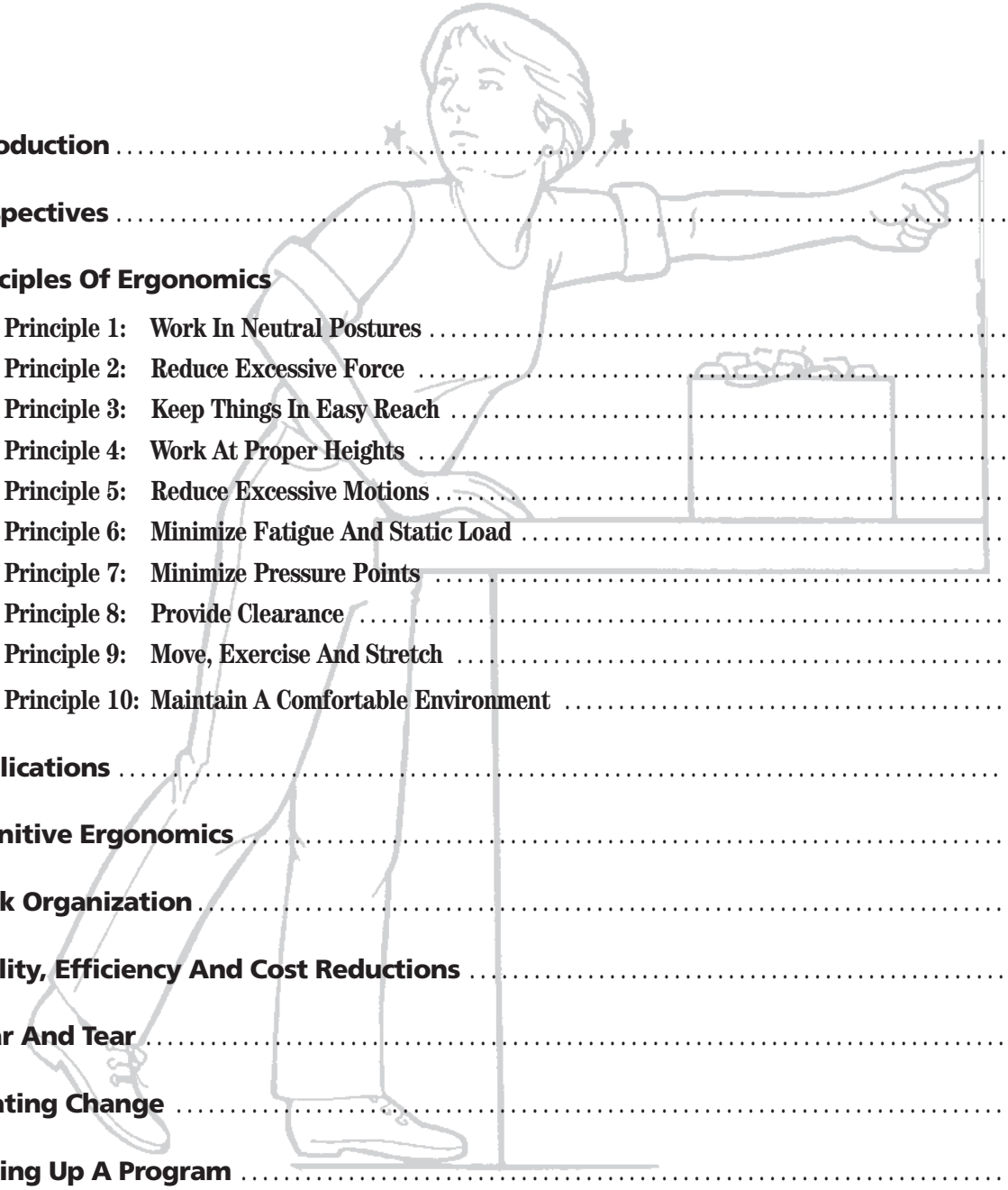
The Ergonomics Manual



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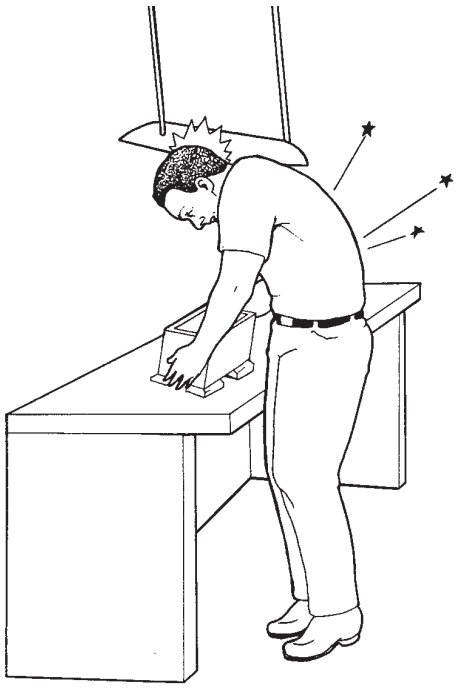
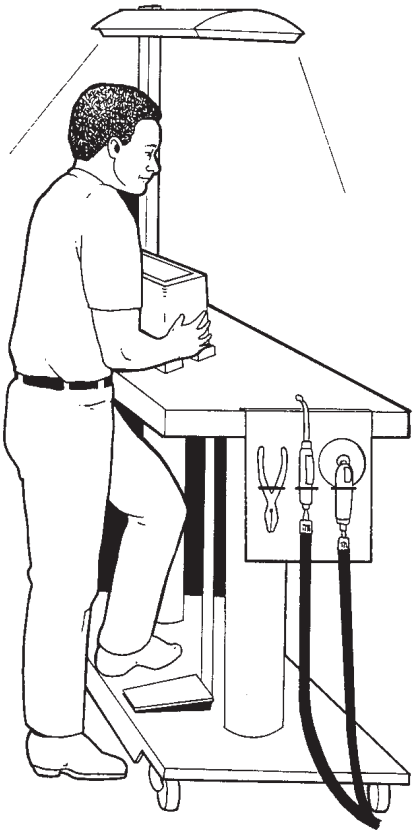
Introduction

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.

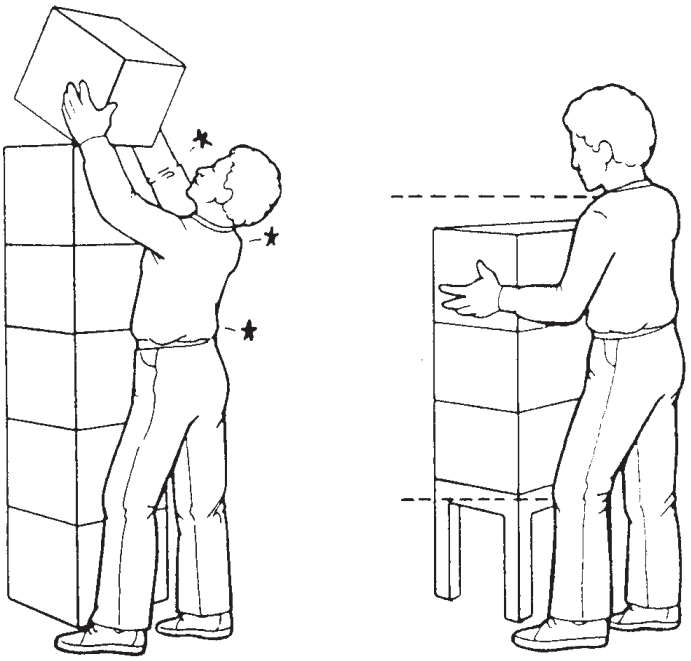
The rules of work — The term *ergonomics* was coined from the Greek words *ergon* (meaning "work") and *nomos* (meaning "rules"); so the literal meaning is "the rules of work," which is a handy concept to think about and then apply.

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.



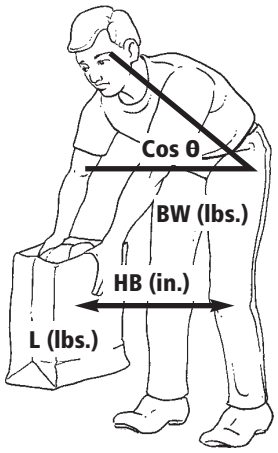
Formal Definition

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.

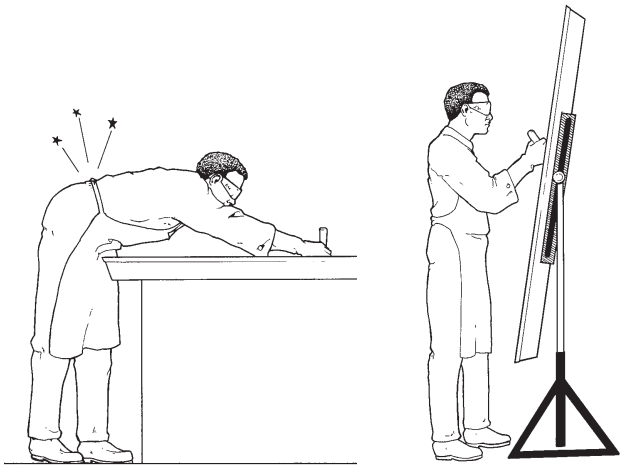
Ergonomics seeks to improve the interrelationship between the human and a system, whether a simple hand tool or an entire production line. Whenever one designs a more effective interface between a human and a tool or task, that is ergonomics.

Perspectives

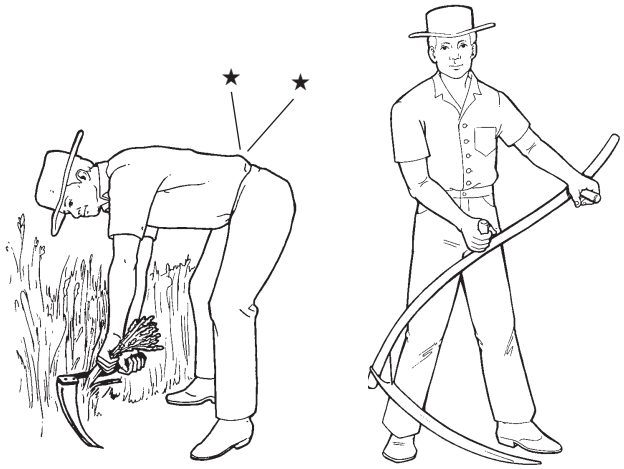
It's not just for work — Ergonomics can be applied to any human activity, including home chores and leisure activities.



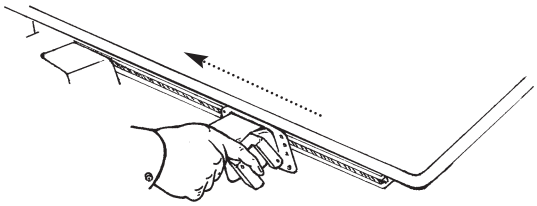
It doesn't have to be hard — Although some technical aspects of ergonomics are difficult, practical application at work doesn't have to be hard. Anyone can have a good idea.



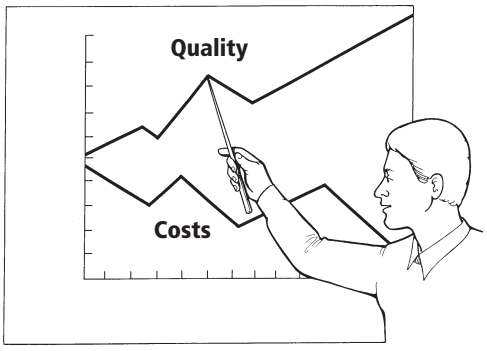
It's about quality and effectiveness — People who are fatigued, uncomfortable or hurting are in no position to do their jobs right the first time, every time. Good ergonomics can put people in a better position to do the jobs they're capable of.



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.

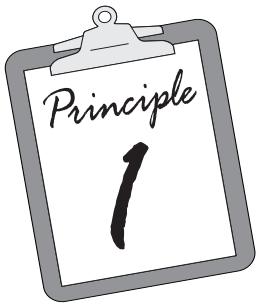


It doesn't have to be expensive — On some occasions, improvements take capital investment, but often enough, the best solutions are inexpensive or even free. It just takes some creativity and thinking. A common example is simply relocating control buttons to be within better reach.

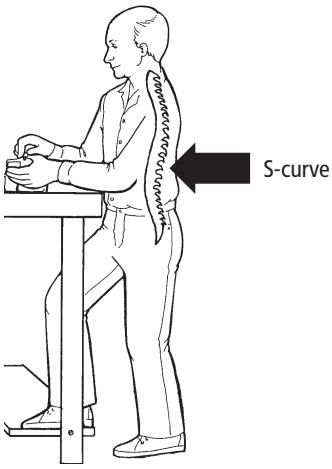


It's good for business — The focus of ergonomics is people. But when properly applied, ergonomics can reduce many costs for business, including workers' compensation costs, turnover, absenteeism and a variety of inefficiencies.

Work In Neutral Postures

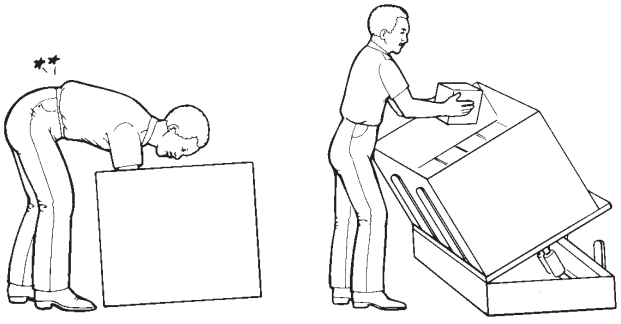


Working in awkward, contorted postures and positions increases physical stress on the body and reduces its strength, thereby making it more difficult to do a task. The optimal neutral posture is the one in which the muscles surrounding a joint are equally balanced — the posture that provides the most 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.

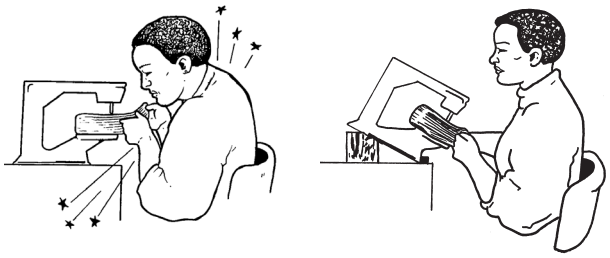


Keep the S-curve — Whether sitting or standing, it is important to maintain the natural S-curve of the back, which essentially means keeping a slight "sway back."

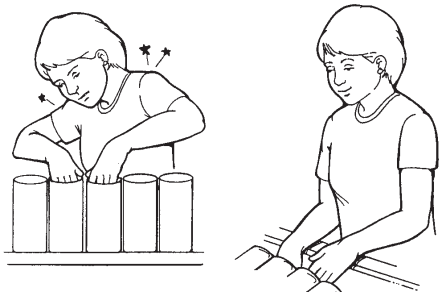
Good lumbar support is important, especially to help prevent an injury-producing "C-curve."



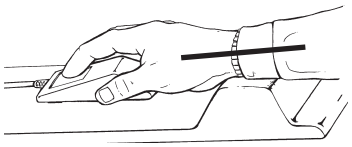
The "inverted V-curve" is a serious injury-producing posture; it can be avoided with use of a tilter. Twisting motions, especially with a heavy load, can also cause injury.



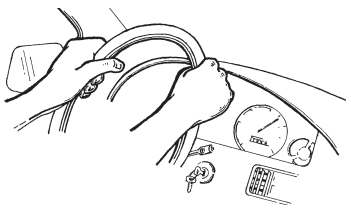
Keep the neck aligned — Adjusting the heights of or tilting the equipment or the worksurface often helps.



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

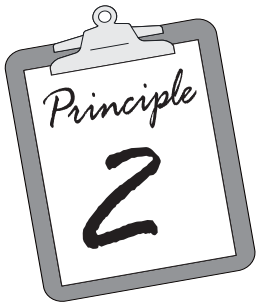


Keep the wrists in neutral — The hands and wrists should be in the same plane as the forearms.

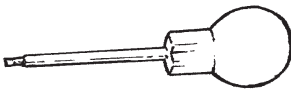


Ideally, the hands should also be slanted slightly in and forward — the position your hands are in when you hold a steering wheel at the 10 and 2 o'clock positions. You can check this posture for yourself by dangling your arms at your sides while standing and noting the position of your wrists.

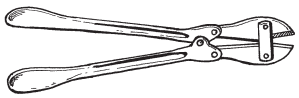
Reduce Excessive Force



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.

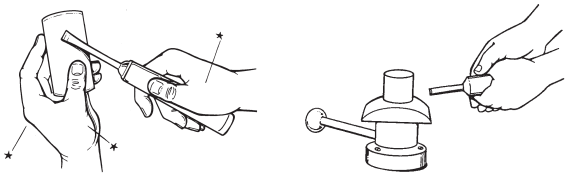


Increase leverage — Levers are usually thought of in terms of lifting large, heavy objects, but they can be applied in virtually any circumstance, such as increasing the diameter of a screwdriver handle. There are many opportunities in industry to use levers to reduce forces on the hands and fingers.

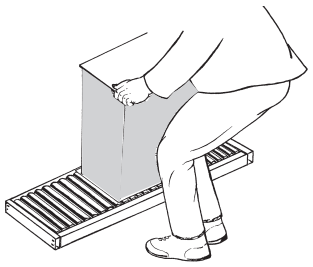


A particularly neglected type of lever is the compound lever, such as in this bolt cutter. It yields tremendous mechanical advantage even with short grips and even when incorporated into small tools used to squeeze tiny parts.

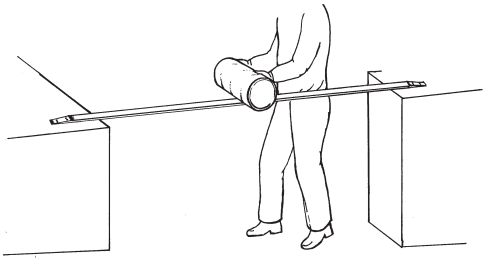
Improve layouts — Poor layout (especially uneven heights, reaches and distances that items need to be moved) often causes forceful, wasted motions.



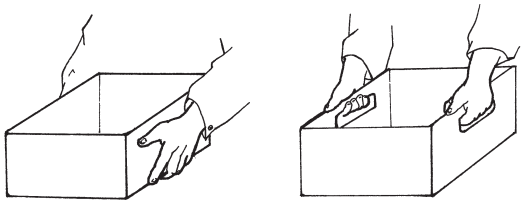
Use fixtures — Using the hand as a fixture increases exertion and wastes effort. If you simply hold the object in a fixture, it becomes much easier to work on. Furthermore, the fixture frees up both hands to do the actual work, rather than simply holding onto the object.



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

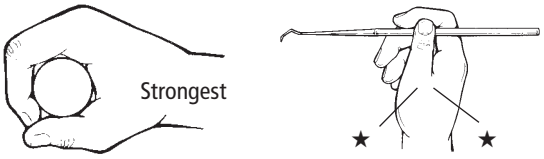


Use skids — Skid bars are an inexpensive way to reduce the amount of lifting and carrying. Even a skid as short as a few inches can be helpful.

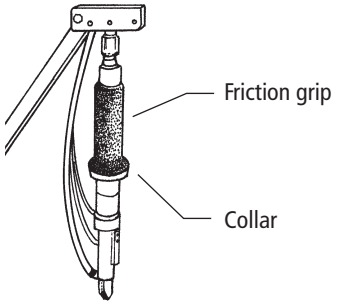


Use power grips — You can exert more force with a full hand grip (a *power grip*) than with the fingers alone (a *pinch grip*). A good example is carrying a box or tote — boxes with handholds take less exertion to carry. Consequently, with a good grip, you can accomplish the same task with less effort.

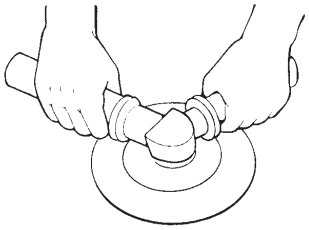
Heat malleable products — If plastic or a similar product needs to be manipulated or fitted, it's often helpful to heat the material to make it more malleable. Heat lamps and hand-held heat guns can be used for this purpose.



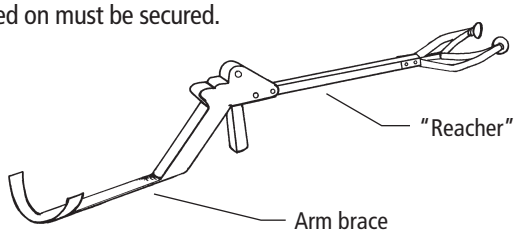
Use appropriate grip size — The optimal size for a power grip is roughly that which permits the thumb and the forefinger to overlap slightly. If the grip is significantly larger or smaller, then more force is needed to accomplish the same work.



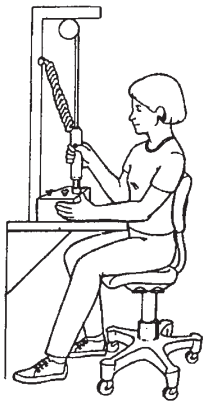
Increase contact friction or use a collar — If a grip is slippery, you must squeeze harder to accomplish the same task. One common improvement is to cover the grip with a material that provides higher friction. In cases where the force applied is coaxial to the grip, providing a collar or stop on the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



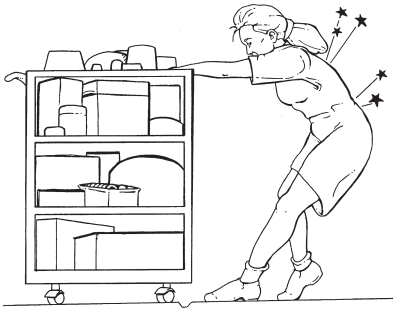
Use two-handed tools — Adding a second handle to a tool can halve the exertion required when one hand alone holds a tool. Having two handles also permits greater control and more accuracy in using the tool. "Tommy gun" grips are a version of this concept used for pressure hoses. Note that a prerequisite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



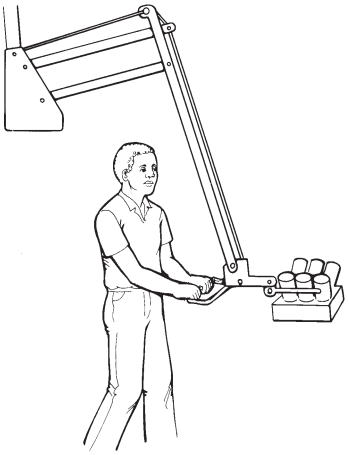
Use arm braces — If a tool or its load is especially heavy, then it may be possible to add a forearm brace. The classic examples are (a) the "reachers" used in old-time grocery stores and (b) high-powered slingshots.



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.

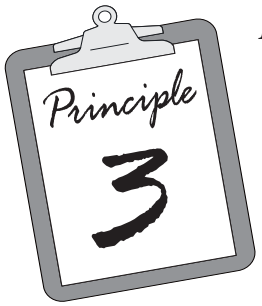


Use good carts — Heavily loaded carts often require high force to be moved. Improvements include increasing wheel size, adding handles and providing better flooring. Power tuggers may be needed in some circumstances.

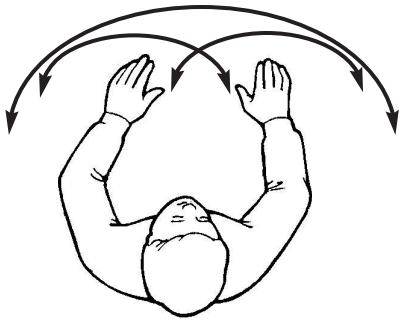


Use power tools, machines and cylinders — Perhaps the most obvious way to reduce force is to completely mechanize the activity. Air and hydraulic cylinders are particularly useful when moderate force is needed.

Keep Things In Easy Reach

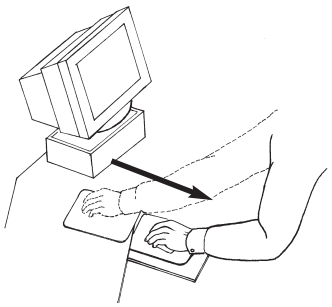


Make your work more user friendly by keeping within easy reach all the parts and tools that you need frequently. Long reaches often cause you to twist, bend and strain, making work more difficult. This principle goes along with that of keeping good posture. If the posture is OK, then the reaches will 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.

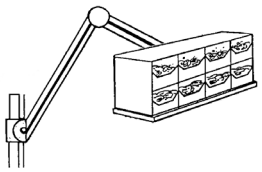
Design for the short person — In general, make sure that shorter-statured people can reach everything. If they can reach, so can everyone else. (There is an opposite rule later regarding clearance.)



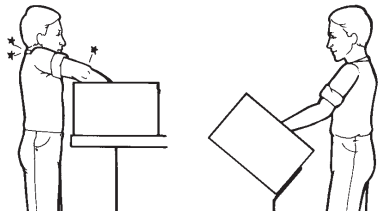
Rearrange — The point behind keeping things in easy reach is not a hard concept to grasp. What *is* difficult is having the presence of mind to notice the reaching. Typically, long reaches are so habitual that you're unaware that you're reaching or that you could easily move items closer.

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.

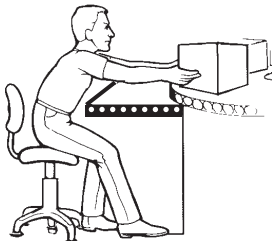
Make cutouts — An increasingly common approach is to make a cutout in the work surface. Cutouts reduce reaches yet still allow large workspaces.



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

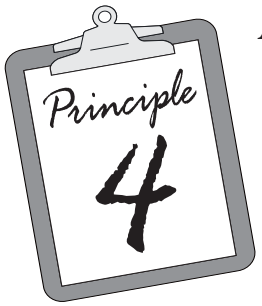


Tilt — When working out of boxes, it's possible to use tilt tables or stands or even to prop up the box on one end. Tilted box stands can easily be fitted with hinges, cylinders and rollers to enable easy transfer to carts and conveyors.

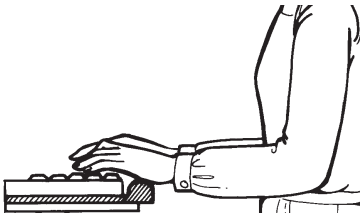


Remove barriers — Many reaches are caused by barriers that can be eliminated or relocated.

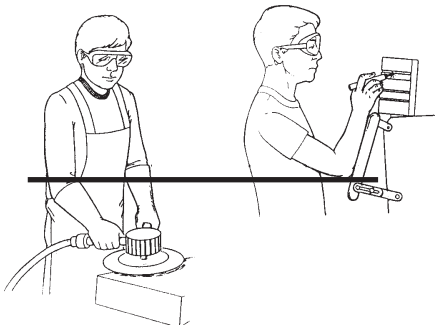
Work At Proper Heights



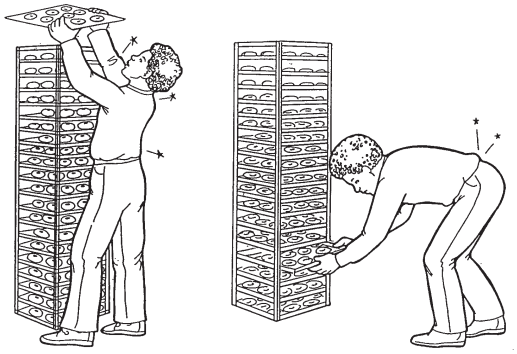
A common workplace problem is a mismatch in heights between people and the work that they're doing. This mismatch leads to poor postures and related fatigue, discomfort and potential damage to soft tissue ***plus*** *unnecessarily harder work and reduced ability to perform the task correctly. Proper 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.*

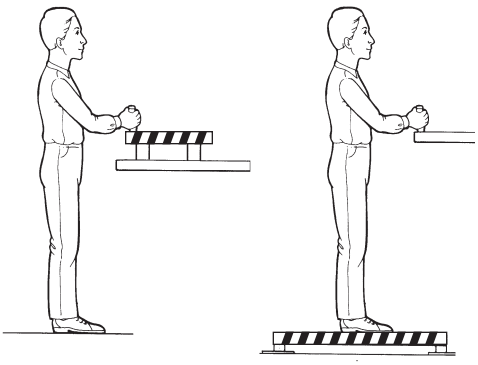


Consider the exceptions — The nature of the work also affects the proper height. Heavier work, requiring upper-body strength, should be lower than elbow height. Lighter work, such as precision work and inspection tasks, should be higher.



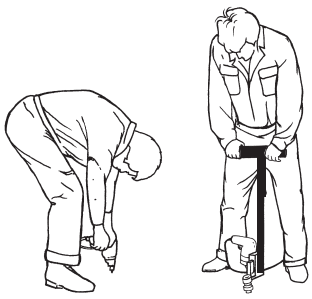
Avoid extremes — When it isn't possible to make every height ideal, it may be feasible to avoid the extremes; that is, avoid working below knee level or above shoulder level.

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.

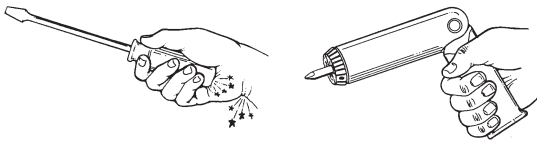
2. *Stand on a platform* — It usually is impossible to raise or lower assembly lines or large pieces of equipment. The alternative, then, is to provide platforms. While they may create congestion and possible tripping hazards, they have worked well in many facilities.



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.

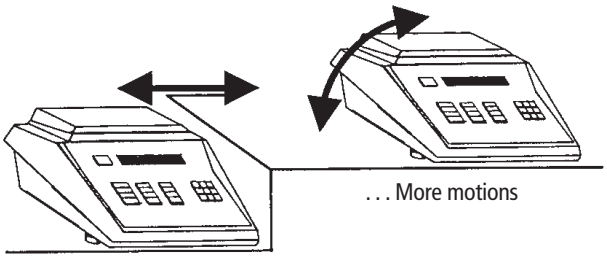
Reduce Excessive Motions

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.

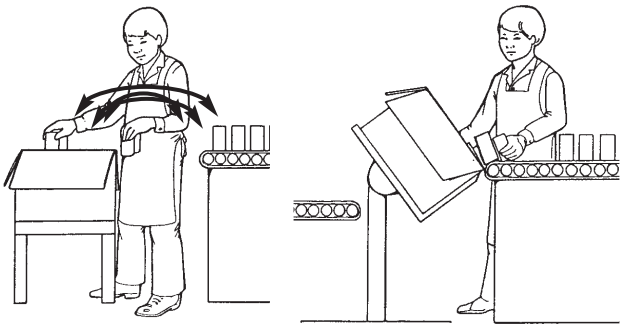
Improve technique — It's not uncommon to see two people working side by side on the same task, one working smoothly and the other with hectic, exaggerated and wasted motions. It's important to help employees learn to use the most efficient, least injurious methods. Sometimes, this might take some study 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.



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

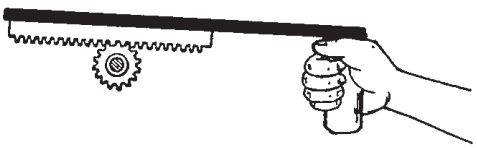
Reduce the range of the motion — There is a distinction between a small, insignificant motion and a large, sweeping one. Thus, even if a motion cannot be eliminated altogether, it might be reduced.

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.



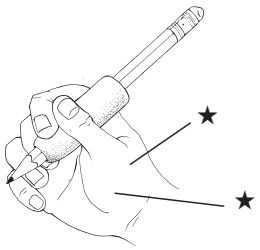
Motion-saving mechanisms — A number of mechanical devices can be applied:

- 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.

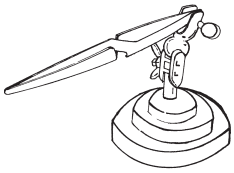
Minimize Fatigue And Static Load

*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.*



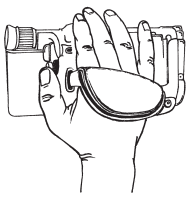
Reduce force and duration — A common example of static load is writer's cramp. You don't need to hold onto a pencil very hard, just for long periods, for your muscles to tire and begin to hurt. To prevent writer's cramp, (1) stop occasionally to stretch and (2) use a pencil grip, which makes it easier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

Self-closing tool mounted on a fixture



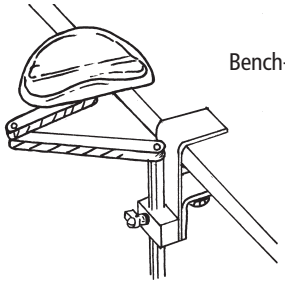
Use fixtures — It's crucial to use fixtures, clamps and other ways to prevent static grasping of items, whether parts, tools or both, if possible. *Don't use your hands as fixtures.*

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.

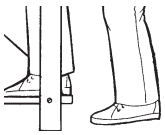


Use straps — Tools held for long periods can be fitted with straps to offload the muscles, as is common with hand-held video cameras.

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.

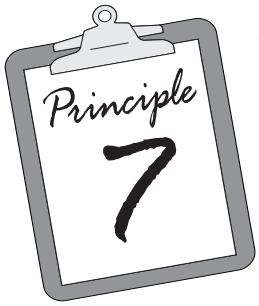


Use footrests — For standing jobs, having a footrest available provides a chance to alternate postures occasionally.

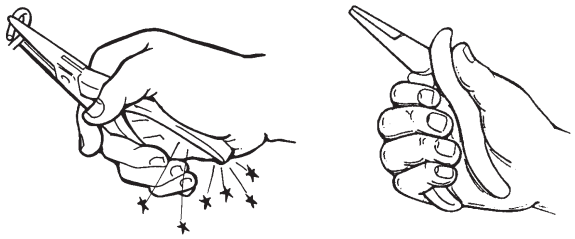
Use lean stands — Lean stands can relieve the static load on leg muscles. You wouldn't want to remain on a lean stand for a long period, but from time to time, it provides relief from constant standing. Furthermore, unlike a chair or stool, which can take some effort to get into and out of, a lean stand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

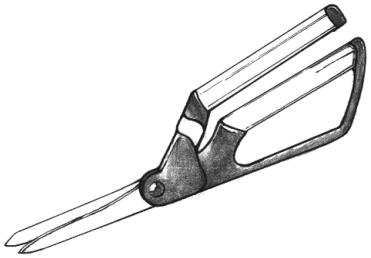


*Direct pressure against the body, or **contact stress,** is a common issue in many workstations. In addition to being uncomfortable and interfering with your ability to work, contact stress can inhibit nerve function and bloodflow. For example, the hand is particularly sensitive because there are (a) 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.*

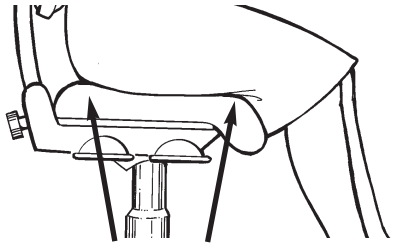


Contour and pad — Many tools and pieces of equipment can be improved with these techniques:

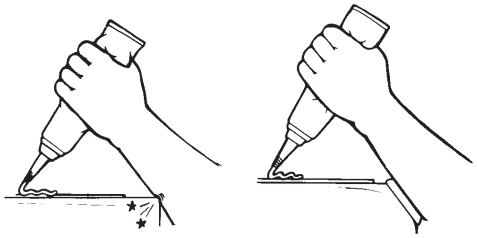
- Contour the item to fit the shape of the body.
- Provide padding to soften the pressure.
- Distribute the pressure over a larger surface area.



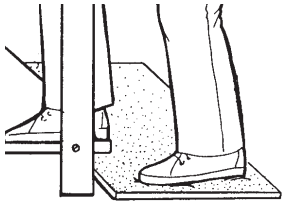
Use whole-hand loops — Rather than using finger loops for tools such as scissors, providing whole-hand loops for heavily used tools eliminates rubbing on the fingers.



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.

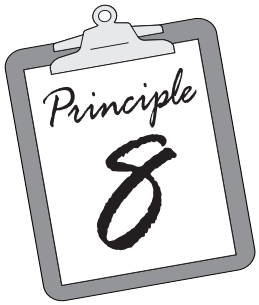


Provide floor cushioning — Standing for long periods of time on hard surfaces (especially concrete floors) can damage tissue in the heels, contribute to other leg disorders and increase fatigue. Options include:

- **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.

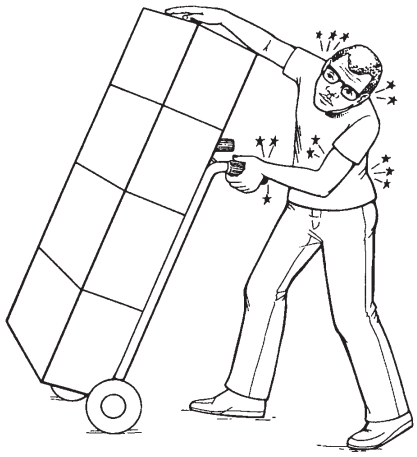
Provide Clearance



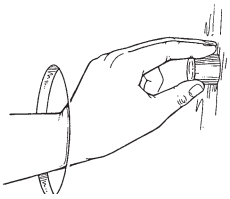
You should have both adequate workspace and easy access to everything you need, with no barriers in the way. Lack of clearance can create bumping hazards or force you to work in contorted postures. It also can increase long reaches, especially if there is inadequate space for the knees or feet. Insufficient 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.



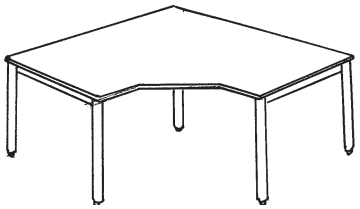
Provide visual access — A related issue is the ability to see what you're doing or to see dials and displays. A common problem is being unable to see when moving a cart or lift truck. Equally common is the difficulty of working at a machine or workstation where gauges are too far from the operator's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



Clearance for maintenance

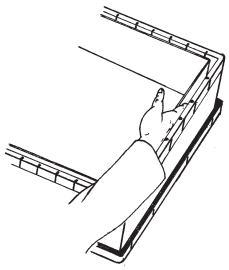
Build in maintainability — Probably the single biggest ergonomics problem for maintenance personnel is lack of clearance. Many activities would be simple to perform if the worker could only reach an item and work on it with easy access. Unfortunately, too often the items to be fixed are buried within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

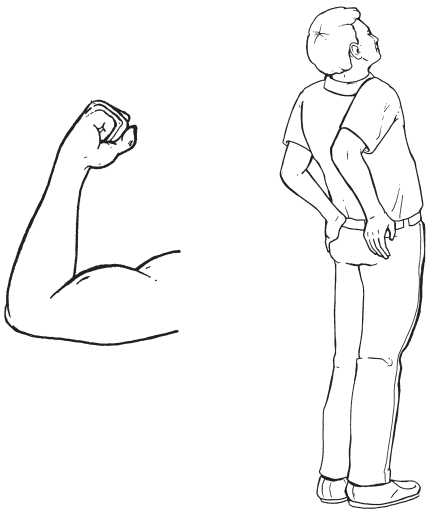
- Thin surfaces, with no hindering drawers
- Removal of obstacles



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.



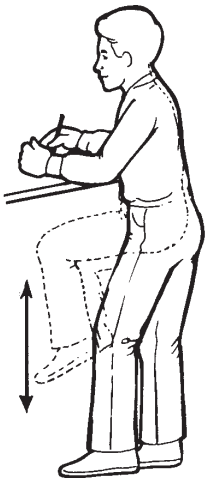
Keep fit — Staying in shape is important; some employers provide fitness centers onsite to help promote good fitness.

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.

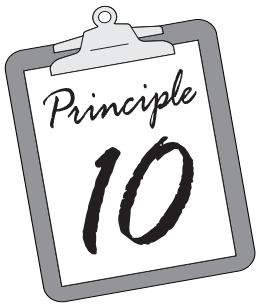
Change chair positioning — For those who sit for long periods, it's important to adjust chairs. Shift, move and change positions often.

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.

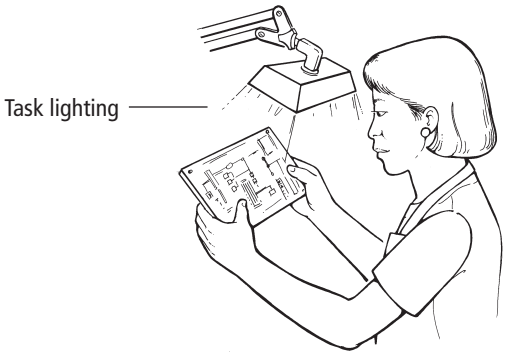


Design for sit-stand —Alternate back and forth between sitting and standing. The most basic approach is to design the workstation for a standing posture and then use a tall stool to sit on as needed. Stand until you get fatigued from standing; then sit and vice versa.

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.

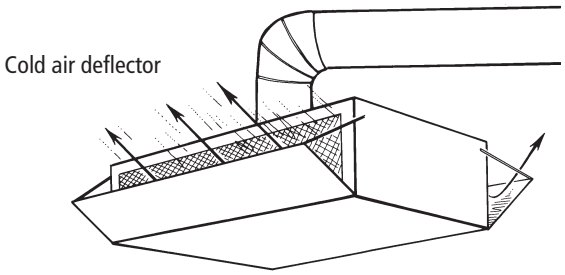


Provide appropriate lighting — The quantity and quality of light at your workstation will either serve to enhance or obscure the details of your work. Common problems include:

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

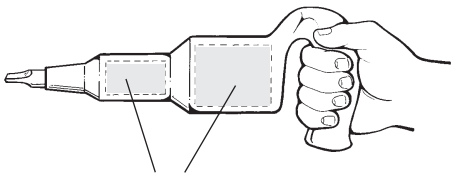
To make improvements, provide:

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



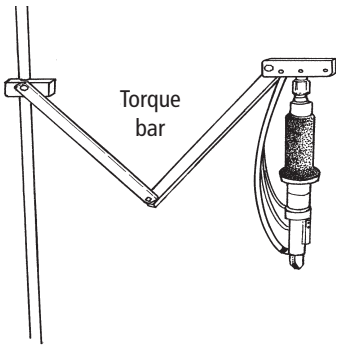
Avoid temperature extremes — Being excessively hot or cold while performing a task can cause discomfort and may contribute to health problems. In many cases, the source of the problem is inherent — for instance, laying shingles on a hot day or moving meat in a cold storage locker. However, steps can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



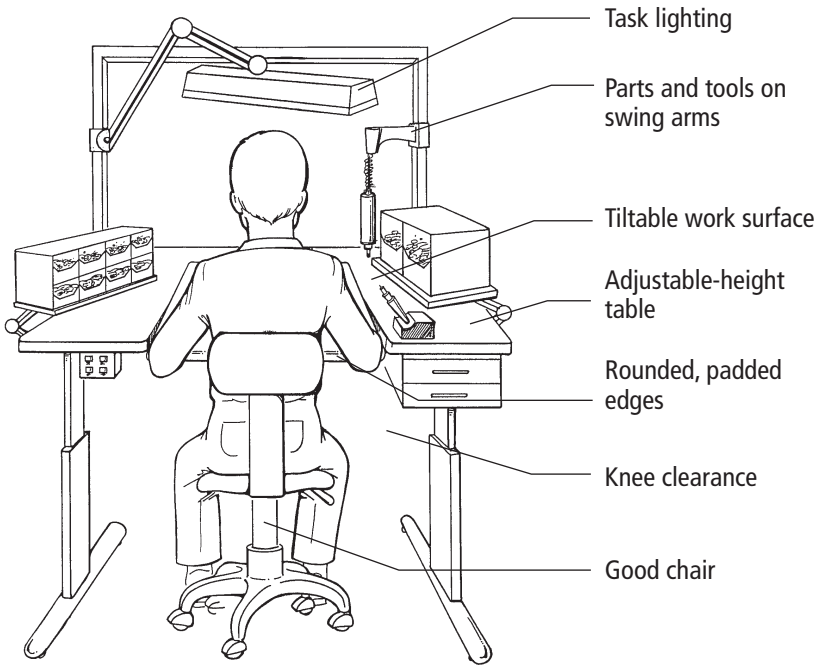
Use torque bars — In operations where power screwdrivers and nutrunners are used, it's important to use torque bars and make other modifications to prevent shock from being transferred to the wrists.

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



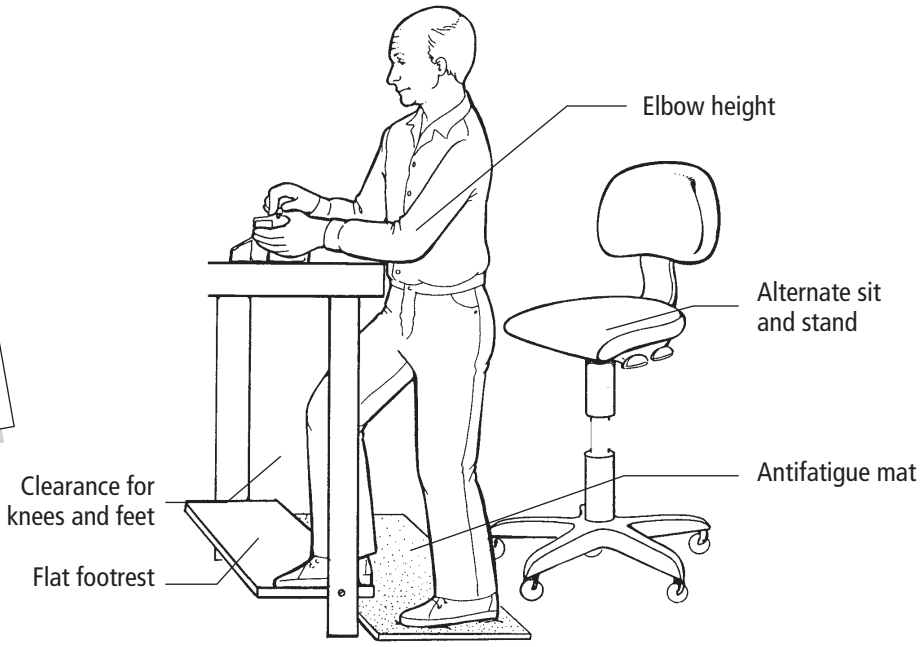
Common Issues

- 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

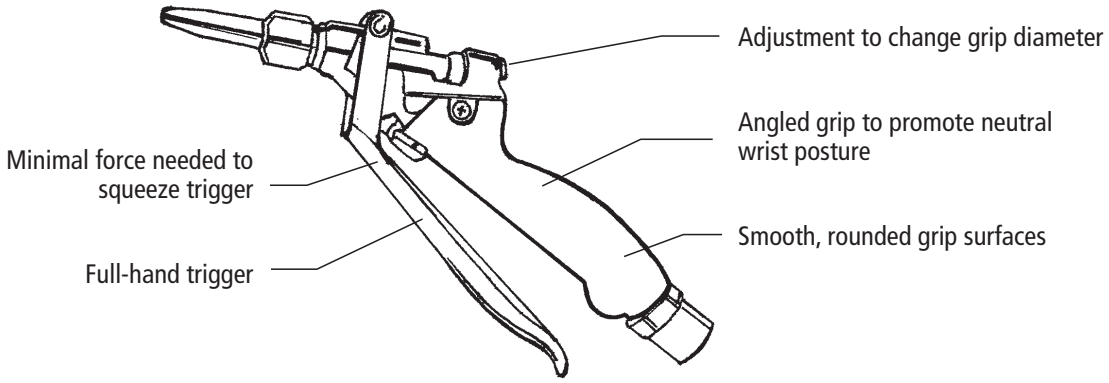
STANDING TASKS

Common Issues

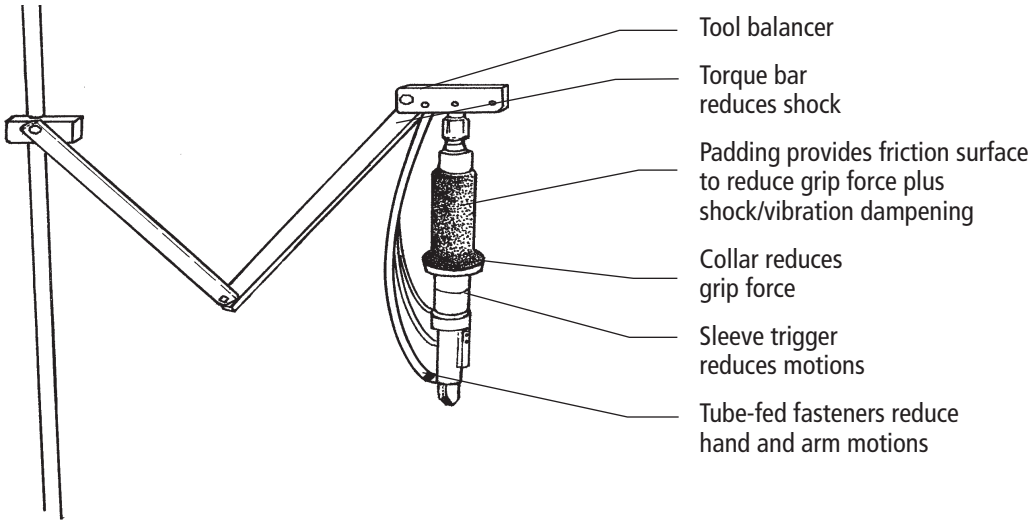
- Static load on legs
- Awkward back posture, bending
- Pressure points from hard floor
- Awkward heights



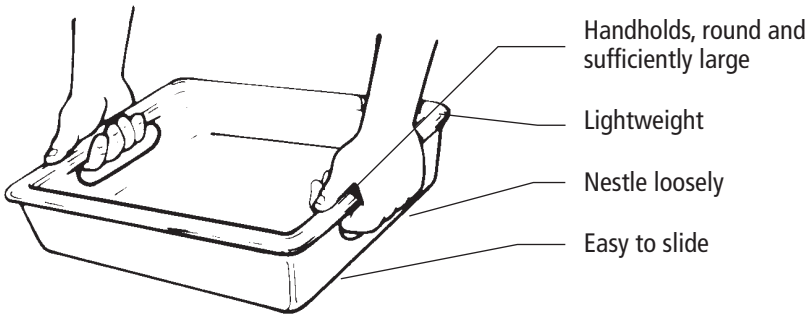
HAND TOOLS



POWER DRIVERS



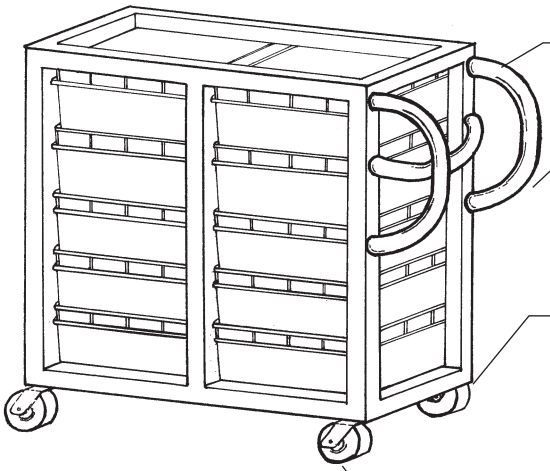
TOTES/BASKETS/PANS



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

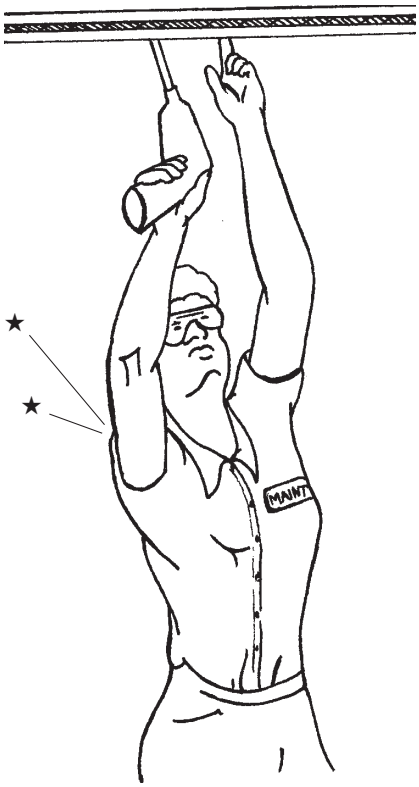
Mechanical Assists

- 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*.

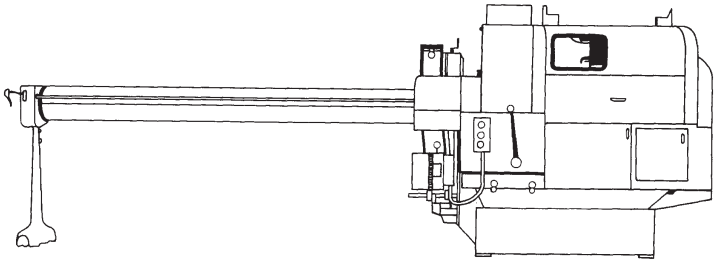
Common Issues

- 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

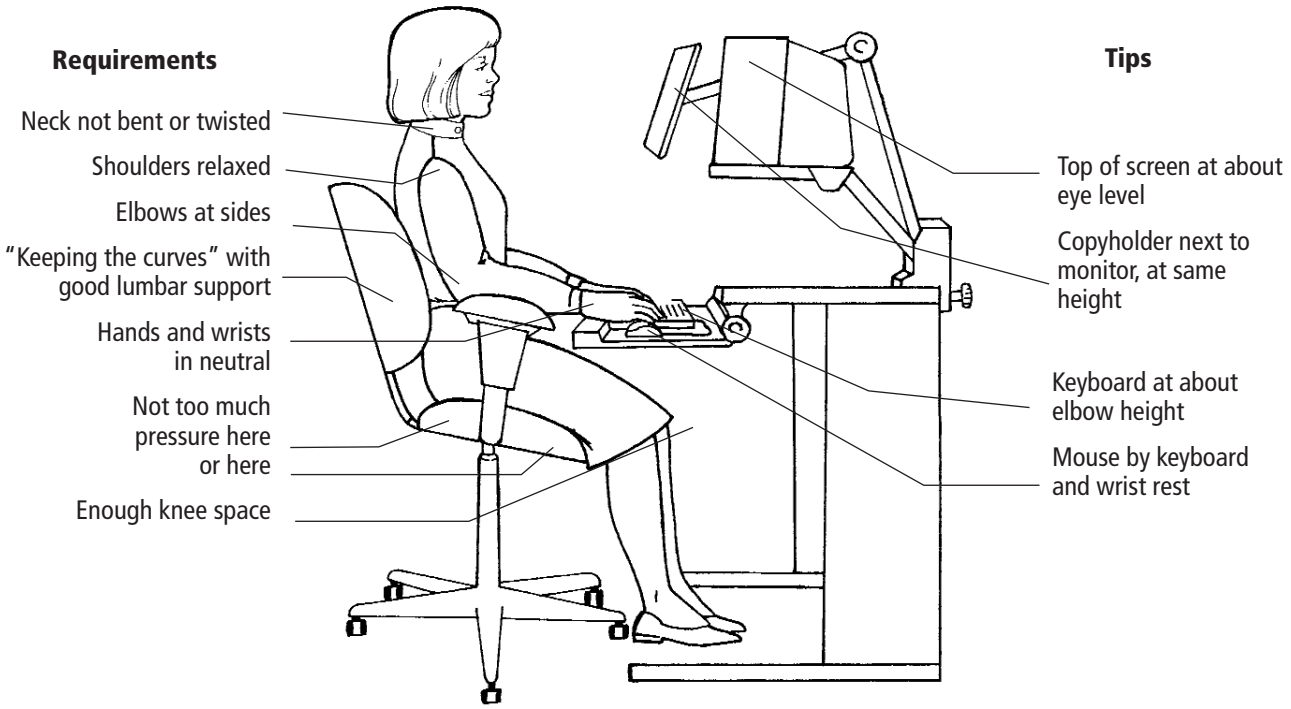
- Heavy lifting and exertion to load stock
- Heavy exertion to change tooling
- Long reaches to access tooling and handle parts
- Long reaches to make adjustments
- Lifting of heavy totes and baskets
- Repetitive hand and arm motions to load and unload parts
- Repetitive hand motions to deburr
- Continuous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



Options For Improvement

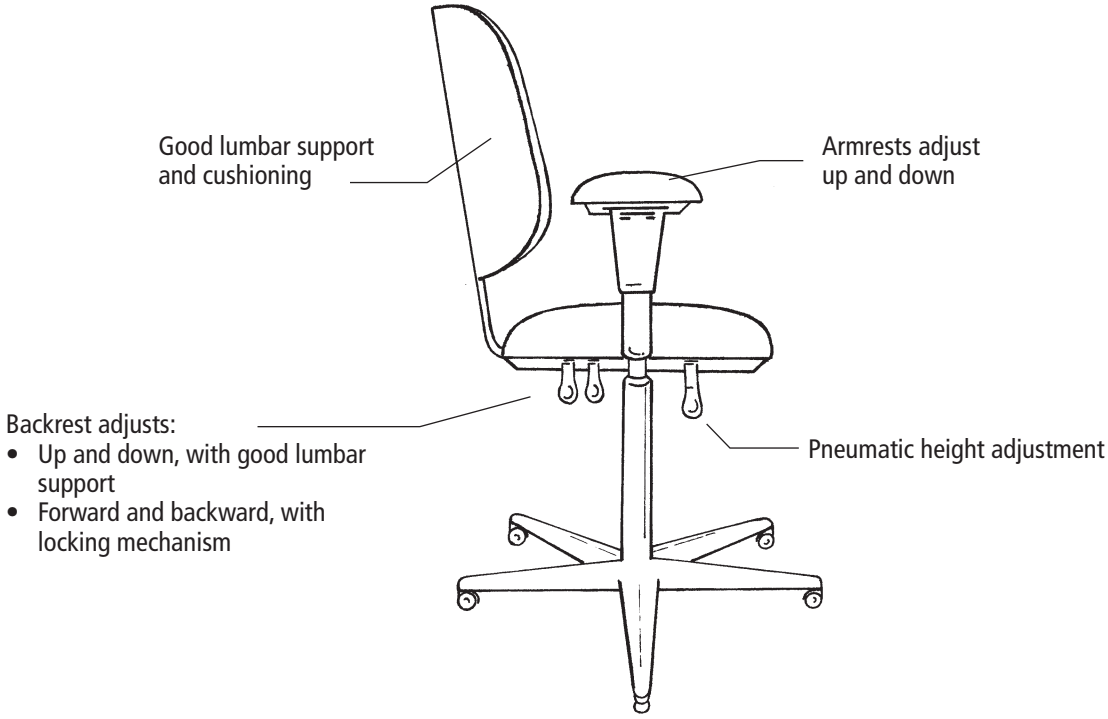
- Shuttles to load parts
- Equalize work surface heights to permit sliding of materials
- Skid bars and guides to support loads while putting in and removing from machine
- Skid bars, conveyors with gates or flex conveyors to handle totes
- Air or hydraulic cylinders to do heavy pushing
- Lift tables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

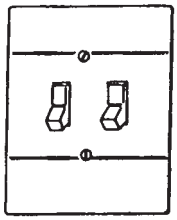
CHAIRS AND WORK STOOLS



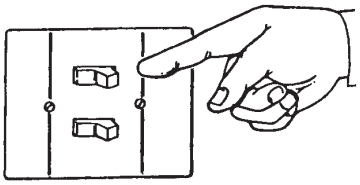
Cognitive Ergonomics

*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

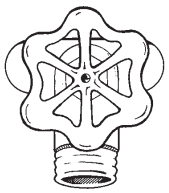


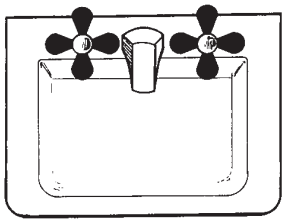
Most people would expect to flip up the switch to turn the lights on.



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





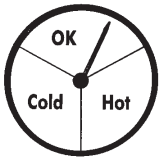
Which way would you turn these faucets to turn the water on?

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.

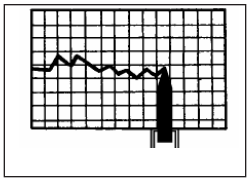
Use Appropriate Displays

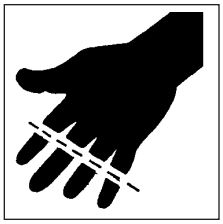
Digital



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.

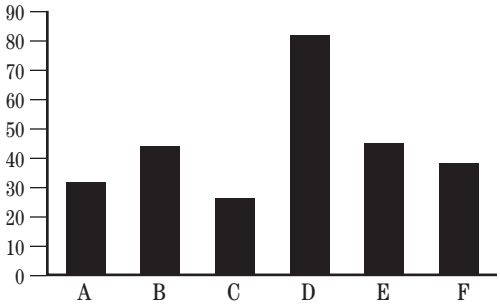




Moving pointers and trend graphs are better for presenting relative information. But icons convey information quickly, particularly for warning signs.

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:

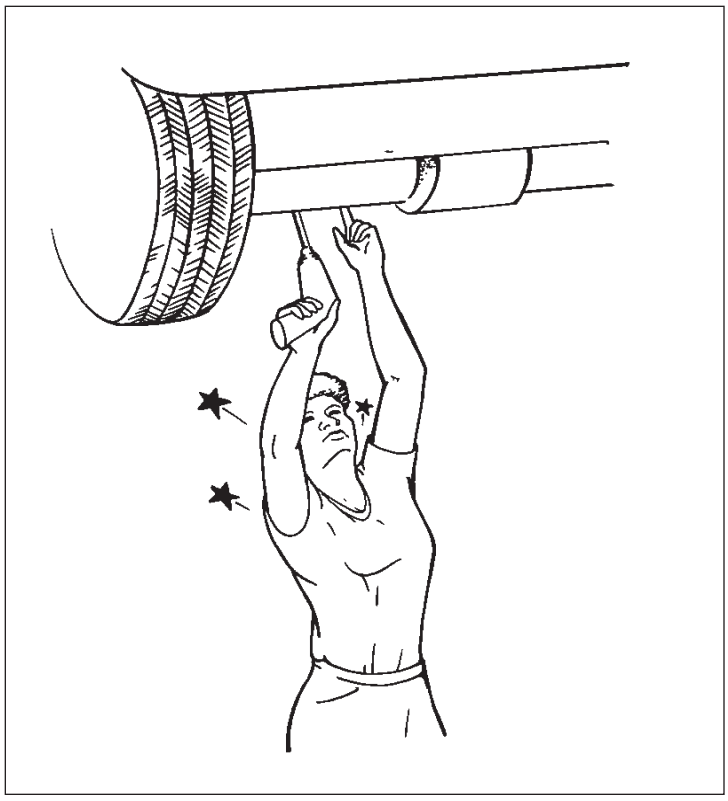
- **Plan** — Anticipate, think ahead and prepare. Think of ways to avoid the stress of hurry-up-and-wait situations. Balance the flow of work.
- **Communicate** — Think of how to share information, coordinate and help plan. Dedicate time so you can discuss issues and be kept up to date.
- **Empower** — 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

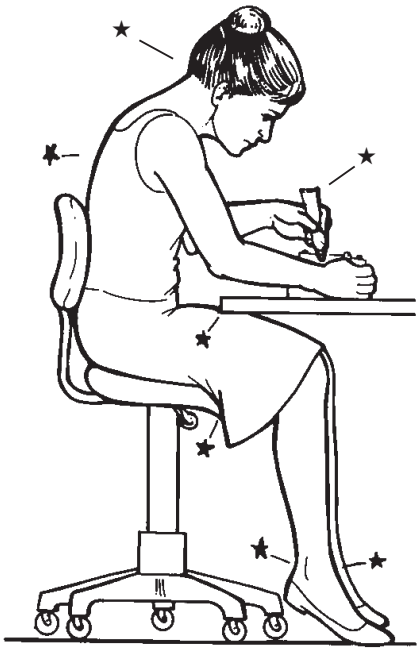
*There is a group of physical disorders that basically amount to **wear and tear** on the tissues surrounding the joints. General terms for these disorders include Cumulative Trauma Disorders (CTDs), Musculoskeletal Disorders (MSDs) and Repetitive Strain Injuries (RSIs). Most people experience disorders 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.

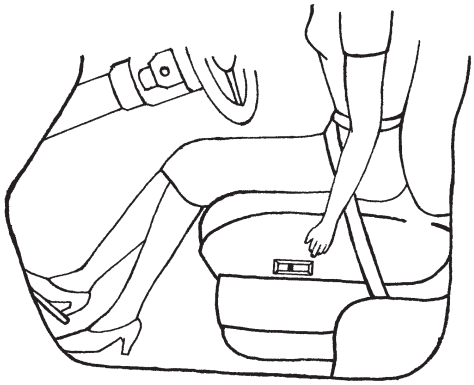
Creating Change

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 _____