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Reducing the Risk of Injury

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INTRODUCTION

Changing the way work is done can be difficult. It is also hard for most people to believe that what is done today may be causing unseen damage that won’t show up for months, years, or longer. The first step is to understand why change must happen. Other chapters in Ergonomics discuss the role risk factors play in developing cumulative trauma disorders (CTDs) and work-related musculoskeletal disorders (WMSDs). The best way to prevent workplace injuries, disease, and permanent damage to the body is to find ways to change the work process and to minimize or eliminate these risks.

KEY TERMS

cumulative trauma disorder (CTD) injury caused by certain work activities performed every day that mainly affects the knees, back, and upper extremities, which are shoulders, elbows, wrists, hands

ergonomics the study of how the work, the worker, and the workplace fit together

micro-break short break from work or using different muscles or performing a different task for a short time to provide rest for fatigued muscles

work-related musculoskeletal disorder (WMSD) injury that usually develops over time, but may have a sudden onset, that mainly affects the muscles, nerves, tendons, ligaments, joints, cartilage, and spinal discs

OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. Recognize features of ergonomic hand tool design.
2. Describe an ergonomic tool.
3. Select tools based on design and use.
4. Examine current practices and recommend improvements.
1 Standards for Ergonomic Tools

Carpenters use many hand tools, such as, hammers, screwdrivers, pliers, wrenches, and tin snips, plus power tools, such as electric drills, power saws, and screw guns. Using hand tools over and over every day can injure the hand, wrist, or arm. Injury can happen if the UBC member holds the tool tightly for long periods of time or keeps twisting the handle. Carpal tunnel syndrome, trigger finger, white finger, tendinitis, and other painful problems may develop. An injury can force skilled, experienced carpenters to quit the construction trade.

The process of selecting and or modifying tools, especially hand tools, to provide a better fit for the user is something every carpenter has attempted to do at one time or another. Comfort and efficiency of use is particularly important for tools used daily on the job. However, no one tool works for all jobs, and no one tool fits all users in the most efficient or comfortable manner. It is easy to find research that documents the association of hand tools and the problems that result if the wrong tool is used or if the correct tool is used improperly. Much of the need to create better hand tools is also driven by the matching desire to create a more efficient work process.

In the last decade, advancements have been made in design and development of hand tools in an attempt to reduce the potential injuries to the UBC member, while also increasing tool efficiency. A variety of bent-handle tools are commercially available that maintain straight wrists and avoid the need to bend or rotate the wrists. These improved hand tools are often sold or labeled as ergonomic hand tools. Although there are benefits from improved hand tools, it is important to remember that no one tool is perfect for every task, and no one tool is perfect for every user. Therefore, tool manufacturers’ research and development teams continue to refine their designs.

Developing a standard for ergonomic hand tool design is difficult because of the variations in people, work environments, and tasks. However, there are guidelines by which tools can be tested to evaluate specific features. Ergonomic hand tool features can be classified by the following design goals:

- Decrease the force or grip strength required to use the tool.
- Decrease repetitive motion associated with using the tool.
- Decrease awkward body postures or wrist positions when using the tool.
- Decrease vibration transmitted to the hand and wrist.

2 Tools and the Upper Extremities

Selecting the right tool for the job can be difficult. UBC members don’t always have a choice about the company-owned tools they use. At least, knowing which design features to look for and which to avoid when purchasing personal tools may help reduce the risk of injuries. Implementing the following
suggestions for proper selection and use of hand tools will help reduce the likelihood of developing CTDs and WMSDs in the upper extremities.

**Features That Decrease Force or Grip Strength** The amount of stress increases as a result from poorly designed tools that apply pressure on the palms, fingers, or other soft tissues. Examples include short-handled pliers and tools with finger grooves that do not fit the UBC member’s hand. See Figure 1. The greater the effort needed to maintain control of a hand tool, the higher the potential for injury. Selecting tools that reduce grip force requirements avoids this stress. A squeezable gripping surface rather than hard plastic should be used. A two-handed grip reduces the stress on the dominant hand and arm. Portable circular saws, large drill motors, and rotary hammers often have support handles.

Changing a tool handle, a simple solution, reduces the force or grip strength required to use a tool. Generally, tools with longer or thicker handles require less force. A longer handle allows the UBC member to produce more leverage, while a thicker tool handle allows more surface for grasping, or in the case of a standard screwdriver, increase the torque, thereby reducing the required force. Handles should be long enough for the whole hand, not just the fingers. See Figure 2. This provides a *power grip*, not a *pinch grip*. That means most handles should be at least 5” long. The handle should be comfortable in the hand, not too thick or too small or too short. If a tool handle
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is too short to grip with all the fingers, the grip will have less power and more force will be needed. See Figure 3. The more force that is used, the greater the risk of developing a CTD. If handles are too short, they can also dig into the soft part of the palm, squeezing and possibly damaging blood vessels and nerves.

Handles should not conduct electricity or heat. Working with a cold handle can make some repetitive stress injuries worse. Tool handles should also be free of sharp edges. Screwdriver handles are made of hard-formed plastic. A variety of handle grips are available with rubber sleeves or custom grips, but sharp edges or ridges should be avoided. Some tools provide extra gripping texture for working in wet or oily situations. This added texture reduces the need to increase pressure to keep the tool from slipping.

Handles and handgrips should be oval or round. The hand should wrap around the handle in a power grip. For most people a handle that is between 1” and 1 ½” in diameter provides the most comfortable power grip. See Figure 4. To determine an individual’s optimum grip diameter, use the “OK” method. Make the okay sign using the thumb and index finger and then measure the inside diameter of the “O” formed by the thumb and index finger. This measurement is the best grip diameter of a hand tool for that UBC member. If a hand tool isn’t the right diameter, customization might be necessary. A variety of materials such as friction tape or pipe insulating foam can be used to customize or modify the handle of most hand tools.

Tools that are heavy or badly balanced put stress on both the hand and arm. The weight of the tool should be concentrated where the tool is held. If a tool is front-heavy, the hand and arm become the counterbalance.
Reducing the Risk of Injury

Trowels come in a wide selection of handle types and sizes. See Figure 5. Selecting the one that fits the UBC member’s hand is critical for comfort.

The handle span on pliers, wire cutters, and other two-handled tools should be between 2½” and 3½”. See Figure 6. This span is good for both men and women. Some tools such as wire snips and pliers are spring-loaded. Spring loading allows the jaws of the tool to automatically open after cutting. Spring loading also relieves pressure on the fingers. Tools should be designed for comfortable use by both right- and left-handed people.

Conventional hand tools, such as pliers and wrenches, are designed with slightly wider handles that allow the grip force to be distributed over a larger surface and thus decrease the grip strength. See Figure 7. Hand tools that open and close such as pliers or tin snips should consider the optimum opening span to permit use by small and large hands, with gloves, and left or right hand operation. See Figure 8. Carefully examine the span of tools and test for comfort before purchasing. Some tools exceed the comfortable stretch for even very large hands.
PRODUCTIVITY TIP

The UBC member performing the task is often the best person to identify ways to redesign a job.

Obviously, hand tools should be properly maintained; for example, a worn drill bit will require more force to use. Saw blades that are coated with non-stick materials may improve tool efficiency, thereby reducing applied forces.

Features That Decrease Repetitive Motions  Repetitive strain injuries affecting the muscles, tendons, nerves, and joints and typically occur in the hand, arm, shoulder, neck, and even the back. These injuries are becoming increasingly common among UBC members who perform repetitive tasks as part of their daily job. A combination of applied force, poor posture, and the repetitive nature of some tasks increases a UBC member's chances of injury.

Many steps can be taken to avoid repetitive motions when using hand tools over a prolonged period of time. If the task allows, changing to a power tool may reduce repetitive motions. Be aware that using power tools may exchange repetitive motion risk for tool vibration risk. If possible, switching to tools with spring-loaded returns can reduce repetition because the hand is only working to close the tool. Finally, some innovative hand tools can also reduce repetitive motions, for example, a hand saw blade that cuts faster due to a unique tooth design where it cuts in both directions.

If it is not possible to reduce the repetitive motions using hand tools due to the nature of the task, it may be valuable to redesign the task itself. The time and resulting solutions may increase production and reduce costly medical bills later.

Features That Decrease Awkward Body Postures and Wrist Positions  There is no such thing as the perfect “ergonomic tool.” Even with the proper tool for the job, sometimes the task at hand may require an awkward body position or poor wrist positioning to complete. The ability to apply force to a hand tool may change based on the hand or arm position. The ability to apply grip strength to a tool depends upon the tool handle type, size, and length. Other factors include the UBC member's gender, overall body size, age, training for proper tool use, posture, and direction of tool travel, for example, pull versus push.

Poor wrist positioning can reduce grip strength. Poor wrist positioning can also lead to repetitive strain injuries. It is best to use hand tools that maintain the neutral wrist position. Several hammers and pliers are designed with a bent or curved handle to maintain a more natural wrist position. New, lightweight materials such as titanium reduce the weight of the hammer as well. Figure 9 shows different types of hammers.

Some tools come with a pistol grip that allows a more natural wrist posture or position. See Figure 10. Think about the job as well as the tool, and use tools that keep the wrist straight. A tool that allows the wrist to stay straight
to do one task may force the wrist to bend under different conditions. Many times changing position keeps the force more natural.

Strip triggers can reduce the risk of trigger finger by allowing the use of multiple fingers in a power grip to activate the tool. Using a pistol grip on a vertical surface keeps the wrist straight. The same is true using a tool with an inline handle on a horizontal surface. See Figure 11. But the same tools used on different surfaces will force bending the wrist!
Consider the possibility of a tool that is bent instead of the wrist. See Figure 12. Utility knives are available with a slight bend in the handle to reduce the amount the wrist must bend. See Figure 13. Scrapers have a textured handle with improved gripping surface and some have a second rounded handle for comfort and control. See Figure 14. Some hacksaws and hand saws have a slight angle built into the handle to help keep the wrist in a natural position. See Figure 15.
Features That Decrease Vibration Vibration in tools is generally associated with power hand tools. Tools are operated by different sources of power such as air, electricity, and gas. Typically, powered tools are used when greater force is required, repetitive tasks are being performed, or to be more productive. With the advantages of power tools also come some disadvantages including possible vibration, different types of repetitive strain, for example, trigger finger, and increased stress to handles and reactions to the forces generated by the power tool. To avoid repetitive trigger-finger actions, select tools with large switches that can be operated with all four fingers. See Figure 16.

Among these disadvantages, vibration may be the largest concern. Exposure to large amounts of localized vibration, over a prolonged period of time might increase the risk of chronic disorders of the muscles, nerves, and tendons. The amount of vibration transmitted by a power tool can be influenced by a tool’s weight, design, and power.
Power tools designed with anti-vibration materials or anti-vibration mounts or handles reduce only some of the vibration. If a tool vibrates, the UBC member must grip harder and could hurt hand muscles.

If the job or work environment requires the prolonged use of heavy power tools, consider redesigning the process, redistributing the work, or using some kind of external support to handle the power tool. Purchasing gloves made of material that dampens vibration have various levels of effectiveness.

Proper maintenance of power tools is a top priority to prevent any added vibration due to worn parts. Keep tools sharp and in good condition. This can reduce the force used on the tool and reduces stress on hands and wrist. Try not to use tools with the wrist bent. Rest hands during the day. Even a perfect tool can hurt the UBC member if used over and over. Lay down the tool or put it in a holster when it is not in use.

Use power tools instead of hand tools when available. Many tools in the stores are labeled “ergonomic” tools; do not be fooled. The UBC member working with the tool is the one who can tell if a tool is comfortable and easy to use. Try many different tools until there is a good fit. Everyone has a different hand size, strength, and preferences. Keep asking the stores for better-designed tools; they usually respond to demand. One tool cannot do all jobs. Using a tool for a job it was not designed for usually makes the job harder to do. How a tool is used is as important as which tool to use.

Look for these features in power tools:
- swivels at the connecting point of tool and power hose that make it easier to manipulate the tool instead of the wrist
- low tool weight and good balance
- support handles on tools allow the weight to be supported with both hands
- make sure handles and grips are the right size, shape and material
- strip triggers instead of “button” triggers

**SELF CHECK**

1. _____________ saw blades and drill bits are examples of ergonomic tools.
2. Tools with longer or thicker handles require _____________ force.
3. New, lightweight materials such as _____________ reduce the weight of tools.
4. It is better to _____________ the tool instead of the wrist.
5. _____________ triggers can reduce the risk of trigger finger.
3 Preventing Back Injuries

In a report dated December 2001, the Washington State Department of Labor and Industry has provided solutions to the following common lifting risk factors found on the job. Moving equipment, for instance compressors, that require heavy lifting of more than 90 pounds or lifting more than 70 pounds from the ground, use mechanical equipment such as cranes, forklifts, or backhoes. Another idea is to get help from another UBC member if mechanical aid is not available.

Equipment should be used to lift heavy objects, store materials at working height, and reduce the amount of bending and kneeling. In each case, the equipment helps reduce the amount of lifting, bending, overhead work, and awkward postures required of the people doing the work. This is where ergonomics comes in. Ergonomics is the study of work and how the work, the worker, and the workplace all fit together.

Holding drywall in place by hand puts tremendous stress on the muscles of the back, shoulders, arms, wrists, and hands. See Figure 17. It can also increase the chances of developing tendinitis of the shoulders and wrists. A drywall lift should be used to hold the board in position. See Figure 18.

In the United States, most contractors order 4 × 8 drywall for most applications. Drywall can be ordered even larger to reduce the number of seems or joints. Fire-rated 5/8˝ drywall weighs 10 pounds a running foot. A 12´-0˝ sheet weighs 120 pounds. Carrying this much drywall puts stress on the discs of the spine and the muscles and tendons of the back and shoulders.
In Sweden, to decrease these stresses they have reduced the size of drywall to 3’-3” by 6’-6”. With these dimensions, the boards can easily be carried by one UBC member. However, these smaller sheets greatly increase the number of joints to be taped and finished. Using a wallboard cart allows the movement of multiple sheets without the need to carry them. See Figure 19. Carts used to transport and store sheet materials reduce the amount of lifting and carrying required.

Another example of reducing the stress is using a drill stand to support the weight of the tool. The UBC member only needs to guide the tool. Use of these stands relieves static loading on the muscles of the back, shoulders, and arms. See Figure 20.
All the improvements in these examples used ergonomics to make the work safer and easier. Ergonomic improvements, changes in work processes, and in the design of tools and equipment can lower the risk of injury. Controlling the environment by improving housekeeping and the way work is organized also can help reduce the risk of injury.

“I wish we could work without burning our bodies out. There are some simple things that could be done, like using lighter tools, supporting the weight of the tool with ropes, more breaks, having more people do certain jobs so each person spends less time on the really hard work. There’s definitely more awareness of health and safety now, but there’s still a way to go.” B.G., 39 years old, 20 years in the trade

When moving material such as lumber, beams and plywood, use mechanical equipment if one piece of material weighs more than 90 pounds, or get help from another UBC member if mechanical aids are not available. Limit loads of multiple pieces of material to 70 pounds or less.

Loads up to 90 pounds may be lifted, occasionally, if using walk-up or tilt-up technique. Using these techniques allow the UBC member to be in an upright position under the load before lifting the entire weight of the object. For the walk-up method, the UBC member begins by lifting one end of the load and continues to walk toward the end resting on the ground. See Figure 21. At the mid-point, the load is pivoted onto the shoulder and carried to the final destination. For lifting plywood and other sheet goods, the tilt-up method is best. The UBC member tips the material on its long edge, lifts one end, and walks toward the other end. At the mid-point, the load is balanced on the UBC member’s hand and arm and carried. Both methods reduce the stress on the back and knees.

![Walk-up technique](image-url)
To reduce bending the back more than 45° during installation of deck sheeting or when constructing gang forms, for example, use a nail gun or screw gun handle extension to secure the decking. Rotate tasks within the crew for half of the day. Build forms on a raised platform at least 20” off the ground. Perform cuts on sawhorses or on plywood stack to reduce bending. See Figure 22.

These risk factors contribute to back injuries:
- lifting, pushing, pulling, and other forceful movements
- awkward postures
- bending and twisting
- repetitive work
- workplace conditions

*Lifting* Whenever possible let machines do the lifting. Use forklifts, pallet jacks, and cranes to lift or move heavy loads. Try to keep lifts between knuckle and shoulder height. Materials that will be manually lifted should be stored at waist height, not on the ground. Objects should be small enough to hold close to the body with handles or hand holds. Lift lighter loads or make more trips or lift with a buddy.

Reduce the weight and size of materials. Select new materials such as plastic fibers to provide a lighter, stronger wallboard product may be an alternative to a smaller size that would increase the number of fasteners and the joints to be finished.

Careful planning, improved housekeeping, and organization of work can all help to reduce the amount of carrying and climbing needed and the distance that loads need to be carried.

*Pushing, Pulling, and Awkward Postures* Use powered material-handling equipment and manual come-alongs to pull the load. Dollies, carts, and other wheeled equipment should have good bearings and stable wheels. Vertical handles on carts should be positioned between waist and shoulder height. Pushing is generally better than pulling. Pulling puts added stress on both shoulders and elbows. Pushing compresses the joints, and the cartilage absorbs the forces. Avoid either pushing or pulling across the front of body because these actions put a lot of stress on the back.

Keep working posture as close to neutral as possible. This exerts less force and therefore less stress on the body. Whenever possible, move around and change body posture often. Try to split up the work. After bending or kneeling on knee pads for awhile, switch to something else to rest the back and knees.

*Bending and Twisting* Using the right tool for the job eliminates the need to use extra force or to work in an awkward posture. Don’t twist, bend, or stretch at the same time as lifting or holding an object. Twisting while...
lifting causes many back injuries. Keep the work area clear of obstacles to reduce the need for bending and reaching over and around them.

Redesigned tools can allow certain jobs to be done from a standing rather than a kneeling or bent over position. This is another example of a change that must come from tool manufacturers and contractors. To avoid bending for long periods of time, it may be possible to change the height or angle of the working surface or the standing surface. During project layout, think about how, when, and where materials will be used and provide proper storage to reduce the need to lift, carry, bend, and reach.

## 4 Workplace Conditions

Good planning, improved housekeeping, and better work organization can reduce obstacles and slip-and-trip hazards. Proper storage can reduce the need to lift, move, or reach around objects later on. Planks, sand, gravel, and walkways can be used to reduce the hazards of mud and slippery surfaces. If practical and safe, fans and heaters can be used to moderate temperature extremes.

When working in cold temperatures, warm-up exercises may help reduce the risk of muscle strain because muscles tend to tighten up in cold. But remember that exercise will not protect the discs of the spine from damage. Doing heavy physical work in hot temperatures can lead to fatigue and increase your risk of injury and heat exhaustion. Set a comfortable work pace. Short exertions with frequent micro-breaks, performing a different task for a short time to provide rest for fatigued muscles, is better than long work periods with fewer but longer rests. It is important to drink plenty of fluids, especially water.

**Fitness and Lifting Techniques** The closer the match between UBC members’ strength and fitness and the physical demands of their jobs, the better they will feel. But strength and physical fitness cannot protect the spine from the cumulative traumas of lifting and other risk factors.

Use a squat-lift if the object will fit between the knees and hold the item close to the body. A squat-lift with a straight back can help reduce the stress on the spine although, squat lifting puts stress on knees and thigh muscles and demands a lot of energy. Store materials at a height that reduces the need to bend, stoop, or lift. Making materials smaller and lighter or organizing them in smaller, lighter units will relieve stress on the back more effectively than using the proper lift technique. Don’t hesitate to get help when lifting heavy materials.
SELF CHECK

1. Store materials at ______________ height for easier lifting.
2. Improved planning and new equipment are examples of ______________.
3. Using a drywall lift ______________ stress on both shoulders and the back.
4. Strength and physical fitness alone cannot protect the ______________ from the risks of lifting.
5. Get ______________ when lifting heavy materials.

“Job safety goes way beyond just watching out for unsafe conditions. It’s also got to do with the use and conditions of the tools you have or don’t have to get the job done. When I look at the scars on my knees from the surgeon’s knife, I wonder what would have been if my employer had provided us with ladders so we could climb in and out of the trenches. And when I tighten up the [support] band on my forearm, I wonder what it would feel like if I didn’t have to frame up forms all day for weeks on end.” E.H., 40 years old, 17 years as a carpenter

Summary

There are ways to control exposure to these risk factors. Some control measures, such as improved planning and new equipment and machinery, are the employer’s responsibility. When the employer provides these measures, it is up to the UBC members to use them. Other changes need the participation and cooperation of employer and employees. These are the controls which try to change work practices from the way they have always been done.
Reducing the Risk of Injury  QUESTIONS

Show an understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. _____________ is the study of work and how the work, the worker, and the workplace all fit together.

2. Handles on hand tools should be long enough for the whole hand to provide a power grip and should be at least _____________ long.

3. Hand tool handles and handgrips should be oval or round and between _____________ in diameter to allow the hand to wrap around the handle in a power grip.

4. The handle span on pliers, wire cutters, and other two-handled tools should be between _____________.

5. Two-handled tools such as wire snips and pliers should be _____________.

6. _____________ _____________ can reduce the risk of trigger finger by allowing the use of multiple fingers in a power grip to activate the tool.

7. The _____________ is the one who can tell if a tool is comfortable and easy to use.

8. Using a pistol grip on a _____________ surface keeps the wrist straight.

9. Identify which of the following increases the risk of back problems.
   a. awkward postures
   b. repetitive work
   c. whole body vibration
   d. all the above

10. Handles for hand tools should have _____________ handle coverings.
    a. non-slip
    b. non-porous
    c. non-conductive
    d. all the above

11. The standard drywall in the USA does not pose a risk for back injury. (True; False)

12. When choosing between pushing and pulling, pushing is generally preferred. (True; False)
13. These three things can help control the effects of CTDs on the body: choosing the right tool, avoiding awkward positions, and getting proper rest. (True; False)

14. The damage done to the body today may not show up for ten or more years. (True; False)

15. One way to reduce the chance of injury is to lift heavy objects alone. (True; False)

16. The more force that is used to perform a task, the greater the risk of developing CTDs. (True; False)

17. Awareness of ergonomics will benefit both UBC member and employer. (True; False)

18. When looking for tools, always try to find tools that bend the wrist. (True; False)

19. Improved housekeeping can reduce slip-and-trip hazards. (True; False)

20. Ergonomically improved hand tools are perfect for every job and every UBC member. (True; False)
**Instructions**  Work in groups to answer the questions.

**Materials**
- Flip charts or white boards and markers.

**Procedure**
1. Identify five work activities that are at high risk of causing CTDs.
2. For each activity, list the risk factors involved.
3. For the risk factors, list the possible effects on the body.
4. Prioritize the activities according to the severity of the risk factor.
5. Determine how the three highest-risk activities could be made safer.
6. Report the group’s finding.

**Questions**
1. Which activities were most often selected?

2. In which activities were some backs, knees, and upper extremities considered to be at greater risk?