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Office Ergonomics

Practical Solutions
for a Safer Workplace

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Introduction

Office work is rapidly changing, as new developments in computer technology come along which can make our jobs easier, but which also can present new problems for both management and employees. This booklet provides you with the information and tools necessary to analyze office jobs, find problems, and develop solutions for them. There is enough information contained here to allow a single employee to set up their own workstation to suit the way they work.

Scope of the document

Office managers, safety, claims and risk managers, facilities and purchasing personnel, and anyone else involved in planning office work will find this document to be useful. It has a dual focus, with information for both employers and employees. Employers are encouraged to read the entire booklet and to photocopy and distribute the pages which are intended for employee use. These pages are listed separately in the Table of Contents and are marked by a border in the document itself. Employees who are involved in safety committees or ergonomics teams will also benefit from reading the entire booklet.

Ergonomics and the prevention of injury

Ergonomics is the scientific study of human work. It considers the physical and mental capabilities and limits of the worker as he or she interacts with tools, equipment, work methods, tasks, and the working environment. Office Ergonomics is the branch of ergonomics dealing specifically with the office environment.

In recent years the main focus of office ergonomics has been on computer work due to the rapid increase in computer use in the modern office and the associated increase in injuries. People are an essential part of every business process and critical to delivering quality products and services. It is especially costly when a person becomes injured or ill given both these direct costs and the loss of the valuable services provided by the person.

Ergonomics is a tool by which administrators can use to help prevent these injuries in the office. Ergonomics reduces the risk of injury by adapting the work to fit the person instead of forcing the person to adapt to the work. In addition to injury prevention, ergonomics is also concerned with enhancing work performance, by removing the barriers that exist in many work places that prevent employees from performing to the best of their abilities. Therefore, another benefit of applying ergonomics to office work is that it helps people work more effectively, efficiently, and productively at their jobs. The application of ergonomics in your workplace is a creative process. You will therefore want to ask for input from all staff levels, including management, supervision and employees, when dealing with ergonomics issues.
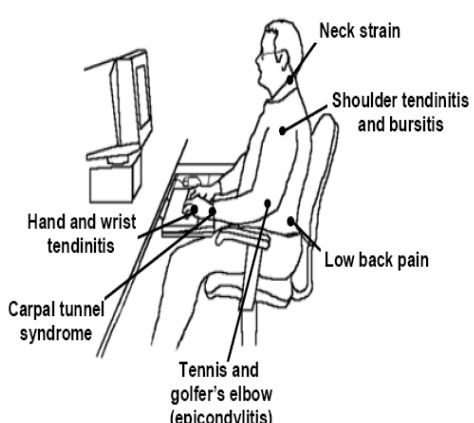
Benefits of ergonomics

While ergonomic improvements to the work environment are primarily used to create a safer and more healthful work environment, the City may experience other benefits as well, including:

- increased productivity
- increased work quality
- increased morale
- reduced turnover
- reduced absenteeism

Sources of injury in the office

If employees are required to adapt to a job that exceeds their body's physical limitations, they can become injured. The single largest class of injury claims in the office are Work-related Musculoskeletal Disorders (WMSD's).

WORK-RELATED MUSCULOSKELETAL DISORDERS (WMSD's) INJURIES TO THE SOFT TISSUES IN THE BODY, THESE ARE: • MUSCLES • TENDONS • LIGAMENTS • NERVES • BLOOD VESSELS SYMPTOMS INCLUDE: • DISCOMFORT • PAIN • FATIGUE • SWELLING • STIFFNESS • NUMBNESS AND TINGLING	Examples of WMSD's Neck strain Shoulder tendinitis and bursitis Hand and wrist tendinitis Carpal tunnel syndrome Low back pain Tennis and golfer's elbow (epicondylitis)	OTHER TERMS FOR WMSD's • Cumulative trauma disorders (CTD's) • Repetitive Trauma Disorders • Repetitive Strain • Injuries (RSI's) • Repeated Motion Disorders • Overuse Syndromes

WMSD's may worsen over time and therefore become more costly when compared to injuries resulting from a sudden event such as a slip and fall. This also means that it can take a long time to get an employee back to work, resulting in higher medical and time loss payments. In addition, there can be higher hidden costs when workers use more sick leave or slow their work pace during the period before a claim is filed when WMSD symptoms are beginning to develop.

Work related musculoskeletal disorder symptoms and claims

Work-related musculoskeletal disorders typically develop over a long period of time. The earlier that employees report symptoms and have them attended to, the better the chance of preventing a serious injury. When an employee reports occasional discomfort due to work activities, it does not necessarily mean that they will eventually develop a WMSD, but it is a sign that problems exist that will need to be addressed. Often, making simple changes to their job, work practices or workstation will reduce the symptoms to a level where injury is no longer a concern; this process will be the focus of the rest of this document.

More frequent, severe, and longer lasting symptoms should be evaluated by a medical professional experienced in diagnosing and treating WMSD's, who will determine whether the symptoms constitute an actual injury, and also if the injury is work-related. More serious cases may be referred to a specialist such as a neurologist or hand specialist. Management of more serious injuries can involve extensive changes to job duties and workstation equipment, and for this you may need the assistance of the City-wide Safety Unit.

Proactive approach

You will find that the application of ergonomics principles is most effective when used before problems result in serious injury. The goals of a proactive program should be to prevent as many workers' compensation claims as possible and to reduce the severity of those claims that do occur.

Injuries that are addressed early on through an ergonomics process will often be less severe, have little or no time loss, and will allow the employee to continue on as a productive member of the department. The City also benefits through reduced workers' compensation costs.

> **Important Elements of a Proactive Approach**
> - Comprehensive program with management support.
> - Employee involvement.
> - Worksite analysis to identify problems.
> - Employee awareness training.
> - Early reporting of symptoms.
>
> **RETURN-TO-WORK PROGRAMS**

Risk factors for WMSD's

Ergonomists have examined a number of jobs where there have been a high incidence of WMSD's, and have found some common elements present in each of these jobs which are associated with these injuries. These elements are called risk factors, because exposure to them increases the chance that a worker will become injured.

> **COMMON RISK FACTORS:**
> - REPETITION
> - STATIC LOADING OR SUSTAINED EXERTIONS
> - AWKWARD POSTURES
> - MECHANICAL CONTACT STRESS
> **FORCE**

The following are examples of risk factors that are found in office work, some or all of which may be present at the same time:

Repetition

Performing the same or similar motions repeatedly can result in trauma to the joints and surrounding tissues. Without time for rest and recovery, repetition can lead to injury.

Examples:

Computer Work	Office Work
• typing at the keyboard	• writing by hand
• moving and clicking the mouse	• using a calculator
• looking back and forth between the monitor and source documents	• flipping through files and paperwork
	• stapling and three-hole punching by hand

repetitive mouse use has been associated with WMSD's
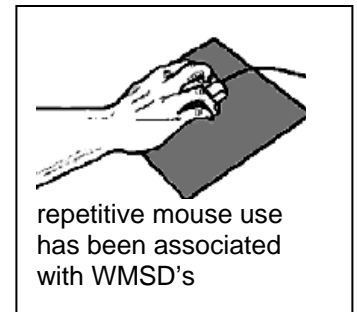
Static loading or sustained exertions

One of the risk factors that has increased in the computerized office is static loading, where the muscles must hold the body in a single position for a long period of time. This lack of movement reduces circulation and causes muscle tension, which can contribute to or aggravate an injury. Sustained exertions are a type of static loading where force is applied continuously for long periods of time.

Avoid sitting without back support

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Examples:

Computer Work	Office Work
• holding the hands in place above the keyboard or mouse	• looking down at documents laying flat on the desk
• holding down the Shift key	• sitting upright without back support
• keeping the head still while reading from the monitor	• holding the handset while talking on the telephone
• sitting still for long periods of time	• holding boxes in the hands while carrying them long distances

Awkward postures

Postures that bend the joints into positions where they are more likely to become injured are termed awkward postures.

Examples:

Computer Work	Office Work
• typing with bent wrists	• slouching or leaning forward in the chair
• turning the head to the side to view the monitor	• cradling the phone between the ear and the shoulder
• reaching up and over the keyboard to use the mouse	• elevating the arms when writing on a work surface that is too high
• leaning over to type in data from papers laying flat on the desktop	• bending at the waist to load copy machines

Avoid awkward postures such as:

Reaching forward to use the mouse

Hunching one shoulder to cradle the phone

Looking down at papers laying flat on the desk
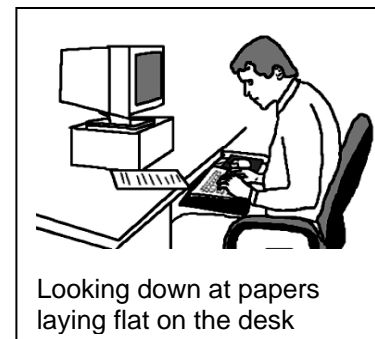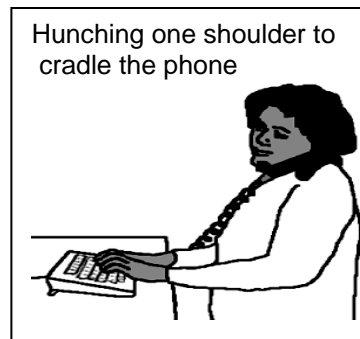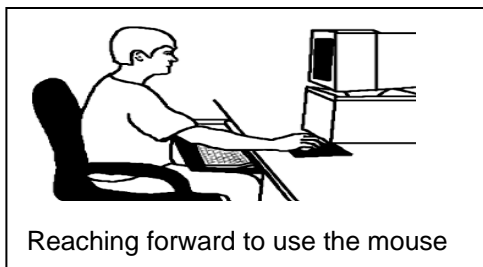
Mechanical contact stress

A hard or sharp surface or object pressing into the soft tissues -- the tendons, nerves, and blood vessels -- can cause damage that over time can result in serious injury. This damage is termed mechanical contact stress.

Sharp edges can damage soft tissues

Examples:

Computer Work	Office Work
• resting wrists on the desk edge while typing or using the mouse	• using rubber stamps with handles that press into the palm of the hand.
• leaning the elbows on hard chair armrests or work surfaces	• using scissors with hard, metal handles
• typing with palms resting on the hard lip of a keyboard tray	• sitting in a chair that places pressure on the backs of the thighs
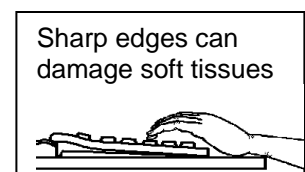
Force

Many office tasks require a moderate amount of force to be applied by very small muscles, which may cause fatigue, swelling, muscle strains and ligament strains.

Examples:

Computer Work
- "dragging and dropping" with the mouse
- gripping the sides of the mouse tightly
- "pounding" on the keyboard
- lifting heavy manuals with one hand

Office Work
- grasping thick file folders or manuals
- stapling or stamping by hand
- opening 3-ring binders

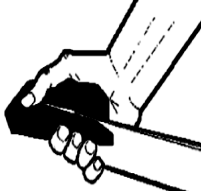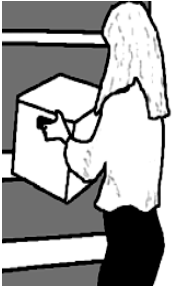|	
STAPLING BY HAND CAN REQUIRE HIGH FORCES	In addition, there is still the occasional need to lift items such as computer equipment and boxes of copy paper or files. Most office workers are not trained in proper lifting techniques. Also, seated work tends to weaken the stomach muscles, which would ordinarily help support the spine when lifting. Both of these factors place office workers at a greater risk for injury, even from the occasional lift.

Additional risk factors

While the risk factors described previously are typically found in the office environment, there are other risk factors that are more common in industrial jobs or work at home which your employees should be aware of.

These include:
- hand-arm vibration, such as when holding a power tool.
- whole body vibration, such as when driving a car over rough roads.
- exposure to extreme temperatures.
- wearing loose fitting gloves when working with tools.

These risk factors all reduce sensation in the hands and fingers, and therefore lead to the use of too much force when gripping objects. In addition, vibration, whether to the hands or the whole body, can lead to changes in circulation and the break down of tissues.

Other considerations

For each of the risk factors above, a longer duration of exposure results in a greater potential for injury. Complaints of discomfort and reports of injury are higher for workers who spend six or more hours a day doing repetitive data entry compared to those who only spend an average of two hours per day repetitively keying.

Also, you may have noticed in the risk factor examples that common tasks such as using the mouse and stapling by hand show up more than once. Combinations of risk factors associated with one task further increase the likelihood of WMSD's. For example, repetitive arm motions when using

> **Factors that increase risk of injury:**
> - **Duration of exposure to risk factors**
> - **Combinations of risk factors**
> - **Environmental factors**
> - **Organizational factors**

the mouse are much more likely to result in shoulder injury if the mouse is beyond the keyboard, forcing the worker to elevate their arm and work in an awkward posture. Also, repetitive

keyboard use has been shown to be more likely to result in WMSD when more force than is necessary is used on the keys. Environmental factors (lighting, temperature, noise) and organizational factors (job design, work schedules) can also increase the risk of injury, as well as cause other problems that affect worker performance.

Factors outside of work

The phrase "work-related" in work-related musculoskeletal disorders implies that workplace factors may not always be the sole or primary cause of the injury. Other factors which have been associated, in part, with WMSD's include:

- Poor physical condition.
- Lack of flexibility.
- Recreational activities which involve the risk factors described previously
- Computer use at home with improper workstation set-up.
- Predisposing medical conditions (e.g. - previous joint injury, some forms of diabetes, pregnancy).

Many predisposing medical conditions increase the risk of WMSD's by causing swelling in the joints, such as with fluid retention during pregnancy. It is important that any such medical conditions be properly diagnosed and treated.

Since this is a workplace guideline, it will focus on those factors at work which may be under your control at work. However, an important part of any ergonomics program is providing training to employees, in order to increase their awareness of WMSD's and their causes. This will allow them to apply the principles of ergonomics to those areas under their control, at home and at work.

Applying Ergonomics to your Office Environment

The first step in implementing ergonomics in the office is to analyze the work being done, whether looking at a single workstation or the entire department. A careful analysis will help to find the true cause of the problem and to apply the appropriate resources. Many times, analysis will reveal that only small changes are necessary, in which case a more involved analysis may not be necessary. Other times, there may be more complex problems that are beyond the scope of this publication, and will require evaluation by an experienced professional. Most of the time, however, you will find that the problems can be resolved with the help of the employees in the area and the resources at hand.

> **Getting Started**
> - Worksite Analysis
> - Implementing Solutions
> - Training and Education
> - Evaluation
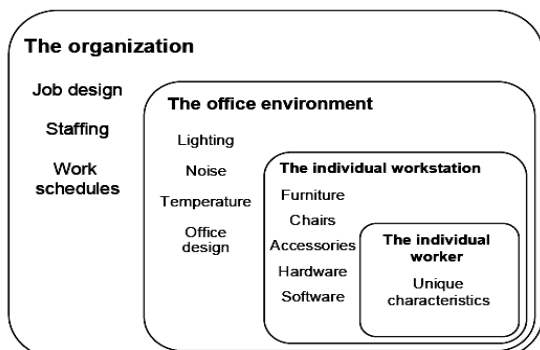


Organization of the office

Ergonomics deals with many issues, starting with a single employee and their workstation, and expanding out to include an entire department. Most of the organizational and environmental factors, as well as the control. Many of the factors related to the arrangement of the workstation and work habits are

under each selection of workstation furniture, are under management employee's control. The focus of ergonomics is always on designing for the individual employee, who brings unique characteristics with her or him to the job. Some of these characteristics, such as height and age, cannot be changed, while others, such as training and experience, can be changed.

Ergonomics process flow chart

Begin the ergonomics process with awareness training, and start applying ergonomic principles early in the process, especially when purchasing new equipment or setting up new workstations. Refer to the flow chart to help decide the level of effort to put into the analysis and development of solutions. If no problems exist, training in the principles of ergonomics is still an appropriate preventive measure.
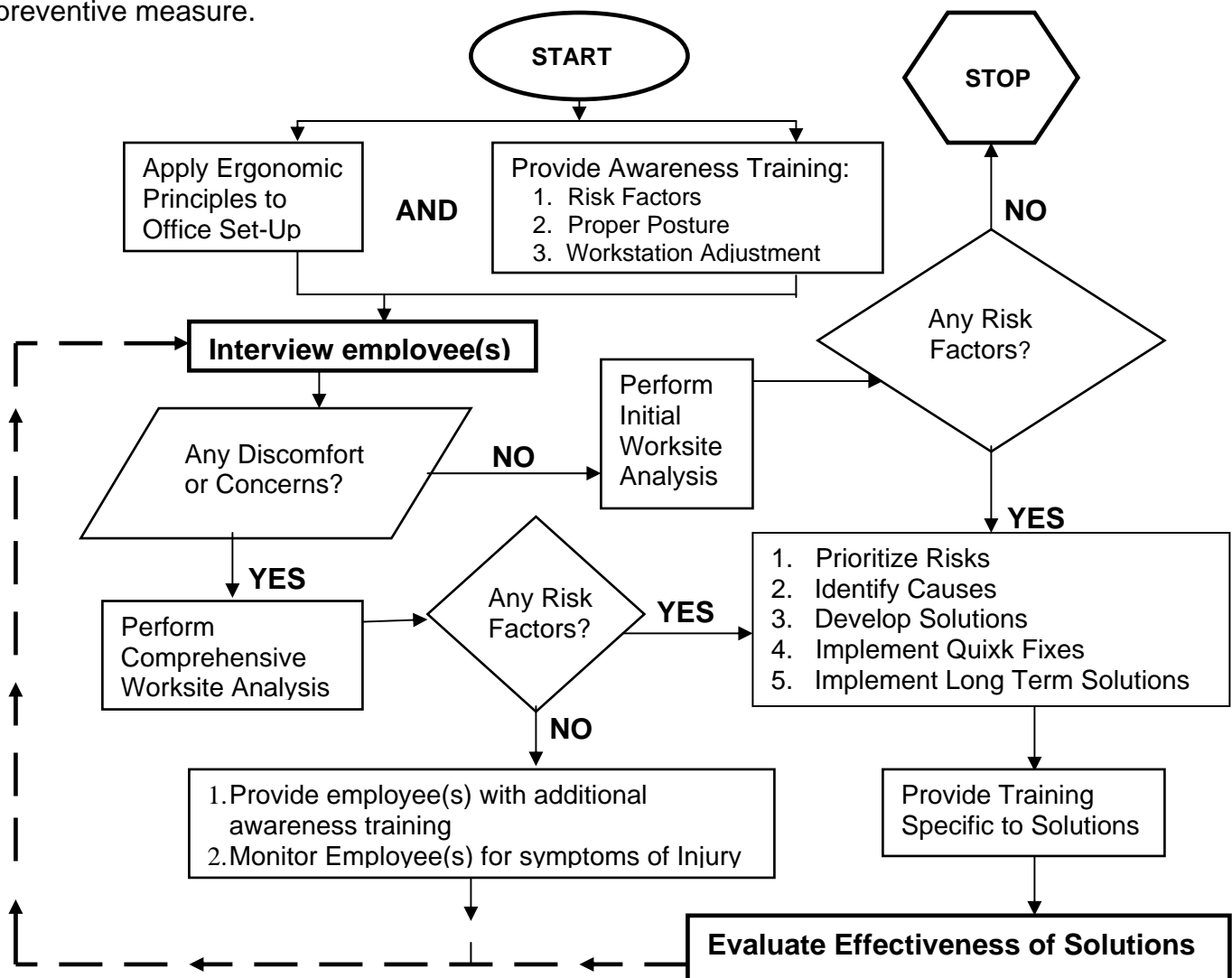
Worksite Analysis

Worksite analysis is the first step in developing solutions to potential causes of WMSD's. Causes of injury can come from any of the different levels in your department, and you should therefore be as comprehensive as possible when performing the analysis. There are a number of different types of analyses that you can do as part of a worksite analysis, including the following:

Task analysis looks at what each of your employees does on the job on a daily basis. It differs from a job description which usually contains generic job requirements, because it gathers information about how a specific worker does his or her job. For this reason, you will need to involve the workers in the task analysis, as they are the best sources of information on their daily activities. The application of ergonomic principles to workstation equipment selection, lighting design and other worksite elements depends on the nature of the task being done. Therefore, you will need to do a task analysis before doing any of these other forms of analysis:

Workstation analysis looks at the physical components of the workstation, such as monitor and keyboard location, work surfaces, and chair adjustments. Each of these components is measured relative to the individual worker, and therefore employee participation will be required for this analysis as well.

Environmental analysis examines the area surrounding the individual workstations, looking at factors such as lighting and glare, temperature, humidity and noise, all of which affect employee comfort and performance.

Organizational analysis deals with issues at the department level, such as staffing levels, assignment of responsibilities, work schedules, overtime policies and other aspects of what are typically considered "working conditions." These issues are typically outside the control of individual employees, but they can have the greatest impact on risk factors such as repetition and static loading, as well as the duration of exposure to all risk factors.

Any or all of these analyses may be appropriate, depending on the nature of the problem. Keep in mind, employees may not be aware of all of the potential problems or risk factors for injury that exist in their area. Therefore, it is always a good idea to perform some analysis beyond the obvious problems or stated concerns.

CASE STUDY: A THOROUGH ANALYSIS RESULTS IN CREATIVE SOLUTIONS

Mark, a human resources specialist at Northwest Technologies, had attended ergonomics training in order to learn how to do workstation analysis and set up a formal program within his company. When he spoke with managers, supervisors and employees in each area, he heard the same thing from all of them: "We need new chairs." Rather than do just a workstation analysis to determine what types of chairs to recommend, Mark began with a full task analysis for each job class and for each individual employee who was experiencing discomfort. With a better understanding of each job, he was able to identify solutions for risk factors in addition to, and in some cases instead of, the chairs. In some areas, he found that the computer monitors were too low, and employees were leaning forward to look at them. He placed reams of copy paper underneath the monitors, allowing the employees to sit in a more upright posture. He also found that some employees had to lift heavy boxes of files which had been placed in storage, even though they were still frequently used. He concluded that their back discomfort was probably just as much due to the lifting as it was to their chairs.

He recommended that more short term file storage be created in each work area to make these files more readily available. Mark found that these solutions were highly effective in reducing injury claims.

Implementing Solutions

Workstation solutions

During the worksite analysis, you may have identified some quick fixes that could be easily implemented and would provide immediate benefits to your employees. Most quick fixes are small changes to the workstation, such as footrests or monitor stands, which help to alleviate problems with awkward and static postures. Some of these small changes can be implemented by employees themselves, and employees may also have suggestions for low cost solutions. You may even notice some "homemade" workstation changes that your employees have made already in an attempt to make their work areas more comfortable or easier to use. Many times these solutions can be used by other employees at their workstations, too.

NOTICE WERE THE MOUSE IS LOCATED

A SIMPLE SOLUTION TO AN AWKWARD POSTURE – BRINGING THE MOUSE DOWN TO THE SAME LEVEL AS THE KEYBOARD
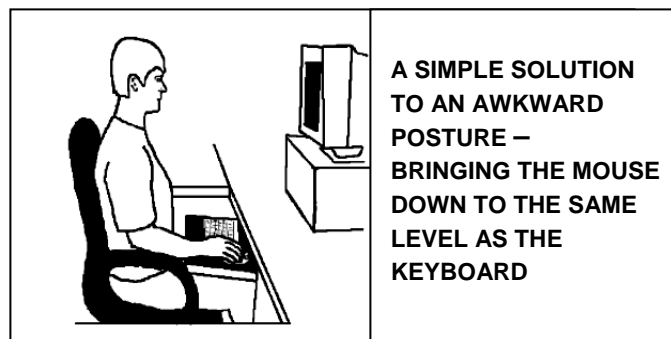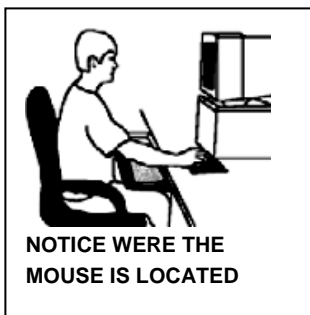
The individual workstation

Setting up an employee's workstation is simply a matter of placing the employee in one of the neutral postures described on the following pages, and then arranging their furniture and equipment to allow them to work in that posture. For example, the monitor should be just below eye level in order to keep the head level, and the keyboard should be close to elbow level, to help keep the wrists straight. If you can't bring the monitor and keyboard down low enough, then raising the chair and providing a footrest might be the solution. The reason for doing a separate analysis for each employee, rather than just setting up all of your workstations according to a few general rules, is that it is impossible to come up with a set of rules that works in every situation. For instance, an employee who wears bifocals may need to position their monitor much lower in order to keep their head level if they read out of the bottom half of their lenses.

If your task analysis reveals that employees work in other places besides their computer workstation, such as a copy room, storage area or mail room, treat these areas as additional workstations. This would mean performing a separate workstation and environmental analysis for each area, using the appropriate section of the Analysis and Implementation Guide. For example, a storage area should be evaluated using the Lifting and Carrying section.

Your employees will be able to participate in solving many of problems with the set up of their workstations once you have trained them on the principles of ergonomics. Feel free to copy and distribute pages from the Ergonomics Tips for Employees as part of your training efforts.

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Ergonomics Tip

Neutral posture at your workstation helps prevent injury

In order to understand the best way to set up a computer workstation, you first need to understand neutral posture. This is a comfortable working posture in which your joints are naturally aligned and your risk of developing a musculoskeletal disorder is reduced.

Change postures frequently

Regardless of how good your posture may be, sitting still for long periods of time isn't healthy. You should make small adjustments to your posture about every 15 minutes, by changing the height of your chair slightly, or leaning back a little further into the backrest. Larger changes in posture are also important; stand up and stretch or walk around for one or two minutes every hour.

Practice neutral posture while seated

The following are the important components of neutral posture while seated:

1. Keep your head level or tilted slightly downward. Place your work in front of you so that you are looking straight ahead.

2. Sit with your shoulders relaxed, not elevated, hunched or rotated forward.

3. Keep your elbows close to your sides and bent at about 90° angle, not extended out in front of your body.

4. Use the chair's backrest to support your lower back, or lumbar curve.

5. Sit with your entire upper body upright or leaning slightly back.

6. Keep your wrists straight while you work, not bent up, down or to the side.

7. Sit with your knees at the same level or slightly below the level of your hips. There should be no pressure points along the backs of your thighs or at the backs of your knees.

8. Place your feet slightly out in front of your knees and make sure they are comfortably supported, either by the floor or by a footrest.
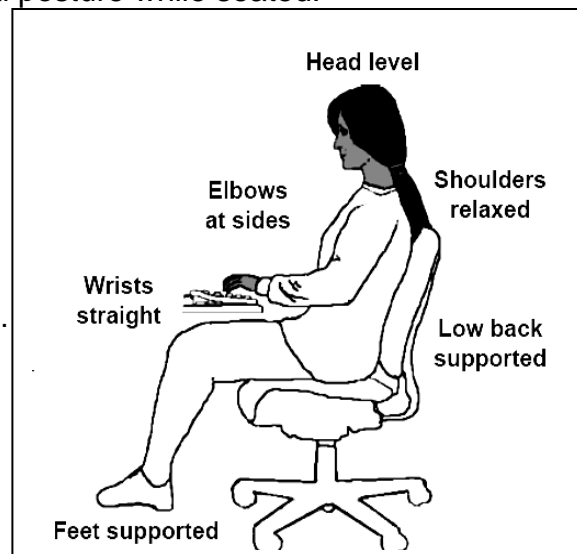
Pay attention to overall posture

Although the components of neutral posture are listed individually above, it is really the posture of your body as a whole that is important. Having just one part of your body out of neutral can affect the rest of your posture. Try sitting with your feet hooked under your chair. You will notice that this tends to pull you forward in your seat, away from your chair's backrest. Now place your feet out in front of you and you will notice that it is much easier to lean back into the chair. Similarly, if you place your monitor too low on your desk, this will also tend to make you lean forward to view it.

Practice adjusting your workstation to achieve a neutral posture for your whole body, It may help to have a co-worker take a look at you while you work and give you feedback on your posture.

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There is no single "correct" posture.

There are many variations of neutral posture, and depending on what tasks you have to perform and the furniture in your workstation, you may find one of these alternatives to be more comfortable for you. These variations are also useful when changing postures throughout the day.
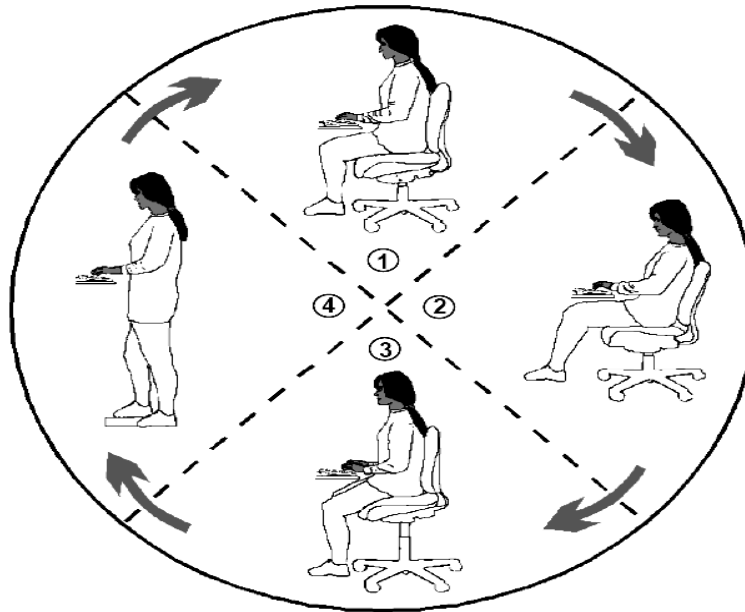
1 "90-degree" posture: Sit upright with your elbows, hips and knees bent at right angles and your feet flat on the floor or on a footrest. This position is biomechanically correct, but it can fatigue your back muscles over time. Fatigue can lead to slouching, even on a chair with lumbar support.

3 Forward tilt posture: Raise the height of your chair's seat a few inches and tilt the front of it downward about 8 degrees. This will open up your hip angle and allow you to support some of your weight using your legs rather than having it all rest on your hips and the backs of your thighs. You may not find this posture comfortable if you have knee or foot problems, or if you feel like you are sliding off the front of the seat. A contoured chair seat can help to hold you in place.

2 Reclining posture: Lean back 10 – 20 degrees into the chair's backrest and put your feet out in front of you to open up the angle at your hips and knees. This helps relax your back muscles and promotes blood circulation. Leaning back too far can result in an awkward neck posture when trying to keep your head upright, however.

4 Standing posture: Standing provides the biggest change in posture, and is a good alternative to prolonged sitting, which can aggravate low back injuries. It can be fatiguing, however, so have a counter height chair available at standing workstations, or use a height adjustable sit/stand workstation. Also, prop one foot up on a low footrest occasionally to help shift your weight.

Adjustable task chairs

It is obvious from the discussion of neutral postures and the need for frequent changes in posture that it will be important to provide employees with an adjustable chair that fits them well.

Adjustable task chairs vs. standard office chairs:

Adjustable task chairs are recommended for workers who spend a considerable amount of time seated, especially if they work at a computer or other job which does not allow for a lot of movement. The adjustments and features on a task chair are intended to provide support and allow workers to vary their posture throughout the day. These features also make them good chairs to provide to workers who have an injury or who do not fit well into standard chairs.

Standard office chairs will typically lack many of the adjustment features of a task chair, although they should have the following: an adjustment for seat height, good lumbar support, a waterfall front edge, a five star pedestal, casters and a swivel base. A standard chair is acceptable for office jobs that have a variety of tasks and frequent opportunities to stand and move around. However, care should be taken to ensure that a standard chair fits the worker well and is comfortable.

Improving existing chairs

Purchasing adjustable task chairs can be a considerable capital investment, although one which should result in a good return.

During the time it takes to budget for the purchase of new chairs, there are steps that you can take to make the chairs you currently have better fit your employees:

Minimum features of an adjustable task chair

1. Make sure that all employees are trained on proper adjustment of their chairs.

2. Have employees report any chair parts that are malfunctioning, especially if they prevent proper adjustment or easy movement of the chair.

3. Provide lumbar cushions for chairs that do not have adequate lumbar support built into their backrest, or for chairs with seats that are too deep for the employees using them.

4. Remove armrests which prevent employees from pulling close enough to their work, interfere with their movement in some way, or create awkward postures such as hunched shoulders.

5. Pad armrests that are hard or which have square edges.
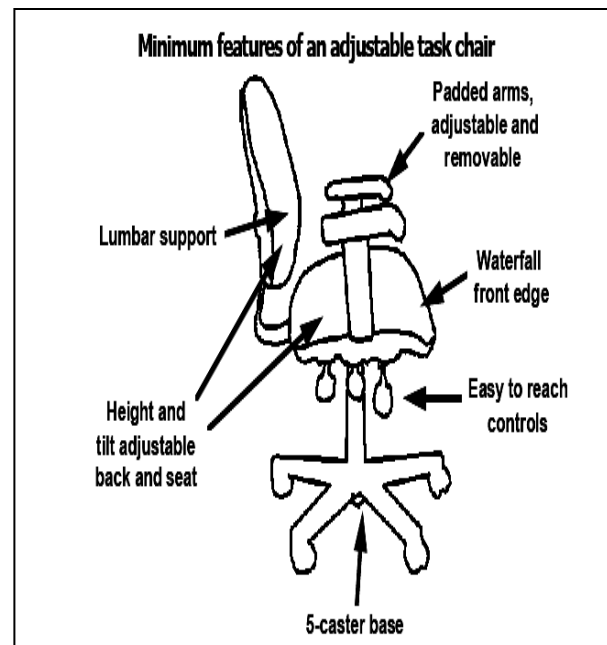
Benefits of adjustable furniture

In addition to chairs, there are a number of other pieces of furniture and equipment with adjustability built in, including keyboard platforms, monitor arms, and entire work surfaces that raise and lower with a hand crank or motor. Because the furniture will fit a variety of sizes of people, the extra expense is easily justified for workstations that have multiple users, or in areas where turnover rates are high. Adjustable furniture also allows individual workers to vary their posture throughout the day to reduce static loading. Some workstations even have enough adjustability to move from a seated to a standing height position, allowing large changes in posture. Keep in mind that these benefits will not come from the furniture alone; you must train employees on how to make the adjustments and the importance of movement and proper posture in order for the furniture to be effective.

Office design

The design or layout of the office and its furnishings and equipment should also be analyzed to determine if they present risk factors that may contribute to WMSD's. For example, when arranging office shelving, place those items used most frequently nearest the work area to reduce the amount of frequent, awkward, overhead reaching. Likewise, consider purchasing equipment that will automate some repetitive office tasks, such as letter folding or date stamping. The cost of automation may be offset by a lower risk of WMSD's. Input from your workers prior to making office changes or equipment purchases will often result in a more efficient work environment while also reducing the employer's risk.

Office floor plans

The layout of furniture in the office can be just as important as the type of furniture. Consider the following when redesigning an office:

Space allocation

When you add a standard computer with a keyboard, mouse and a monitor to a cubicle and account for room in front of it for an operator to sit, it takes up an additional 12 square feet of floor space. However, most offices are still the same size they were before the introduction of the desktop computer, and some companies have even begun reducing office size to save on facilities costs. This often leads to overcrowding, poor layout, awkward postures, and inefficiencies. Allocating additional space to employees with computers provides more room for an ergonomic set up. Also, allocate additional square footage as necessary for the following:

- Printers and other large pieces of equipment
- Telephones
- Storage such as bookcases and file cabinets
- Space to work with documents, especially large binders, folders or technical drawings
- Adequate room for visitors
- Sufficient space for changes in posture, stretching
- An unobstructed path at least 36" wide for safe exit in case of emergency

    (For ADA [Americans with Disabilities Act] purposes, a width of 36" is required for wheelchair users, according to 28-CFR-Part 36).

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Work flow

The layout of furniture and the organization of an individual workstation can make a big difference in the way work gets done; poor layout can be a barrier to physical movement and communication, while a well-planned layout can enhance teamwork and efficiency.

Keep the following in mind when designing workstations:

- Right-handed workers usually find it easier to move between the computer and desk work if the writing surface is to the right of the computer, while left-handed workers are the opposite.

- Right-handed people may need to answer the phone with their left hand if they need to take notes with their right, while left-handers are the opposite; locate phone lines accordingly.

- Phone lines, power cords and computer cables should be long enough to allow some flexibility in the placement of equipment.

- Smaller cubicles and offices will require more in the way of organization aids such as file holders, shelves, telephone stands, etc., to maximize use of space.

The following apply to the design of the floor plan as a whole:

- Place co-workers who interact frequently close together; pass-throughs and half-height cubicle panels will aid communication.

- Provide a central location for common use items such as printers and copiers and make sure they are accessible by a main aisle; avoid locating equipment that can only be accessed by walking into or through someone's office, as this can be distracting.

Your employees will want to have some control over the way in which their work areas are arranged, and will probably be able to make many of the necessary changes themselves.

Ergonomics Tip

Organizing your work area

The way you organize your work affects your body's position and the amount of reaching that you have to do. Long reaches to pick up heavy objects or items that you use frequently can contribute to discomfort and injury. This is because reaching puts your body in an awkward position and stretches your muscles beyond their normal limits, making them vulnerable to pulls and strains. An important concept to think about is how far you can reach without straining your body (reach zones). You can determine your easy reach zone by moving just your hands and forearms with your elbows at your sides and shoulders relaxed. For most people, this is an area about 16" to 18" in front of their body.

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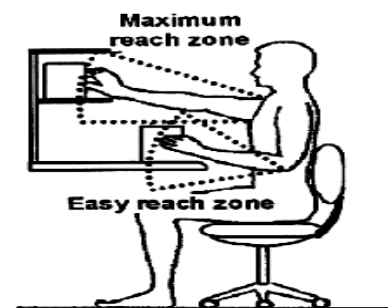
The other zone you need to consider is your maximum reach zone, which is how far you can reach just by moving your arm at the shoulder, without leaning forward. For most people this is an area about 26" to 34" in front of their body.

Keep these items in your easy reach zone:

- Frequently used items.

- Items that require finger dexterity to use (keyboard, mouse, telephone).

- Items that require hand force to use (stapler, 3-hole punch, staple remover).

- Heavy objects (large binders, manuals, telephone books).

Try to keep items that you use less frequently within your maximum reach zone. Stand up to reach items that are above your shoulder height or beyond your maximum reach zone.

Customizing your work area

Depending on what your job requires, you might have a different layout than your co-workers. For example, a receptionist might need to have the telephone within easy reach, while an accountant might need to have the calculator closer than the telephone.
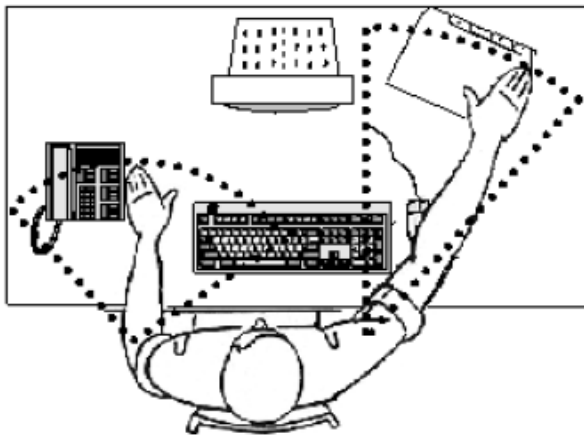
Receptionist's Work Area   **Accountant's Work Area**
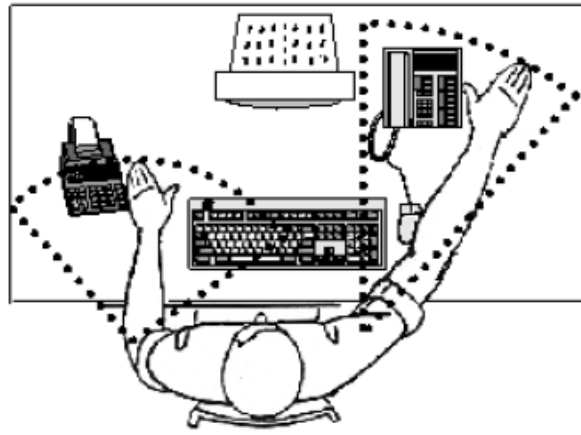
You are the best judge of how to arrange your work area, since you know what you use the most often. If you take the time to bring everything into its appropriate reach zone, you'll not only be more comfortable as you work, but also more efficient.

Lifting, carrying, and storage

While frequent, heavy lifting isn't typically a requirement of most office jobs, some lifting is inevitable no matter where you work. The way that materials are stored and moved around the office can create risk factors for injury. It can be as simple as an employee picking up a box of copy paper, or as complex as all the tasks a mail room employee must perform to deliver the mail, including lifting, carrying, pushing, pulling and sorting.

| TYPICAL WEIGHTS OF ITEMS IN THE OFFICE:	
Computer Manuals, Set	6-1/2 lbs
2"- 3-ring binder, full	4 lbs.
File folder, overstuffed	4 lbs.
Copy paper, single ream	5-1/2 lbs
Copy paper, whole box	42 lbs.
Computer Monitor, 15"	41 lbs.
Laser Printer	55 lbs.
Laptop computer, in case	15-1/2 lbs.
Side Chair	28-1/2 lbs.
Recycling barrel, ½ full	37 lbs.

Common WMSD's from lifting and carrying include injuries to the low back, upper back and shoulders. Injuries also can occur to the abdomen, hips, knees and ankles. Unlike computer-related injuries, which are a recent and rapidly growing phenomenon, injuries from lifting and carrying have always been a part of office work. For this reason, lifting injuries don't always receive the same amount of attention as WMSD's from computer work. However, since these injuries are one-third of all of the injury claims in the office each year, you should include lifting and other materials handling tasks in your worksite analysis. Evaluate lifting and carrying tasks by analyzing the tasks themselves, looking at the location where items are stored and where they are used, and observing your employees' work practices when they lift.

Proper storage and movement of supplies

In areas where lifting tasks are infrequent, it may not be practical for you to try to observe all of the possible lifting tasks during your analysis. An alternative method is to look at the area where items are stored, find out how, where, and how often they will be used, and what means are available to transport the items (e.g. wheeled carts vs. carrying by hand).

Use the following guidelines during your analysis:
- Store heavy and frequently used items just below waist height (~29"). A cart with a platform at this height will allow items to be slid over and transported, rather than lifted and carried.
- Store lighter, but still frequently used items, between shoulder and knee height, and lightweight and rarely used items above shoulder height. Avoid storing items overhead. If you must store at this height, use a stable step stool or platform ladder instead of reaching.
- The heaviest items are more easily handled if they are stored on the floor and moved with a hand truck or lifted with the assistance of a co-worker.
- Avoid storing items behind other items, so that they do not have to be lifted up and over each other.
- Avoid making shelves too deep. Around 20" is a good depth unless larger objects are stored.
- Place labels on items listing their weight.
- Whenever possible, break down heavier loads into smaller parts before lifting, carrying or storing them. Have an open work surface available to place boxes on when breaking them down.
- To reduce carrying, store items close to where they will be used.
- Keep aisle ways clear.
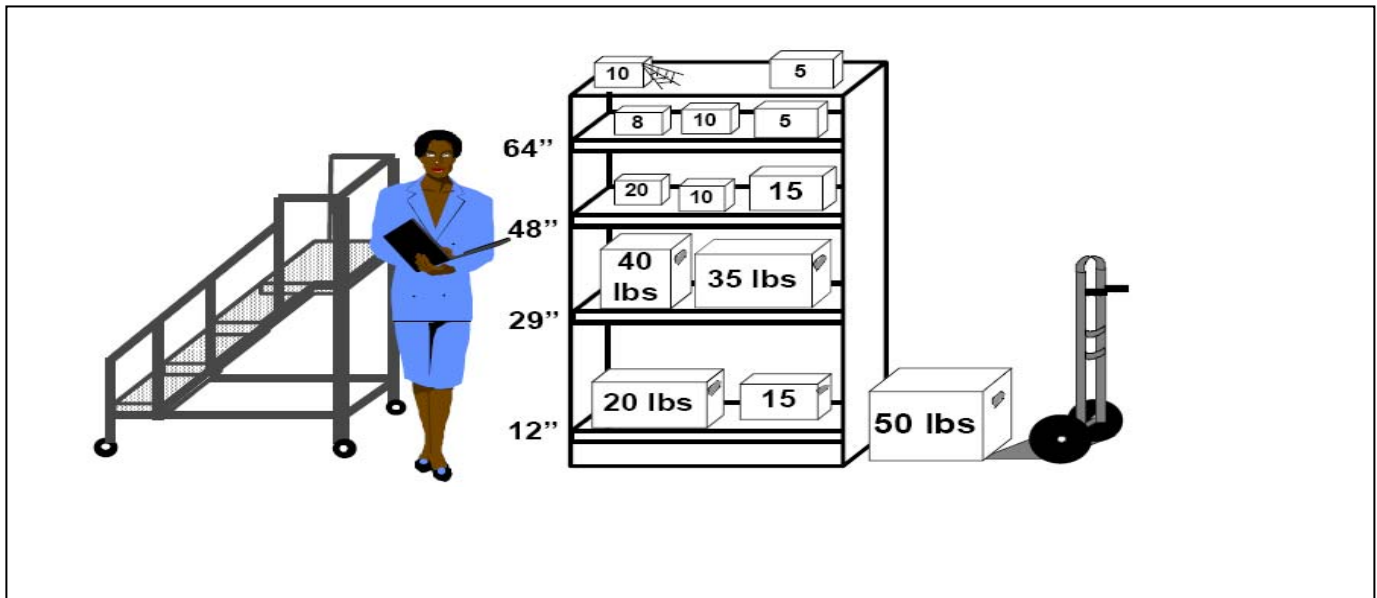
Boxes and containers

The design of boxes and storage containers can make a difference in how they are lifted and moved. Purchase or modify boxes so that they:

- are small in order to keep their weight down when fully loaded, and to allow employees to lift them close to their bodies.
- have handles that allow employees to grip them with their whole hand rather than their fingertips.
- have cut-outs in the sides so that contents can be accessed without having to reach up and over the side.

Cut-out in box for easier access
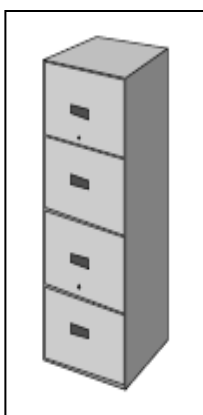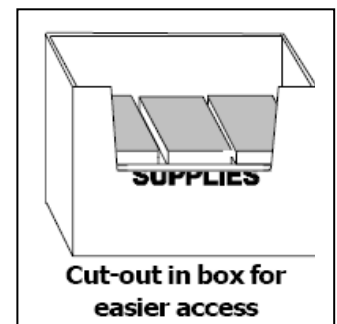
Working with files:
- Place frequently used files in middle drawers.
- Avoid overloading upper drawers to prevent tipping.
- Keep frequently used files in file stands or portable filing carts for easier access.
- Break large files down into smaller ones to make them easier to handle.
- Keep file drawers loosely filled, so that files will be easier to remove and replace.
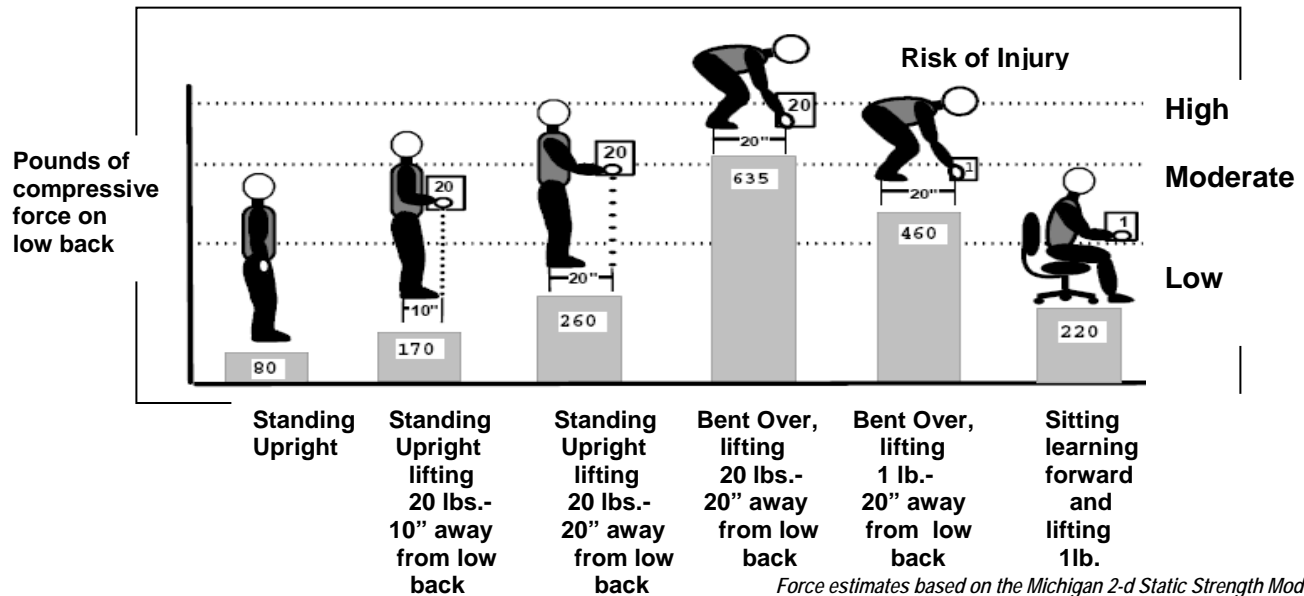
Safe lifting training

If you notice that employees tend to use poor posture when lifting, you will need to address this with training. See Ergonomics Tips, "Your Lifting Posture affects your Risk of Injury".

Ergonomics Tip

Your lifting posture affects your risk of injury

The weight of the objects you lift is an important factor in determining your risk of injury, and you will want to be especially careful when lifting heavy items such as storage boxes full of files and cases of copy paper. However, weight is not the only thing that determines your risk of injury. The figure below shows the effect that posture can have when combined with lifting different size loads:

| | Standing Upright | Standing Upright lifting 20 lbs.- 10" away from low back | Standing Upright lifting 20 lbs.- 20" away from low back | Bent Over, lifting 20 lbs.- 20" away from low back | Bent Over, lifting 1 lb.- 20" away from low back | Sitting leaning forward and lifting 1lb. |

Force estimates based on the Michigan 2-d Static Strength Model

Remember the following when lifting:

1. **Keep the load close:** Holding a 20 pound object with your hands 20 inches from the body creates more compressive force on your low back than holding it 10 inches away. This is because the muscles in your back have to work harder to counterbalance the weight when it is further from the body. ***As the compressive force on your low back increases, so does the risk of muscle strains, ligament sprains and damage to disks in the spine.***

2. **Avoid lifting from the floor:** Lifting from the floor can greatly increase your risk of injury for two reasons. Firstly, it is difficult to bring objects close to your body when picking them up from the floor, especially large objects where your knees can get in the way. Secondly, your low back must now support the weight of your upper body as you lean forward, in addition to supporting the weight of the item you are lifting. Lifting the same 20 pounds from the floor more than doubles the amount of force on your low back when compared with lifting it from waist height. Even a one pound object lifted from the floor increases your risk of injury if you use a bent over posture.

3. **Plan ahead**: Decide how you will lift, carry, and place the item before you pick it up. Test the weight of the load by moving or tipping it before you pick it up. Figure out if you can break the load down by placing the contents of a large container into a number of smaller ones before moving them.

4. **Get help when you need it:** Don't try to lift heavy or awkward loads on your own. Even though the muscles in your upper body may be strong enough to handle the load, the muscles, ligaments and disks in your low back may not be because of the additional forces they have to withstand. Get help from a co-worker, and whenever possible, use a cart, hand truck or other mechanical device to move the load for you.

Preventing visual discomfort

About half of all computer users experience symptoms of visual discomfort such as dry, tired eyes or difficulty focusing. In fact, visual discomfort, or eye strain, is much more common than WMSD's. Research to date has not found any permanent effects on vision from computer use. However, eye strain can result in reduced performance and increased errors, and workers will often adopt awkward postures in an attempt to avoid glare or other causes of visual discomfort.

<u>CASE STUDY:</u> <u>THE EFFECTS OF GLARE</u>

It is April and Kathy, the office manager for Swayword Enterprises, a P.R. firm of sixty employees, has noticed a greater number of staff coming to her with headaches, fatigue and sore necks. Curious, she notices that most of the people who have these symptoms are from the same general location in the building.

When she goes to the location it becomes clearer to her why she is seeing people from this area. She is at the south side of the building and there are many windows, but no drapes or blinds. All of the people who have cubicles against the windows, as well as many others who are at some distance from them, have considerable glare on their screens from the sun shining into the room. In all, twenty people are affected. Kathy notices that many of the affected employees have their computer monitor screens either facing the windows or with a window directly behind the screen, and both of these situations seem to be causing considerable problems with glare. In talking with these employees, she finds that they too have some discomfort. Also, they relate that the glare slows them down, because they have gotten into the habit of printing out their work to check for errors, since they find it easier to proofread from hard copy than from their computer displays.

She visits other floors on the south side of the building, and finds that the businesses there have installed blinds on their windows and their employees either have moved their monitors so that the screens are perpendicular to the windows, or have installed glare screens when this was not possible. Kathy decides to discuss this with the affected employees in her own company to see if it would be possible for them to reposition their own monitors to help reduce glare. In addition, she decides to contact the president of Swayword and gain her support to install either blinds or mylar film to cover the windows and reduce overall glare.

As a result of her analysis, she was able to provide the company president with the following information:

- One third of Swayword employees were affected.
- Absenteeism due to headaches and eyestrain was costly to this one area.
- The glare could be resulting in errors and affecting productivity.

The president gives Kathy the go ahead to make the changes she requested. At the same time, she contacts the building owners, and finds that window coverings were part of her lease agreement, and all she has to do is request them. Installation of blinds and a glare reducing film costs the business nothing, while repositioning of workstations involves only a small cost of hiring a facilities contractor to move the cubicles. Following the change, Kathy notices an immediate decline in employee symptoms.

Some of the causes of visual discomfort, such as lighting and glare, are dealt with later in the Environment section. Many of the other causes are subject to individual differences in vision, work habits, job tasks and workstation set-up. One of the simplest strategies that you can use to address problems affecting your employees' vision is to provide them with the information they need to decide what works best for them, and then respond to any remaining concerns they may have. See the two page handout in Ergonomics Tips for Employees for more information.

Ergonomics Tip

Avoiding eye strain at the computer

If you experience symptoms of visual discomfort, or eye strain, at the computer you are not alone; it is a common complaint among computer users. The following paragraphs will help you understand the causes of discomfort and what you can do about it:

> Symptoms of Eye Strain
> - Dry or Itchy Eyes
> - Tired Eyes
> - Sore Eyes
> - Blurred or Double Vision
> - Headaches

Lack of blinking

A common complaint among computer users, especially those who wear contacts, are dry or itchy eyes. This is mainly due to the fact that we tend to blink only one-fifth as much when looking at a computer monitor when compared with reading from paper. Combined with the low humidity levels found in many offices, this results in a drying and irritation of the eyes. If you experience dry eyes, try lowering your monitor so that you are looking slightly down (see the Monitor height section below) in order to promote blinking. Make sure that exhaust fans from equipment and from the building's ventilation system aren't blowing directly on you. If dryness and irritation persist, see your eye care specialist.

Close work

Your eyes are adapted for distance vision; they are most relaxed when you are "staring off into space". However, most of the work that you do in the office, whether it's reading from papers or the computer monitor, is done relatively close to your eyes, and this can cause eye strain. This is because small muscles within your eyes have to work to turn your eyes inward and change the shape of the lenses to focus for near vision. When these muscles fatigue you can experience symptoms of tired, sore eyes the same way that your back muscles will feel tired and sore if you sit for too long in the same position.

Visual angle

When you look down, your eyes have a natural tendency to turn inwards and focus for near vision, since objects that are lower in your field of vision tend to be closer to you. The opposite is true of looking straight ahead or upwards – your eyes tend to turn outwards and focus at a distance, and you will have to work harder to focus on close objects with your head in this position. This is why, when reading from a book or a newspaper, we tend to hold it below eye level. If you read from a monitor or document that is located at eye level or higher, it can contribute to eye strain.

Monitor location
While having your monitor too close or too high can increase your chances of having eye strain, having it too low or too far away can result in awkward postures as you lean forward to view it.

Monitor height
If you have normal vision, or wear a single lens prescription, set the height of your monitor so that the top of the screen is just below eye level, and then tilt the screen up slightly towards you. This will allow you to work with your head level, but with a downward visual angle. If you wear bifocals, trifocals or progressive lenses, locate your monitor so that you can view it with your head level when reading through the lenses that give you the best focus at that distance.

Monitor distance
The viewing distance at which our eyes relax varies from person to person, and so there is no one correct distance. For most people, a distance somewhere between 18" and 30" is comfortable. If you're sitting closer than 18", you may not have the proper vision correction that you need (see the Corrective Lenses section below). In general, the further away you can place the monitor the better; you may even be able to place it beyond the 30" distance as long as you can comfortably read the text without leaning forward.
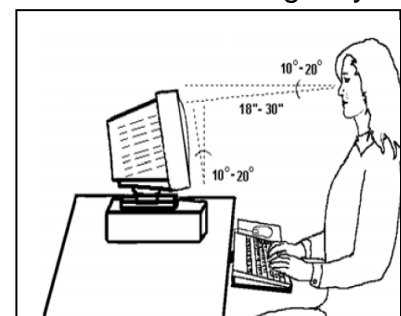
Large monitors
If you work with a monitor which is 17" or larger, you may need to have it a few inches farther away from you than you would a smaller monitor. This is because the size of the screen would otherwise require you to tilt your head either too far up or down in order to view the very top and bottom of the display. To avoid awkward postures such as these, increase the size of the text or image you work with in order to take full advantage of the larger screen, and move the monitor as far back as you safely can.

Document location
If your source documents are at different distances from you eyes compared to your monitor, then you will have to be continually refocusing your eyes as you look from one to another. Like your monitor, place your documents just below eye level and angle them up slightly towards you. Ideally, they should be the same distance from your eyes as the monitor so that you don't have to refocus; if the text on the document is small, you will need to bring it closer. You may also have one eye that is dominant over the other. Try placing documents on either side of the monitor until you find a location that is comfortable for you.

Corrective lenses
If you still have problems with eye strain after trying the fixes described above, you may be one of the many people who require vision correction such as eyeglasses or contacts for close

PROPER MONITOR HEIGHT AND DISTANCE TO PREVENT EYE STRAIN Ace the monitor at least 18" from your eyes, but close enough so that you can easily read the text without squinting or leaning forward. Adjust the height of the monitor so that the top of the screen is about 10 to 20 degrees below your horizontal line of sight, and tilt it up about 10 to 20 degrees so that the screen remains perpendicular to your gaze. If you wear bifocals, trifocals or progressive lenses you may have to locate the monitor even lower to keep your head level.

work. Even if you already wear corrective lenses, the prescription may not be appropriate for computer work, especially if it is outdated. In addition, if you wear bifocal or trifocals lenses, you may experience neck discomfort if you tilt your head up or down in an awkward posture when viewing the monitor or documents. This can happen if the reading lens isn't in a good location for the type of work you do. If this is the case, raise or lower your monitor until you can work with your head in a level position.

If any of the above are true, you should visit your eye care specialist to see about a new prescription. Once you have your workstation set up properly and your monitor located according to the directions above, you should write down the distance to the monitor and any other reading that you do, as well as a general description of your daily tasks, and bring this information with you when you see your eye care specialist.

Environmental Analysis

The environment surrounding an employee's workstation can be just as important as the workstation itself in determining their comfort and performance. The ideal office environment is well lit, without being overly bright or harsh, has a comfortable temperature and humidity level, is quiet enough to allow concentration, and is not overcrowded or hectic.

Below are some general guidelines to consider when analyzing the environment in your office. For more assistance in developing solutions, refer to the Analysis and Implementation Guide.

Lighting

Office lighting can have a considerable effect on both comfort and performance. Harsh, excessively bright fluorescent lighting can cause eye strain, especially when it creates glare on computer monitors. Too little lighting can also result in eye strain when working with paper documents, as well as a "gloomy" atmosphere in which to work. Windows can cause lighting and glare problems as well, although most employees prefer to have natural light and a view, given the choice. Direct sunlight can create light levels many times brighter than what is needed for office work, however.

Benefits of improved lighting
• Reduced glare
• Increased productivity
• Improved work quality
• Energy savings

Appropriate light levels

Light levels for computer use should be lower than those for reading from paper documents. The difference is due to the fact that computer monitors give off their own light, while paper depends on reflected light to be legible. In order to prevent eye strain at the computer, it is important that the surrounding, or ambient, light levels are similar to the amount of light emitted by the monitor screen. A window or other bright light source in the field of vision behind or to the side of the monitor can be just as annoying as glare reflecting off of the monitor itself.

Testing light levels

While you could measure light levels in your office using a photographer's light meter, a simpler method is to survey employees in the area as to whether the lighting is too bright, too dim, or just right. A quick test to see if overhead lights are too bright is to shade your eyes by placing

your hand above them, as if searching for something at a distance. If you can feel your eyes relax, then the lighting is too bright or too harsh.

Optimizing light levels

There are considerable differences in individual preferences for light levels. These differences can make consensus difficult when trying to set a single light level. Lighting to a uniformly low level and then providing task lighting to employees who need more light can help to resolve this issue.
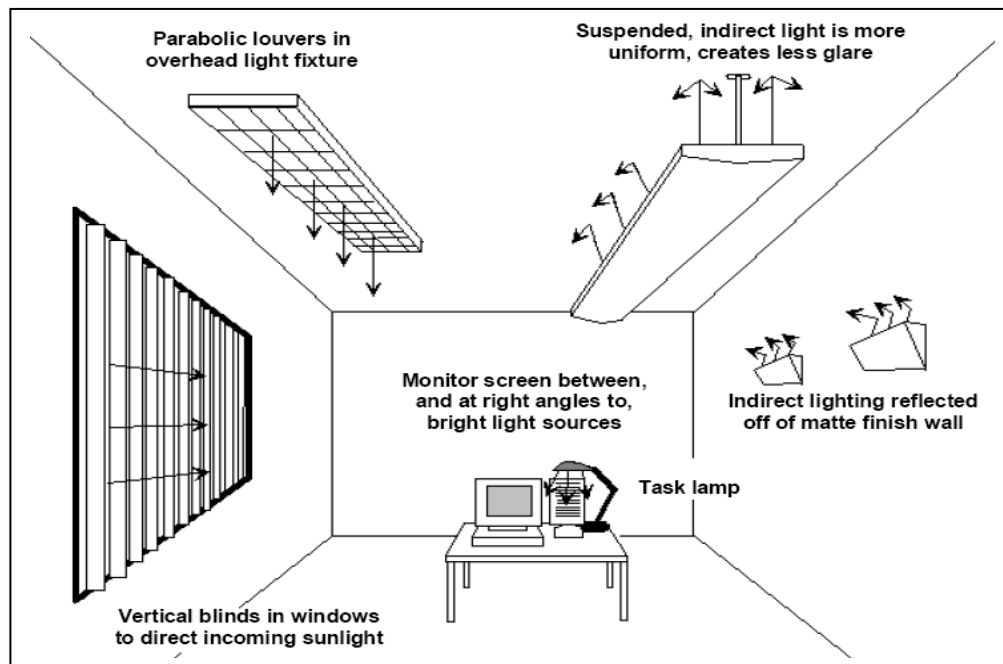

Preventing glare

Light can shine directly into the eye, such as sunlight through a window, or be reflected off surfaces such as the monitor screen or the desk top. The glare that direct or reflected light causes can result in eye strain and poor performance. Our eyes are especially sensitive to glare from light sources in our peripheral vision. For this reason, it is important to evaluate all light sources from the worker's perspective. Glare is best prevented at the source, and so many of the steps which reduce light levels will also help to reduce glare.

Lighting common use areas

The need to control the amount of available light is not limited to an individual workstation. Common use areas, such as copy rooms and areas where there are file cabinets, may require more available light. In general, any time when someone has to read small print, visually inspect something, or search for something, higher light levels are appropriate.
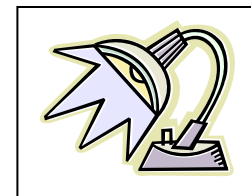
Temperature and humidity

As with lighting, the temperature and humidity levels in the office affect not only comfort, but also productivity.

Most office work is done while seated, and the low level of physical activity means that employees will typically prefer a slightly higher temperature than if they were active. However, offices can get too warm when the number of people and amount of heat producing equipment overwhelms the ventilation system. Problems can also be caused by installing cubicle or hard-wall offices where they cut off the normal flow of air through the building. Uncomfortably high temperatures can cause fatigue, which can then lead to awkward postures such as slouching or slumping in the chair.

Problems with low temperatures are typically localized, such as when an individual employee's office has been placed directly under a cooling vent. The cool air blowing directly down can cause cold feet and hands, as well as increased muscle tension and increased risk for tendonitis.

Humidity levels are also important to comfort and health. Too low a level of humidity results in dry skin, especially when handling paper, and can increase the amount of force used as sensation through the fingertips is reduced. Too much humidity can lead to a "stuffy" feeling and can make the temperature seem higher than it actually is. It can also have an effect on actual or perceived indoor air quality.

Noise

Noise in the office almost never reaches a level where it is harmful to our it can be a distraction that is detrimental to performance and productivity. Studies have shown that noise is most disruptive when workers are performing tasks that are mentally demanding, require attention to detail, or rely on spoken communication. Conversation can be especially distracting, since it is harder to filter out than random noise.

While you can have a consultant come in to take measurements with a sound level meter, a simpler method is to use your own judgment regarding noise levels. Also, ask employees if they have any concerns about noise, or if it interferes with communication or creates a distraction.

There are a few simple steps that you can take when a noise problem arises:

- Reduce or eliminate noise at the source whenever possible.
- Maintain equipment to prevent noisy malfunctions.
- Isolate or enclose equipment that generates noise even when it's in good repair.
- Have conference rooms available for meetings and conversations.

Organizational Analysis

Introduction

Organizational analysis includes both business-wide and department-wide issues that are beyond the control of a single employee. The analysis looks at job design factors such as scheduling, overtime, shift work, rotation, staffing levels, incentive work, machine-paced jobs, and break schedules.

Job design

How your employees' jobs are designed can influence the risk factors associated with work-related musculo-skeletal disorders (WMSD's). Good job design is especially important in reducing duration of exposure to risk factors and reducing the overall repetitiveness of a job.

When analyzing how your business's or department's work is performed, you should look at any factors that influence how frequently your employees are performing repetitive tasks and for what duration. Machine-paced jobs or incentive work both have the potential for increasing repetitions and the risk of WMSD's. If the work pace is out of the control of your employees, pauses to rest over-stressed muscle groups may not be possible. While the pace of incentive work is under your employees' control, their desire for financial gain may cause them to work through pain, to skip breaks, and to work faster, all of which create more repetitions. This may result in a greater number of WMSD's and/or more serious WMSD's.

> **JOB DESIGN FACTORS ASSOCIATED WITH AN INCREASE IN WMSD SYMPTOMS:**
> - Overtime
> - Incentive pay
> - Lack of control over work pace
> - Deadlines
> - Electronic monitoring
> - Close supervision
> - Conflicting responsibilities
> - Boring, mundane work
> - No authority to make decisions
> - Social isolation
> - Lack of support from supervisor

While it seems obvious that factors such as overtime and deadlines can result in an increase in WMSD's through a longer duration of exposure to risk factors or a tendency to work through breaks, it is less obvious why factors such as social isolation and a lack of participation in decision making are associated with higher injury incidence. These job and organizational design factors, sometimes referred to as psychosocial factors, may increase risk for injury by increasing stress levels. High workplace stress can cause physiological changes to body systems that lead to musculoskeletal changes such as increased muscle tension. A relaxed working atmosphere, on the other hand, may increase productivity and reduce the risk of WMSD's.

> **THE BODY'S RESPONSE TO STRESS:**
> - INCREASED MUSCLE TENSION
> - INCREASED BLOOD PRESSURE
> - INCREASED HEART RATE
> - EYE STRAIN DUE TO CHANGES IN VISION
> - REDUCED RESISTANCE TO ILLNESS

Improving the design of office jobs

Employee participation, which has been mentioned repeatedly in this booklet, is especially important when it comes to job design. Allowing employees to provide input into the structure and content of their own jobs is one of your best opportunities to have a positive effect on injury prevention and productivity, without the capital expense of buying new furniture or equipment. Your employees may have a number of ideas on ways that they can share tasks, rotate between jobs, increase variety and improve efficiency.

Job rotation

Periodic (every 2 hrs.) job rotation to tasks with lower repetition, or to tasks where different muscle groups are used, may not only provide your employees with variety and increased job satisfaction but also may decrease their risk of WMSD's. For example, rotating someone from a data entry task, which involves repetitive keyboard use, to an information retrieval task, which allows more time for thinking and interacting with co-workers, gives them a chance to recover from repetitive finger movements. Avoid rotating employees from a task which seems different on the surface, but which actually contains similar motions. For example, you wouldn't want to rotate an employee from typing at a keyboard to sorting, folding, and mailing letters, as each

task involves repetitive finger movements. A well designed rotation scheme can be especially helpful in reducing the risk of injury when your employees are working overtime at repetitive tasks.

Staffing and scheduling

In some cases adding temporary staff rather than requiring employees to work overtime at a repetitive task may have long-term financial advantages due to reduced injury costs. Likewise, if you adjust your scheduling to spread out highly repetitive tasks over a longer time, rather than letting a job wait until it requires lengthy repetitive work, you may lessen the risk of WMSD's.

Rest breaks

Breaks at mid-morning, lunch and mid-afternoon have long been a part of work schedules and are an important part of allowing employees time to recover from the demands, both mental and physical, of their jobs. You should encourage your employees to take these breaks away from their computers and use the opportunity to walk around and give their hands and eyes a rest.

Recovery pauses

Recent studies have shown that shorter (one to three minutes), more frequent (every 30-60 minutes) breaks, when given in addition to the usual breaks, may help to reduce discomfort while improving productivity. These short breaks, called micro-breaks or recovery pauses, work best if taken before discomfort and fatigue set in. Recovery times will be faster and employees will be less tired at the end of the day. It is important that you recommend more frequent breaks to your employees rather than trying to enforce a set schedule, however. Experience has shown that employees will rush to get work done before a scheduled break, and this actually increases their level of stress. Instead, it is best to design these breaks so that they occur naturally in the job, educate your employees on the importance of recovery time and then allow them the latitude to take breaks as they see fit.

Stretch and exercise breaks

Computer work, and seated work in general, can cause a number of problems because of the lack of whole body movement combined with awkward postures motions of the joints in the upper body. Blood flow to the extremities is reduced, while muscles become either stretched out and weakened or shortened and tight. Stretch and exercise programs can be useful in increasing movement and circulation while addressing muscle imbalances that can occur, but it is important that they be well designed.

Problems that have been found with some exercise programs include: exercises that involve the same motions as computer work, and therefore add to the repetitive strain; exercises that could aggravate a pre-existing injury; exercises that are unsafe, such as seated exercises that could cause the chair to tip over; and exercises that place employees in embarrassing positions or are not practical while professionally dressed. There are a number of commercially available stretch and exercise programs designed for office workers; evaluate each one carefully before deciding if any are appropriate for your employees.

Also, it is best to allow your employees to decide if they want to participate in an exercise program or not, especially if they have pre-existing injuries which are best managed through exercises prescribed by a health care professional. Finally, keep in mind that an exercise program alone won't alleviate all of the problems that hours of awkward postures and repetition can cause; it should be just one component of your overall program.

Emerging Technology in the Office

Computer technology is developing rapidly, and you can expect to see many changes in the way in which we interact with computers in the next few years. Often, it is necessary to wait a few years for the technology to reach a level where it fulfills its promise of making our lives easier and also becomes affordable to small businesses. One example of technology that is now at this level is the use of page scanners and optical character recognition (OCR) to convert typewritten papers to electronic documents. Improvements in scanner resolutions and OCR software have now made this process very accurate and much more efficient than retyping the pages by hand. The following are descriptions of other emerging technologies that have the potential of becoming usable and affordable in the next five to ten years:

Alternative forms of input

Keyboards, mice, trackballs and other commonly available input devices all require repetitive motions of the hands and fingers and, regardless of how "ergonomic" their design is, are therefore a potential source of WMSD's. One alternative form of input that requires almost no hand motion is the use of speech recognition, where the user simply dictates directly to the computer. At the time that this is being written, the technology is not quite ready for general use, since it has many drawbacks, including: the amount of training time required, the fact that it is typically slower than touch typing, concerns about strain on the vocal cords, and the increase in office noise levels that would occur if everyone talked to their computer. However, for specific functions, such as filling out forms with a limited number of options, legal and medical dictation, or for use by workers who have limited use of their hands, it has been somewhat successful. Simpler programs are available which replace the mouse functions with voice commands, and these have fewer drawbacks. In addition to voice input, work is currently being done on technology that would allow your computer to recognize hand gestures, facial expressions, or even track eye movements. These alternatives are currently being used for special application or as assistive technology for the disabled, but they could also be used individually or in combination to allow us to interact more naturally with our computers.

Display technology

Computer monitors have been getting larger, and while this allows for larger font sizes and graphics to be displayed, it also requires more desktop space. This makes it difficult to place the monitors directly in front of the users and at the correct visual distance; often this results in awkward postures and eye strain. New forms of display technology have resulted in flat panel displays, which have the potential to overcome these drawbacks. Currently, models are available which offer a 21" display that is only 3" thick, with resolution comparable to an SVGA monitor, and which claim to be viewable from a very wide angle. While still out of reach of most

small businesses, prices should come down and performance improve as more manufacturers develop these products.

Software packages and data exchange
Many applications these days are designed to work with other applications and allow information exchange. For example, data can be brought directly from a database into a spreadsheet program, and vice versa, without the need to re-enter the numbers. Software has the potential to greatly reduce repetition if well designed.
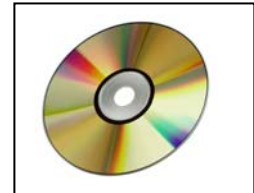
Networking and the Internet
As computer processing power becomes less expensive, it will become easier for small businesses to run their computers through a common server, allowing employees to share data with each other or download information from the Internet. A lot of redundant data entry can be eliminated in this way; in addition, networks open up another line of communication that can help reduce the negative effects of social isolation.

Technical Information

Worksite issues
If you have the resources to take the following measurements they can be useful in ensuring that your workplace meets commonly accepted guidelines:

1. Lighting Levels
   Computer use only   300-500 lux (28-50 foot-candles)
   Computers and paper documents   500-750 lux (with supplemental task lighting)
   Paper only   750-1,000 lux (100 foot-candles)
   (including document storage areas)
   From the Illuminating Engineering Society of North America (IESNA).

2. Temperature
   Summer months   73-79 degrees
   Winter months   68-75 degrees
   From the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

3. Humidity Levels   30-60% relative humidity
   From the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

4. Noise Levels
   Open Office Plan (e.g.-cubicles)   35-40 dBA average, 60 dBA maximum
   Private Offices   30-35 dBA average, 55 dBA maximum
   The Canadian Standards Association (CSA).

5. Storage
   Shelf Depth   20" (can be deeper to safely hold larger items)
   Shelf height for heaviest items   29" measured from floor
   Lowest shelf for frequently used items 22" measured from floor

Highest shelf for frequently used items   48" measured from floor
Height for labels which must be read   22-52" measured from floor?????
Based on measurements of height and reach capabilities (anthropometry) of adults workers.

6. Workstation Layout   Measured From Edge of Worksurface
     Forward reach for frequent work   not more than 16"
     Forward reach for occasional work   not more than 24"
     Overhead reach to access storage   not more than 48" high measured from floor
     (occasional)   and not more than 12" forward
Based on measurements of height and reach capabilities (anthropometry) of adults workers.

Computer issues

Many companies have their information or computer services people involved in their office ergonomics programs, since they are typically the ones responsible for initial computer set up and are also the first ones to become aware of problems related to computer use. In addition to the general information regarding computer and workstation set up contained in this booklet, they may also want to use this checklist containing more technical information:

Monitor display

Does the display driver installed offer the best resolution with the type of monitor (e.g. VGA, SVGA) used?

Has the refresh rate been optimized using the graphics driver software settings? (Refresh rate should at a minimum be 60 Hz and is best at 75 Hz.)

Are the brightness and contrast set to avoid screen flicker?

Are color combinations used in displays chosen to maximize contrast and prevent eye strain?

(Black text or graphics on a white background provides the best contrast. Avoid using reds whenever possible, especially on the same screen with blues. Dark green on a white background and light green on a black background are also acceptable combinations.)
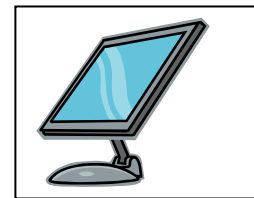
Software

Have the appropriate drivers been installed for the pointing devices used?

(Many of the newer pointing devices come with software which allows custom programming of one or more buttons to allow a single click to substitute for double-click or click-and-drag operations, thereby reducing repetitive finger movements.)
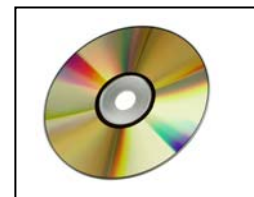
Have fully functioning on-line help utilities been installed with all of the programs?

Are end users fully trained on the most efficient way to use the software?

Is it possible to create macros for commonly used functions in order to replace repetitive keystrokes?

Could custom software be created to allow data exchange between existing applications that would eliminate redundant data entry?

Network/Intranet

Are computers interconnected to allow file sharing to eliminate the need to retype existing documents?

Can the intranet be used as a way of keeping employees aware of ergonomics issues, allowing communication of ideas and tips for reducing repetitive work, and passing on useful macros (e.g. - bulletin board, ergonomics "tip of the day", etc.)?

New technology
Can scanning and optical character recognition (OCR) be used to replace data entry from hard copy?

Could voice recognition be used for navigation between and within programs to reduce the use of pointing devices, or as a means of input to reduce keyboard use?

For more discussion of issues related to new technology, see the section entitled "Emerging Technology in the Office."

Appendix: Analysis and Implementation Guide

The following guide is included to help you perform a worksite analysis and provide you with some recommended solutions. The Worksite Analysis Form can be used to organize your findings from the analysis; a completed form is included as an example.

The guide is organized in the form of a checklist, with a "No" response indicating a possible problem. A brief explanation of the associated risk factors and the physical discomfort that could result are provided for each question.

Also provided is a list of possible solutions for each problem; these are listed in order from the simplest and least costly to the more complex and expensive to implement. When selecting the appropriate solution, you should consider not only the cost, but also the potential benefit of each option. Depending on the situation, a less expensive solution may not be as effective in preventing injury or may only provide a temporary fix that will need to be corrected again later. However, in some cases an inexpensive solution can be just as effective, and can also free up resources for other needs.

Do not feel limited to the solutions listed in this guide. You may have situations unique to your business which are not covered here, or you may be able to improve upon the recommendations given. Often, discussing the options with affected employees, your safety committee or your ergonomics team can help you brainstorm solutions to more complex problems that are not covered here.