

Ergonomics 102: Creating a Healthy Workstation



Employees are spending a greater percentage of their work hours sitting at the computer. A basic knowledge of ergonomic principles plus a small investment in ergonomic work tools can go a long way toward improving their comfort and health.

NOTE: This article updates the information previously presented in “Ergonomics 101: Working Painlessly,” which was first published in the June 2000 issue of *Interiors & Sources*. This updated report chronicles the new information available as a result of continued research in the area of ergonomics, and presents a current and comprehensive evaluation of ergonomic issues as they relate to office workers in the first part of the 21st century.

The past decade has been marked by a dramatic shift in the way we work—the result of which is that we are spending longer periods of time sitting in one place. Technologies including instant messaging, e-mail and on-line faxing have greatly reduced the number of times people are compelled to walk away from their computer workstations. Though this shift may seem insignificant from a health standpoint, the reality is that it could have serious consequences for the average worker.

While 90 percent of all U.S. office workers now use computers, 40 percent work on their computers at least four hours a day. According to Dr. Alan Hedge, Professor of the Human Factors Laboratory at Cornell University, the risk of musculoskeletal discomfort increases with as little as one hour of computer use per day, and the risk of musculoskeletal injury in someone who works on a computer four or more hours per day is nine times greater than it is for a one hour-per-day user. These statistics explain the growing number of work-related office injuries, and why increasing emphasis is placed on ergonomics in the workplace.

In a broad sense, ergonomics is about fitting work to people with the intention of maximizing productivity by reducing operator fatigue and discomfort. While that definition is pretty straightforward, its

application is often open to debate. And that, quite simply, is the purpose of this article—to highlight the real issues facing workers in the modern office, and to debunk the many misconceptions that typically surround ergonomics discussions.

ERGONOMIC MISCONCEPTIONS

Most of us learn from a young age that if something is good for us, it's likely not very pleasant. Spinach comes to mind. Vaccines too. Nowadays it's exercise and low-fat foods. We're taught throughout our lives that if it's good for us, it probably must be suffered and endured.

Unfortunately, that same thinking has seeped into our ideas about healthy workplace postures and behaviors. Despite what your mother said, sitting up straight is *not* good for you. And despite what the old ergonomic theories proposed, sitting with your body at 90-degree angles is not the healthiest way to spend a workday. In terms of workplace ergonomics, the real truth is that comfort and health are synonymous. In other words, if you're not comfortable at your desk, you are probably sitting and working in an unhealthy way.

Another misconception is that greater adjustability equals better ergonomics. What's important is that products be adjustable *within* a safe operating range, and that they don't allow untrained users to put themselves at risk. Given that the vast majority of users know very little about ergonomics or proper workstation set-up, it's not surprising that when they are free to set up their own workstations, they place their keyboard, mouse, monitor, copy holder, etc. based on factors such as available desk space and personal habits. In this all-too-common scenario, the likelihood of their workspace being set up appropriately is next to nil.

Furthermore, adjustability does not alone guarantee usability. If the adjustments on a piece of equipment are too cumbersome or complicated to use, then people will likely not use them. At that point, there is no ergonomic benefit despite the adjustable features.

Lastly, while this may come as a surprise, not all products labeled “ergonomic” are actually good for you. There are currently no laws in place and no governing bodies overseeing the use of the “ergonomic” label, which means that anyone can call any product “ergonomic”—from tortilla chips to dog food bowls and toasters. As a result, the label has been overused and watered down, creating confusion about what is and is not “ergonomic.” Bottom line, ergonomics in

LEARNING OUTCOMES

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After reading this article, you should be able to:

- ▶ define ergonomics and identify the six major principles of good office ergonomics;
- ▶ describe how ergonomics can positively—and negatively—impact business;
- ▶ identify the ideal placement of various elements within the workspace for maximum user comfort and long-term health benefits.



A poorly set-up workstation forces the user to twist in her seat and risk repetitive stress injury to the neck, back and shoulders. Here the monitor is misaligned with the keyboard and document surface, and the desktop is cluttered with the CPU, monitor, keyboard and mouse.

the workplace is serious business, and product functionality and claims ought to be backed up by research and testing.

COST OF INJURIES TO EMPLOYERS

As a result of the many misconceptions and/or lack of ergonomic awareness, workers continue to succumb to task-related injuries, and the associated costs to employers are staggering. Based on the most recent information from the Bureau of Labor and Statistics, work-related musculoskeletal disorders (MSDs) now account for more than one-third of all occupational illnesses and injuries, and constitute the largest job-related illness and injury problem in the U.S. today. In 2002, employers reported a total of 487,900 lost workdays due to work-related MSDs, representing nearly 50 percent of all lost work days. On top of these productivity costs, employers have paid approximately \$20 billion annually in direct worker's compensation costs. Indirect costs associated with these injuries increase that total by another \$60 billion annually.

In addition to lost days having a negative impact on the bottom line, it is becoming increasingly clear that people who are working in pain are not as productive as those who are pain free. As reported in



Use of a flat panel display supported by a monitor arm and a properly aligned, negative tilt keyboard tray will maximize the likelihood that the user maintains neutral postures throughout the day. The neck, back and shoulders align, and the workspace is clear of clutter with the CPU mounted under the desk and the monitor, keyboard and mouse off the work surface.

the November 2003 *Journal of the American Medical Association*, common pain conditions are having an adverse impact on productivity. Researchers found that lost productive time due to back pain, headache, neck pain and other musculoskeletal discomfort is costing U.S. companies an estimated \$61.2 billion per year.

POSITIVE IMPACT OF ERGONOMICS

Obviously, these costs are very real. So, too, are the injuries, which can be extremely painful and debilitating. The good news, however, is that most work-related, repetitive stress injuries are avoidable.

Companies across all industries have seen the economic benefits of having ergonomic programs in place. Reports of success include fewer workers' compensation claims, decreased cost per claim, and increased productivity. For guidance, The National Institute for Safety and Health (NIOSH) has outlined a pathway for creating a successful ergonomics program, with details available at www.cdc.gov/niosh/ephome2.html.

ERGONOMIC PRINCIPLES

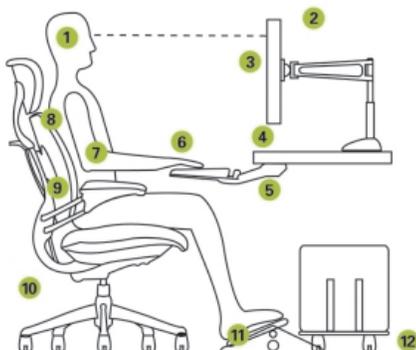
With some attention to the basic principles outlined below, employers

can enhance their employees' comfort and productivity, while at the same time reducing their risk of MSDs and other costly injuries. As stated by the American Industrial Hygiene Association, "Ergonomic principles are most effectively applied to workstations and new designs on a preventive basis, before injuries or illnesses occur. Good design with ergonomics provides the greatest economic benefit for industry."

I. ENVIRONMENT AFFECTS BEHAVIOR.

This is the driving principle of ergonomics. In other words, a well-designed workstation goes a long way toward ensuring that people work safely. Conversely, a

12 Tips for an Ergonomic Work Station



- 1 Top of monitor at or below eye level
- 2 Monitor and keyboard centered in front of you
- 3 No glare on screen
- 4 Documents in line with keyboard and monitor
- 5 Negative tilt keyboard support
- 6 Wrists flat and straight
- 7 Arms and elbows close to body
- 8 Change postures often
- 9 Work in a reclined position
- 10 Take frequent short breaks
- 11 Feet flat on floor or footrest
- 12 CPU off desk

poorly designed workstation can have a negative impact. According to a study published in the journal *Occupational Medicine*, office workers who were most likely to report pain associated with musculoskeletal disorders (MSDs) were not the ones who spent the most time using a computer, but the workers who said their workstation design was poor.

Ultimately, the authors suggested that, "More consideration should be paid to the ergonomics of workstations, the placing of the mouse, the postures of the upper extremities and the handling of the mouse." [*Occupational Medicine 53: 443-451 (2003)*].

The impact of environment on health and comfort is even more evident as office work space continues shrinking. As reported by the International Facility Management Association (IFMA) in June 2004, eight years of research by the organization shows that the average amount of square footage allotted to each worker in the United States has diminished by as much as 17 percent since 1994.

Ultimately, workers are being forced to adapt to progressively smaller workspaces. "The shrinking office is not a myth, but a reality, and a clear sign of the economic times," said IFMA President and CEO David J. Brady. He added that "For the facility professional, balancing the needs of workers in shrinking space takes some additional creativity and ingenuity."

2. MOVEMENT IS CRITICAL. While the old school of thought suggested that certain fixed postures were ideal (i.e., the 90-degree theory), the overwhelming evidence today shows that fixed postures are inherently dangerous. According to Marvin Dainoff, Director of the Center for Ergonomic Research at Miami University of Ohio, "Any fixed posture, no matter how closely it approaches the optimal, will generate muscle fatigue. Therefore, it is important to build in flexibility to allow operators to shift positions easily." While constant motion is obviously not the goal, frequent positional changes are vitally important to good health.

Additionally, there has been recent concern on the negative impact of decreased movement with regard to potential for development of

deep vein thrombosis (DVT) in the lower extremities. Sitting with the legs immobile for long periods of time can lead to swelling in the lower legs and potentially the formation of a blood clot in the deep leg blood vessels. Some data suggest that immobility from sitting for long periods at a computer workstation may be associated with higher DVT risk [see *European Respiratory Journal*, 21(2), 374-376].

Clearly, incorporating movement into the work day is not only a matter of comfort, but one of maintaining overall health.

3. MINIMIZE EXTREME POSTURES. While movement is important, so too are the postures you assume while performing your daily tasks. Neutral postures, meaning those that require minimal muscle activity to maintain, are synonymous with health and comfort. Extreme postures, on the other hand, such as arms splayed outward or wrists bent upward, are to be avoided at all costs. Maintaining body symmetry is equally important, particularly with respect to the spine. "Good posture" for the spine generally means maintaining the spine's natural curvature. Sitting bent forward or twisted to the side puts mechanical pressure on spinal discs, ligaments and muscles. This type of strain over time can lead to damage of any of these structures and be the source of considerable pain.

4. AVOID CONTACT STRESS. Focused pressures on specific parts of the body are extremely dangerous and can cause circulation problems at a minimum and nerve damage in more severe cases. According to OSHA's Federal Register, "Contact stress commonly affects the soft tissue on the fingers, palms, forearms, thighs, shins and feet. This contact may . . . inhibit blood flow, tendon and muscle movement and nerve function. Tissue that is compressed for prolonged periods of time may be damaged. The problem becomes worse with extended or repeated exposure." Such stress can be transmitted to arms and wrists by extended contact with the hard, sharp edges of desks and hard

THE LAPTOP HUNCH

One of the most visible changes in the workplace prompted by advances in technology is the increased prevalence of laptops in the office environment. More and more employees are using laptops as their primary computer, taking advantage of the power now available in these machines at more affordable prices. The paradox here: for all of the technological advances built into a laptop, the physical design of the machine is reminiscent of an older era. That is, the computer keyboard is attached to the monitor, which creates several ergonomic issues. When used alone on a desk, the laptop forces users to lean forward, away from the backrest of the chair, often with hunched shoulders, no lower back support, and contact stress on their forearms and wrists. Furthermore, the laptop display is usually too low for most users, which puts additional strain on the neck.

An effective way to eliminate this high-risk posture is by placing the laptop in a height adjustable stand, and using it in conjunction with an external keyboard and mouse on an adjustable keyboard tray. These relatively simple changes allow the user to enjoy a more neutral, low-risk posture for the entire body—with a fully supported back; neutral shoulder, neck and wrist positions; and no contact stress—while taking full advantage of the flat panel display and other technological benefits of the laptop.



As more workers use laptops as their everyday computers, the risks of injury also increase. Here the user is shown in a hunched over position (very common for laptop users), which over time will create back, neck and shoulder problems. Contact stress on the forearm adds further to the risk of injury.



Use of an adjustable laptop holder with an external keyboard and mouse on an adjustable keyboard tray promotes safe laptop work. Here the user is shown fully supported in his chair with arms and wrists in neutral positions and the laptop screen at a proper height and distance.

armrests on chairs. Likewise, the undersides of thighs or backs of the knees are at risk from hard seat edges or simply seats that are too high.

5. TAKE BREAKS. When performing repetitive tasks, it is extremely important to take breaks from those tasks on a regular basis. Such breaks could include actual work breaks, short exercise or stretch breaks, or simply switching gears and performing a different task for a few minutes. As noted by Dr. Hedge, “. . . with appropriate rest breaks, combined with stretching exercises, computer workers should be able to sustain work at an appropriate work/rest pace, while at the same time minimizing postural injury risks.” In addition, he states, “Provision of discretionary rest breaks produced a statistically significant increase in keying accuracy [13.4 percent].”

6. EDUCATION, EDUCATION, EDUCATION. When all is said and done, a worker who has been educated on ergonomics in the workplace is more likely to remain healthy. With an awareness of critical risk factors, healthy working postures, and the warning signs of injuries, employees can begin to arrange their workspace with a strategy for injury prevention.

While prevention is ideal, it is important to address early warning signs and symptoms of MSDs. Discomfort that increases with intensity or duration can be a sign of increasing inflammation. Addressing mild inflammation is a much simpler prospect than treating inflammation that has gone on for so long that soft tissues have become damaged. In the latter scenario, costs go up dramatically—not only for the company, but in terms of the negative impact of the injury on the employee. By educating employees and managers about early warning signs and symptoms of MSDs, problems can be addressed before they become severe.

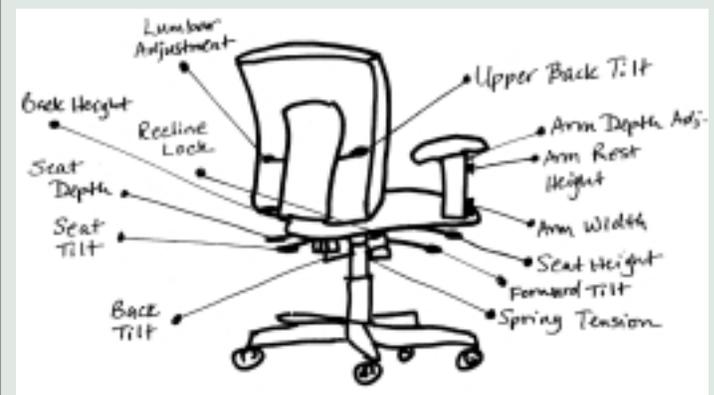
WORKSTATION SET-UP

As stated in Ergonomic Principle #1 above, the first defense against workplace injuries is to create a working environment that positively influences behavior and therefore minimizes risk. Such a working environment is made up of four key elements with which the user will interact on a daily basis: the chair; keyboard and mouse; monitor and documents; and lighting and glare.

These elements are interactive, and must be considered together for a truly comprehensive approach to ergonomics. In other words, the way a person sits affects how they will use their keyboard and mouse, and how they view their computer screen or documents. Likewise, awkward positioning of the keyboard and mouse will have an impact on the ability to achieve appropriate positioning in the chair. These components, their interactions and appropriate uses are outlined below.

THE CHAIR: The most important piece of office equipment, from an ergonomics standpoint, is the chair. According to the Liberty Mutual Insurance Co., “Low back pain remains the most prevalent and costly work-related musculoskeletal disorder facing industry, both in the United States and in other Western industrialized countries.” Low back pain is often the direct result of sitting for days, months and years in poorly adjusted chairs. The typical office worker will spend more time sitting in their office chair than they’ll spend anywhere else, with the possible exception of their own bed. With such tremendous user-equipment interaction, it’s critical that task chairs meet the following important criteria.

► **TASK CHAIRS SHOULD ENCOURAGE MOVEMENT.** As we now know, frequent movement and positional changes are critical to long-term health and comfort, yet most chairs on the market encourage users,



Many “ergonomic” chairs boast of extensive manual controls and adjustments. However, research shows that users rarely make adjustments, which means that they may be sitting in maladjusted chairs or, worse, in a fixed position day in and day out. The “best of breed” ergonomic chairs offer automatic (passive) adjustability and few manual controls.

by default, to fix themselves into one position. While some current generation chairs have weight-sensitive mechanisms that alleviate this problem, traditional task chairs still have recline springs and tension controls that must be manually set to accommodate the user’s particular weight and body proportions. Unfortunately, this is easier said than done. According to a 1995 study performed by Martin Helander, less than two percent of the subjects in a laboratory setting were able to identify the purpose of the back tension adjustment knob on a variety of chairs. The problem is, if the tension spring is set too firm, the user won’t be able to recline, and will be forced to sit in an upright posture. Likewise, if the spring is set too loose, the chair will typically fall back to its most reclined position, which is where the user will likely sit for hours at a time. Even if set properly for the user’s particular body weight, the tension spring will only provide optimal support in the middle of the recline range.

To accommodate for these inherent failings of the tension spring, many chairs are equipped with recline locks. However, locks can be extremely dangerous because, by definition, they are designed to keep the chair in a fixed position, which we know is not healthy for the user. As written by Galen Cranz in *The Chair*, “Ergonomic furniture has created back problems because it succeeds too well in supporting the body in one position.” The solution? First, adjust the spring tension to best support the user. Secondly, use locks with caution and conscientiously unlock them on a fairly frequent basis to change recline positions,

BY THE NUMBERS

- 281 million U.S. population
- 94 million Number of people using Internet at home (2000)
- 57 million Number of people using Internet at home (1998)
- 70 million U.S. workers who use computers regularly
- 226,000 Number of Carpal Tunnel Syndrome (CTS) cases in 2002
- 90 Percent of computer users who experience Computer Vision Syndrome (CVS)
- 85 Percent of U.S. population that will experience lower back pain
- 34 Percent of all lost time incidents in 2002 that were the result of musculoskeletal disorders (MSDs)

or third, choose one of the newer breeds of task chairs that utilize weight-sensitive mechanisms to provide optimal support, while avoiding the inadequacies of tension springs and the danger of locks.

► **TASK CHAIRS SHOULD FIT THE USER.** In addition to offering proper recline support, it's important that a task chair provide good body fit for the user. No one would consider wearing a pair of shoes that didn't properly fit their feet, yet day in and day out, millions of office workers sit in chairs that are maladjusted to their body size and shape. Not surprisingly, such workers are at high-risk of injury.

The most common size adjustment is seat height. Ideally, the seat height should be set so that the user's feet rest comfortably on the floor while the upper body is high enough so that work can be done comfortably at the desk. However, because the height of most desks is fixed, petite users will usually have to raise their chair to a point where their feet get lifted off the floor. Maintaining such a position for any length of time will put undue stress on the undersides of the thighs, which can cause circulation problems and nerve damage. In this case, placing a height-adjustable footrest under the desk will solve the problem and give petite workers proper support for their feet and legs.

A second, somewhat common size adjustment is seat depth. The primary concern with seat depth is to provide a maximum amount of surface area on which to distribute the body weight, while being certain that the delicate area behind the knee is kept clear of potential contact stresses, such as pressure from the front of the seat. As a general rule, when sitting with your back properly supported by the backrest, there should be approximately two to four inches of space between the front of the seat cushion and the back of your knee.

A third, less common size adjustment is backrest height. As with seat depth, the idea of adjustable backrests is to maximize surface contact and minimize pressure points. While the curvature of people's backs, particularly the curvature of the lumbar area of the spine, varies somewhat from person to person, it is the *position* of the curvature that matters most. Therefore, a contoured and height-adjustable backrest can offer exceptional lumbar support while maximizing surface contact and weight distribution.

► **RECLINE IS HEALTHY.** As mentioned earlier, your mom wasn't passing along the best information when she told you that sitting up straight is good for you. Today, researchers everywhere agree that recline is healthy. As renowned industrial designer and human factors expert Niels Diffrient said, "The more you recline, the more comfortable you get. Ergo, the best chair is a bed." Essentially, the more work you can perform while reclining, the more of your body weight will be distributed to the backrest of your chair, and the less pressure your spine will have to endure. However, extended recline can put additional stress on your neck and shoulders as they work to maintain the upright position of your head. Therefore, it's wise to consider a chair with headrest if you expect to perform extensive work in a reclining position.

► **ARMRESTS SHOULD BE ADJUSTABLE AND KEPT LEVEL.** Most chairs today offer adjustable armrests, which are critical because different tasks and different sized users require different armrest positions. However, since most of these chairs have independently adjustable armrests, users are free to set the right and left arms at different heights. A common choice is to keep the armrest on the mousing side lower than the other armrest. Such users will sit, potentially for years, with a crooked spine. And as we know from Ergonomic Principle #3, that's a high-risk posture for injury.

THE KEYBOARD AND MOUSE: The thought of Carpal Tunnel Syndrome (CTS) strikes fear into the hearts of most office workers, and for good reason. The statistics surrounding CTS are staggering. In 2002, CTS cases resulted in the highest median number of days away from work for any injury or illness—30, compared to seven days for all other injuries and illnesses combined. CTS is a painful and debilitating disorder that can take months and even years to heal. However, it can be avoided in most cases with some basic preventative measures.

► **POSITION OF THE KEYBOARD IS MORE IMPORTANT THAN SHAPE.** While "ergonomic" keyboards (i.e., those with curved layouts or split designs) can help keep wrists in safer postures, they can also create other problems, such as shoulder abduction (elbows moving away from the sides of the body). Think of the hand and arm as a chain—

GOOD ERGONOMICS = GREAT ECONOMICS

Each year, more companies are reporting substantial economic benefit from their ergonomics programs. Below are highlights of successes from three companies that recently initiated ergonomics programs in response to increasing costs due to computer related injuries:

BLUE CROSS BLUE SHIELD OF KANSAS

In the early 1990s, the company realized that repetitive motion injuries were on the rise. In response, the company launched a proactive and comprehensive approach to ergonomics, including:

- Purchasing ergonomically correct chairs in an attempt to reduce lower back pain and carpal tunnel syndrome.
- Using accessories such as glare screens, articulating keyboard supports and split keyboards, different mouse varieties and document holders.
- Educational ergonomic programs and training for all employees.
- Since 1993, providing ergonomically designed workstations and indirect lighting in the company's new buildings.

The results: By 2001, repetitive motion injuries claims decreased by 50 percent, with the total cost going from \$526,000 in 1991 to \$137,000 in 2001.

SUN MICROSYSTEMS, INC. (CALIFORNIA OFFICES)

In the early 1990s, the company realized that repetitive motion injuries were increasing in incidence and cost. An ergonomics program was put in place, and included provision of equipment, workstation screenings and employee training.

As a result, in a 10-year period from 1992 to 2002, the company saw a considerable

reduction in costs associated with repetitive motion injuries:

- Total cost reduced from \$1.5 million to \$100,000.
- Average cost per claim decreased nearly 80 percent.
- Number of claims dropped from 300 to 50.

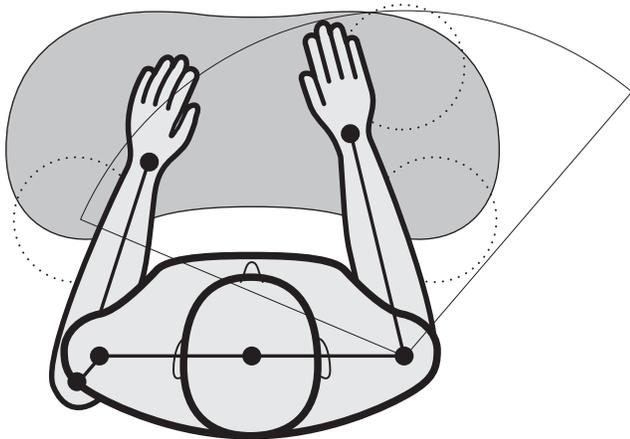
SIEMENS VDO AUTOMOTIVE

In 1991, the company documented musculoskeletal complaints reported by 43 percent of 250 office workers in one division. Siemens responded by initiating an ergonomics program including the provision of ergonomic chairs and workstation evaluations for all 250 employees. In this process, vision issues were among the elements considered for improving ergonomic conditions. Workers were encouraged to take short exercise breaks, and were given training on posture and injury prevention strategies.

Following the introduction of the office ergonomics program, the company saw fewer injuries coupled with increased productivity:

- Savings of 20,000 hours per year previously lost to pain and treatment of injuries.
- As reported in September 2002, two previous years with zero lost days due to repetitive motion injuries.
- Avoidance of surgery in at least two cases due to training and workstation improvement.

For more details and other success stories, visit the Occupational Safety and Health Administration (OSHA) Web site: www.osha.gov/SLTC/ergonomics/success_stories.html.



Mousing within the Neutral Reach Zone minimizes shoulder abduction and wrist flexion/extension.

what happens at one end affects the other. A safe posture at one end of the chain does not guarantee the same benefit at the other end.

So, keyboard design alone is not necessarily the answer. What is the answer, however, is keyboard position. Liberty Mutual's Research Institute for Safety reports that input devices themselves may not be the real source of the musculoskeletal discomfort experienced by office workers. "Keyboards are well designed now . . . but people do not use the technology appropriately," Tom Leamon, Director of Liberty Mutual's Research Institute for Safety said in a recent interview with the *Boston Globe*. "That is why the next innovation must be to have everyone set up their workplaces in a way that will minimize stresses."

To minimize risk for injury, first, remove the keyboard from the desktop and place it on a platform below desk level. This will help eliminate contact stress at the wrists and reduce forward reaching. The second critical step is to angle the keyboard slightly away from the user in what is referred to as a "negative slope." The lowered keyboard height combined with the negative tilt will allow the user's wrists to remain straight ("neutral position") and their elbows to open up. The best way to achieve this desired keyboard position is with the use of an articulating keyboard holder with negative tilt adjustability. "Using a lowered keyboard holder on a preset tilt away from the user can help prevent carpal tunnel," according to the results from a 1995 Cornell study. Such a keyboard position also encourages a healthier seated posture (see second image on page 49). Also, the palm support

should only be used as a resting place for the palms between periods of typing. It should *never* be used as a place to rest the wrists, and *never*, ever support the wrists during periods of typing.

▶ **MOVEMENT IS CRITICAL.** As with seated postures, being able to change positions frequently and easily is the foundation upon which a good ergonomics program is based. A keyboard platform, such as one used to position the keyboard in a lowered, negative-tilt position, should also allow spontaneous changes to keyboard height and depth, so that the user can easily change positions as different tasks necessitate.

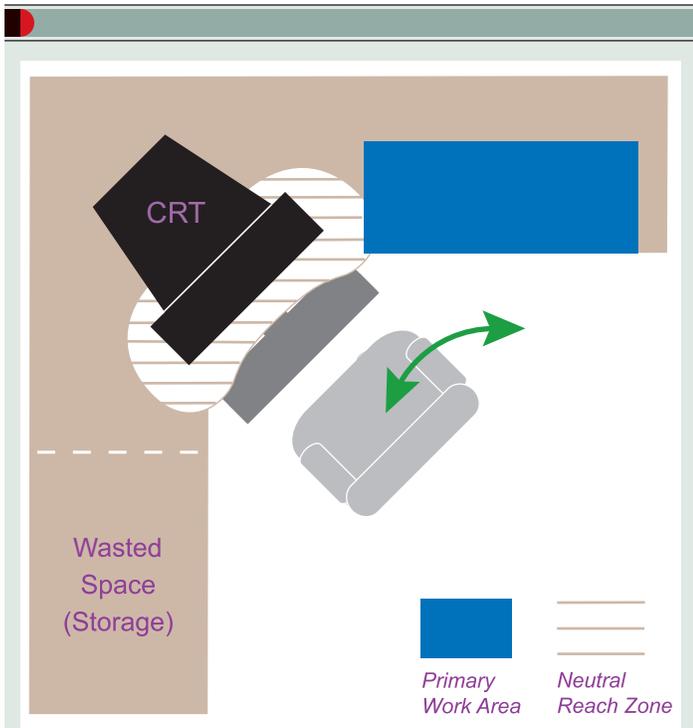
▶ **MOUSE WITHIN THE NEUTRAL REACH ZONE.** With the phenomenal increase in graphics applications and Internet use, mousing has become a major cause of CTS. To combat these dangers, it is important to always mouse within the Neutral Reach Zone. This follows from Ergonomic Principle #3, which emphasizes the importance of avoiding extreme postures. Mousing within the Neutral Reach Zone minimizes shoulder abduction and wrist flexion/extension.

▶ **BEWARE THE MOUSE.** In addition to position, the mouse itself can also be a major risk factor. Research recently conducted at Cornell University suggests that a mouse with a larger, flatter surface area can reduce wrist extension and therefore CTS risks. The shape of the mouse is also critical. Avoid mice that cause the wrists or fingers to be bent sideways or upward in simply grasping the device. It is essential that users monitor their mousing hand and consider mousing with their other hand at the first sign of any pain or tingling. Accordingly, it's important that the mouse be symmetrical so that it can be used equally well in both hands. Likewise, the keyboard platform should allow for mousing on both sides of the keyboard.

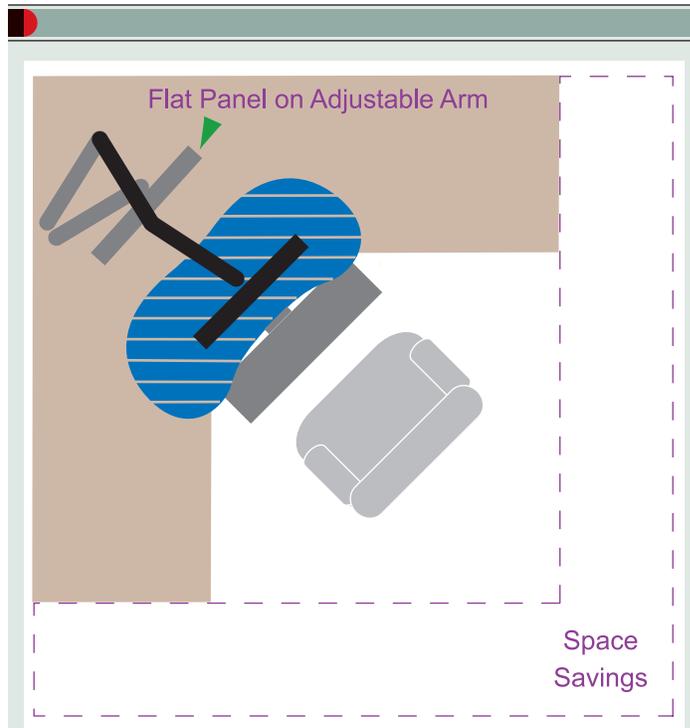
MONITOR AND DOCUMENT PLACEMENT: Because our bodies follow our hands and eyes, it is critical to properly position the things we look at during the workday. While much discussion has surrounded the proper placement of the monitor, researchers overwhelmingly agree that the top line of text should be at or slightly below eye level. In fact, any portion of the monitor above eye level contributes to neck and shoulder strain. If your monitor is too high because it rests on top of the CPU, invest in a below-the-desk CPU holder. Placing the CPU below the desk not only allows for better positioning of the monitor, but also creates additional desk space. If the monitor is positioned too low, consider spacers or adjustable monitor arms to lift it off the desk.

If the CPU is already off the desk and sitting on the floor, a below-the-desk CPU holder will not only protect the CPU from damage, but will increase leg room under the desk and make the CPU more easily accessible. Again, maintaining body symmetry is a critical component of healthy work habits.

In 2002, employers reported a total of 487,900 lost workdays due to work-related musculoskeletal disorders, representing nearly 50 percent of all lost work days. Employers have paid approximately \$20 billion annually in direct worker's compensation costs. Indirect costs associated with these injuries increase that total by another \$60 billion annually.



In a typical set-up with the CRT taking up much of the Neutral Reach Zone, users are forced to do their non-computer-based work off to the side.



With a flat panel monitor on an adjustable monitor arm, users are able to do all work within the Neutral Reach Zone, which results in maximum health and efficiency.

As technology advances, more offices are being outfitted with flat panel monitors. The beauty of flat panel monitors is the space savings they allow—if mounted on an adjustable arm. If you purchase a flat panel monitor and simply place it on the desktop where the old CRT used to sit, not only will all the space savings be *behind* the monitor, but you'll more than likely end up with a monitor sitting lower than your CRT.

Attaching your flat panel monitor to an adjustable monitor arm allows you to both customize the height and depth of the monitor for optimal viewing, while also being able to move the monitor out of the way when you need more desk space for writing or referencing documents. A flat panel monitor on an adjustable arm thus provides both ergonomic and space saving benefits.

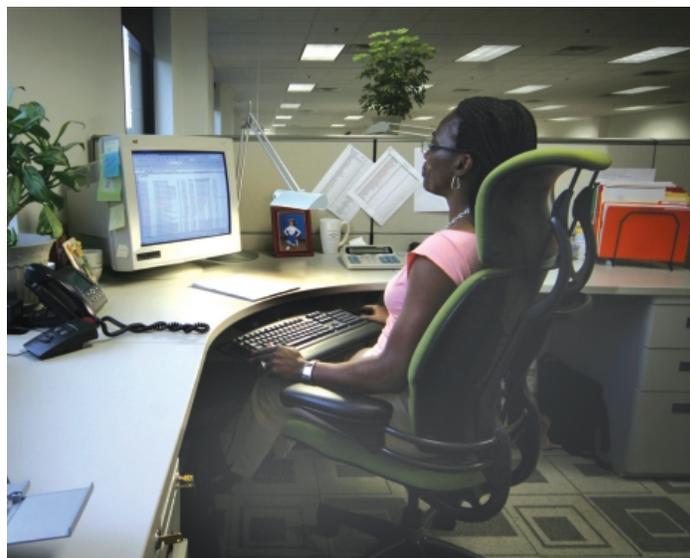
LIGHTING AND GLARE ISSUES: Another major issue facing office workers today is Computer Vision Syndrome (CVS), which can cause headaches, eyestrain, neck and back pain, and light sensitivity. According to OSHA, "Some studies estimate that 90 percent of the 70 million U.S. workers using computers for more than three hours per day experience [CVS] in some form." Glare and lighting are significant factors related to CVS.

Lighting is perhaps the most understated aspect of an ergonomic workstation and yet is arguably one of the most important with respect to human health and performance. As with ergonomics in general, there are common misconceptions with regard to lighting. The truth is, brighter is not always better. In fact, many office environments are overlit, which not only contributes to vision and glare issues, but also leads to unnecessary energy consumption.

At issue is the fact that different tasks requires greatly different amounts of light. For example, reading a document requires four to five times *more* light than does viewing a monitor. On top of that, the growing population of older office workers need more light than their younger counterparts.

Specifically, people in their 60s require approximately 350 percent more contrast than do people in their 20s. What this adds up to is a tremendous disparity between the lighting needs around an office—and the conclusion that a single source system of overhead lighting is quite inadequate.

Using a task light to supplement the ambient lighting scheme of the office can be an integral part of a comprehensive strategy to combat CVS and musculoskeletal discomfort. Task lighting solves the



People require approximately five times more light to read standard documents than to view a monitor. That's why single source overhead lighting is not an effective lighting solution, because different parts of the workstation require different amounts of light. Task lighting, an essential component of an ergonomic workstation, allows users to direct light where they need it (e.g., on documents) for maximum visual comfort and minimal glare.

above lighting issues by offering a direct and adjustable source of light where it is needed most—on the task at hand.

Furthermore, task lighting has been shown to have the added benefit of increasing worker productivity, largely due to individuals being given control over their own lighting levels. A laboratory study at Rensselaer Polytechnic Institute's Lighting Research Center found that subjects who had controllable lighting felt more comfortable in the room, rated the tasks as less difficult, and rated the lighting quality as higher than subjects who did not have control. Interestingly, participants who had control over their lighting produced a 35 percent to 42 percent decrease in energy consumption. The most cost effective way to provide employees with additional control over their environment is through the use of task lighting.

Good task lights provide a wide range of adjustability to avoid creating glare on the monitor, work surface and documents, and the best ones also offer an asymmetrical design to direct light where it is most needed, and a compact fluorescent bulb that reduces heat output and saves energy.

Another strategy to reduce the risks of CVS involves addressing computer screen glare, which primarily affects vision but can also cause awkward postures as people move to avoid the glare. Says Dr. Hedge, "Optical glass glare filters on computer monitors can dramatically reduce health and vision problems related to computer glare and help boost productivity in full-time computer users." While CRT monitors are a prime source of glare and should be outfitted with quality eye protection filters to minimize the risks of CVS, the new breed of flat panel monitors is less prone to glare and may not need external eye protection filters.

ECONOMICS OF ERGONOMICS

The bottom line is that a good ergonomics program will have a positive

impact on a company's bottom line. Businesses across industry sectors are finding that successful programs are characterized not only by a reduction in the number of workers' compensation claims, but decreased costs per claim and increased productivity (see sidebar for examples). When people are healthier, productivity goes up and costs go down.

Effective ergonomics programs are integrated into a company's business plan, and can be managed by processes successful in other areas of the organization. Good programs include a solid educational component as well as follow-up procedures to determine the effectiveness of selected interventions.

Through the application of basic ergonomic principles, office workers can reduce their risk for developing a musculoskeletal disorder. As technology advances and the physical workspace shrinks, it is more imperative than ever that strategies be put in place to maximize safe and efficient space utilization.

The office workstation should be viewed as a system of integrated and overlapping factors that contribute to health and comfort. Keeping in mind that our bodies follow our hands and eyes helps illustrate the notion that the chair, keyboard, mouse, monitor, documents and light must be considered together when striving to create an ergonomically correct environment. ●

With more than 15 years professional experience, including 10 as a physical therapist, Ronda Crenshaw currently serves as Director of the Humanscale National Ergonomic Group, where she is responsible for leading Humanscale's research initiatives, representing Humanscale to the ergonomic professional community, and providing ergonomic training for Humanscale employees and key customers. Crenshaw specializes in assisting customers in their identification of ergonomic goals, and developing strategies for achieving them. For more information, visit www.humanscale.com.

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EXERCISE

1. Define ergonomics and describe two common-held misconceptions.
2. Briefly describe how ergonomics can positively—and negatively—impact business.
3. List and briefly describe the six fundamental principles of good office ergonomics.
4. What is the most important piece of office equipment from an ergonomic standpoint? Why?
5. What are the three criteria that task chairs should meet?
6. What are the four basic preventative measures against Carpel Tunnel Syndrome?
7. Explain the importance of monitor and document placement.
8. What is Computer Vision Syndrome? How can task lighting be used to accommodate different tasks and the needs of different users?

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