What to look for when selecting or modifying hand tools to provide a better fit for the user

Selecting or modifying hand tools to provide a better fit for the user is something almost everyone has attempted to do. Whether that tool is a computer keyboard used at work or a small Phillips screwdriver used for a woodworking hobby in the garage, no one tool works for all jobs and no one tool fits all users in the most efficient or comfortable fashion.

In the last decade, tremendous strides have been made in design and development of hand tools in an attempt to reduce problems, including potential injuries to the worker, while also increasing tool efficiency. These improved hand tools are often sold or labeled as "ergonomic" hand tools. Although everyone—including farmers and ranchers coping with effects of arthritis, strokes, finger or hand amputations, the aging process, or repetitive strain injuries (RSI)—can benefit from improved hand tools, it is important to remember that no one hand tool is perfect for every job, and no one hand tool is perfect for every user.

Developing a "single standard" for ergonomic hand tool design is difficult because of the variation in human anthropometry (i.e., branch of human science that deals with body measurements, human performance, work environments, and tasks). There are guidelines and methods by which tools can be tested to effectively evaluate specific ergonomic features. In general, 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.

Features That Decrease Force or Grip Strength

Changing the tool handle often goes a long way towards reducing the force or grip strength required to use a tool. In general tools with longer or thicker
handles require less force. A hand tool with a longer handle allows the user to generate more leverage by applying a smaller force at a greater distance whereas a thicker tool handle allows more surface for grasping, or in the case of a standard screwdriver, increase the torque thereby reducing the overall required force. In some situations, a hand tool designed with a pistol grip may require less gripping force than an in-line tool handle being used for the same job, but other factors such as task orientation may have to be taken into account.

Conventional hand tools, such as pliers and wrenches, are designed with slightly wider handles that allow the grip force (and resultant contact stress) to be distributed over a larger surface and thus decrease the grip strength. Hand tools that open and close such as pliers should consider the optimum opening span to permit use by small and large hands, gloves, and left or right hand operation. Hand tools should be properly maintained; for example, a worn drill bit will require more force to use. Saw blades that are Teflon coated or coated with other non-stick materials may improve tool efficiency thereby reducing applied forces.

Hand tools with cushion grips may also provide improved tool comfort, and depending upon the texture or cushion material used, may provide some slip resistance and reduced grip force. Often a simple handle flange or handle taper is just as effective in reducing the grip strength needed to use a particular tool as a handle cushion or coating material.

Features That Decrease Repetitive Motion

Repetitive strain injuries (RSI) are a family of injuries affecting the muscles, tendons, nerves, and joints and typically occur in the hand, arm, shoulder, neck, and even the back of the tool operator. In the past, RSI was associated with sports injuries such as "tennis elbow." Today, RSIs are becoming increasingly common among workers who perform repetitive tasks (e.g., typists, meat cutters, assembly line workers, etc.) as part of their daily job or occupation. While research continues into the exact cause of RSI, ergonomists tend to agree that a combination of applied force, poor posture, and the repetitive nature of some tasks combine to increase a person's chances of RSI.

Many steps can be taken to avoid repetitive motions when using hand tools over a prolonged period of time. For example, if a repetitive assembly task has sufficient clearance, changing to tools with a ratcheting mechanism or gears can help to reduce repetition. Keeping hand tools properly maintained (e.g., sharpen saw blades, drill bits, etc.) and using proper operating methods (e.g., making pilot holes for drilling, etc.) can reduce the required grip force and repetition. If the work environment allows, changing to a power tool might also reduce repetitive motions. However, using power tools may just exchange repetitive motion for tool vibration, and other power tool related issues. If possible, switching to hand tools (e.g., pliers and scissors that open and close) that have adjustable spring-loaded returns can reduce repetition. Finally, some innovative hand tools can also reduce repetitive motions. For example, the Stanley® SharpTooth™ Tool Box Saw® has a blade that cuts 50% faster due to a unique tooth design that cuts in both directions.
If it is not possible to reduce the repetitive motions using hand tools due to the nature of your job/task, it may be beneficial to take some time to plan or redesign the work task itself. The time and resulting solutions may save some costly medical bills later.

**Features That Decrease Awkward Body Postures and Wrist Positions**

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 task. A user's ability to apply force to a hand tool may change based on the limb or limb position (e.g., extending arms versus keeping arms close to the body, or using the non-preferred hand instead of the preferred hand) and on body position (e.g., using the tool while lying down rather than using the tool while standing). As noted previously, the ability to apply grip strength to a tool depends upon the tool handle type, size, and length. Equally important, however, may be the user’s gender, overall body size, age, training for proper tool use, posture, and direction of tool travel (i.e., pull versus push).

Poor wrist positioning can diminish grip strength. One study found that grip strength is decreased by 27% when a wrist is held in flexion, 23% in extension, 17% in radial deviation, and 14% in ulnar deviation. Poor wrist positioning can also lead to repetitive strain injuries; therefore, using hand tools that minimize flexion, extension, and deviation is preferred.

Several hammers and pliers are designed with a bent or curved handle to maintain a more natural wrist position. Some tools, such as gardening tools or paintbrushes, can be modified with an add-on pistol grip that allows a more natural wrist posture or position.

**Features That Decrease Vibration**

Vibration in tools is generally associated with power hand tools. Typically, powered hand tools are used when the advantages of a greater force are required, repetitive tasks are being performed, or a time savings might be achieved. With the advantages of power tools also come some disadvantages including possible vibration, different types of repetitive strain (e.g., trigger
finger), and increased operator demands and requirements to handle and react to the forces generated by the power tool.

Among these disadvantages, vibration may be the largest concern. Exposure to large amounts of vibration in a localized area, such as the user's hand, over a prolonged period of time might increase the risk of chronic disorders of the muscles, nerves, and tendons.

Although vibration is sometimes a desired effect (e.g., sanders, grinders), most often vibration is an undesirable by-product of using a power tool. The amount of vibration transmitted by a power tool can be influenced by a tool's weight, design, and various attachments. Proper maintenance of power tools is a top priority, to prevent any added vibration due to a failing bearing or worn, out-of-balance parts.

Power tools designed with anti-vibration materials or anti-vibration mounts/handles have had limited success in reducing the amount of transmitted vibration. If your job or work environment requires you to use power tools for prolonged periods of time, you may wish to consider redesigning the process, redistributing the work, or using some kind of external support to handle the power tool. You can purchase gloves with material that dampens vibration being transmitted to the hands, wrists and upper extremities, but their effectiveness may vary.

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