonstrations. None of the instructors had problems playing the short videos with their computers and/or projection systems. All of the instructors thought that the technical level was appropriate for their employees and that the interactive exercises pertained to their sites. Giving the training during two sessions worked best for both sites.

Three of the four instructors thought the homework assignment was completed satisfactorily by the employees. Because some employees at both sites were not literate, not everyone understood how to complete the assignment. However, 42 homework assignments were turned in at the beginning of the second session.

When asked for suggestions on how to improve either the training or the instructor's manual, the instructors provided two comments:

- Organize the manual so that the various parts can be found more easily.
- The sequence of some of the slides needs to be changed.

Table 3.—Responses by Mine C trainers related to the specific topics presented

Question	Strongly Disagree	Disagree	Slightly Agree	Slightly Agree	Agree	Strongly Agree
Topic: Ergonomics						
I was comfortable presenting this topic.					3	1
I needed information from the workshop to present this topic.					2	2
I needed information from the training manual to present this topic.				1	1	2
Topic: MSDs						
I was comfortable presenting this topic.				1	2	1
I needed information from the workshop to present this topic.					2	2
I needed information from the training manual to present this topic.				1	1	2
Topic: Risk factors						
I was comfortable presenting this topic.					2	2
I needed information from the workshop to present this topic.					2	2
I needed information from the training manual to present this topic.				1	1	2
Topic: Root causes/exercises						
I was comfortable presenting this topic.				1	2	1
I needed information from the workshop to present this topic.					1	3
I needed information from the training manual to present this topic.				1		3

Table 4.—Responses by Mine C trainers related to presenting the employee course

Questions	Yes	No
Was the instructor's guide easy to read? *Comments: Need larger size font for notes pages; need better organization*	3	1
Did you have any problems playing the videos on your computer?		4
Did you feel comfortable doing the demonstrations?	3	1
Do you believe giving this training during two sessions is best for your site?	4	
Was the technical level appropriate for the employees at your site?	4	
Did the interactive exercises pertain to your site?	3	
Did the trainees satisfactorily complete the homework assignment? *Comments: They could have been more task-specific; some employees understood, but others did not; some employees cannot read or write*	3	1
Did the trainees ask you questions about topics that were not covered by the material? *Comment: What is carpal tunnel and how is it medically corrected?*	2	2

Mine C employees attending this training were also asked to complete evaluations after each session. The results of these evaluations are provided in Tables 5–6 (Part 1) and Tables 7–8 (Part 2). Forty employees attended Part 1, while 35 employees attended Part 2.

For Part 1, most of the employees thought the videos were helpful in understanding risk factors and believed they could identify risk factors from the material presented to them. Also, most of the employees understood the differences between acute and cumulative injuries. For Part 2, the employees agreed that the video exercises helped them to understand risk factors and how to reduce exposures to risk factors. The employees also agreed that the homework assignment helped them to understand risk factors. In general, most of the employees would like to apply what they learned and thought that the training helped them to apply the material presented to their jobs. The employees thought much of the material covered could be applied to mining jobs, as well as to their own jobs. At least 60% of the employees did not think too much information was presented during either Part 1 or 2. Both sessions took approximately 75–90 minutes each. Compared to the original training provided to Mine A employees, which took 90 minutes, additional time was needed during Part 2 to discuss the results of the homework assignment and to do a short review of material covered in Part 1. Most of the employees would recommend this training to others. Of the 21 comments received regarding how to improve the training, 17 did not believe any changes were needed. Of the four comments suggesting changes, one stated too much emphasis was on the employer costs associated with musculoskeletal disorders, another suggested providing better instructions for the homework assignment, and a third comment wanted more hands-on exercises. The fourth comment was not related to the training but to the need for NIOSH to collect baseline data, which would not normally be part of the training.

The information received from the employees who received the training from Mine C trainers was very similar to the responses of employees who received the training from NIOSH trainers. Both groups understood the material presented and believed they could apply the information learned to improve their jobs. This would indicate that the trainers received sufficient information during the train-the-trainer course and from the training materials to effectively present the employee training.

Table 5.—Mine C employee responses for questions 1 through 6, Part 1 (n=40)

Question	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1. The videos helped me understand risk factors.	1		2	2	20	15
2. I understand the differences between acute and cumulative injuries.				4	13	22
3. I would like to apply what I learned to my job.			2	0	18	18
4. I would recommend this training to others.			1	3	18	18
5. There was too much information given during this training.	8	13	7	3	5	4
6. I believe I can identify ergonomic risk factors from what I learned today.			1	4	18	18

NOTE.—Because some employees did not answer all questions, the row totals do not equal 40.

Table 6.—Mine C employee responses for questions 7 through 10, Part 1 (n=40)

Questions	None/Not at all				A lot
	1	2	3	4	5
7. How much experience do you have in applying ergonomics in your workplace?	6	3	16	5	9
8. Did this training teach you how to apply the skills presented to your work setting?	1	1	12	16	9
9. How much of the information presented during this training could be applied to mining jobs?			8	12	19
10. How much do you think you will be able to apply to your job?		2	13	10	14

NOTE.—Because some employees did not answer all questions, the row totals do not equal 40.

Table 7.—Mine C employee responses for questions 1 through 6, Part 2 (n=35)

Question	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1. The video exercises helped me understand risk factors.				3	17	13
2. The video exercises helped me understand how injury risk can be reduced.	2			1	17	13
3. I would like to apply what I learned to my job.	1		1	2	16	12
4. I would recommend this training to others.	2			2	17	12
5. There was too much information given during this training.	8	12	1	3	9	
6. The homework assignment helped me understand risk factors.	1	1	1	4	14	11

NOTE.—Because some employees did not answer all questions, the row totals do not equal 35.

Table 8.—Mine C employee responses for questions 7 through 10, Part 2 (n=35)

Questions	None/Not at all				A lot
	1	2	3	4	5
7. How much experience do you have in applying ergonomics in your workplace?	1	7	4	12	8
8. Did this training teach you how to apply the skills presented to your work setting?		3	3	14	15
9. How much of the information presented during this training could be applied to mining jobs?		1	4	10	20
10. How much do you think you will be able to apply to your job?		1	6	9	18

NOTE.—Because some employees did not answer all questions, the row totals do not equal 35.

As a result of the information received from both the trainer and employee evaluations, the following modifications have been made:

- A train-the-trainer course was developed and will be made available on the NIOSH Web site. (This course is very similar to the employee course, but contains additional information that may be needed by an instructor.)
- The sequence of some of the slides for the employee training was changed.
- A table of contents was added to the instructor's manual.

NOTE: Evaluation information from technical reviewers and pilot sites using the Internet training course will be added to this document as it becomes available.

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