ALGONQUIN COLLEGE | Risk Management

Office Ergonomics Program

OCCUPATIONAL HEALTH & SAFETY

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Glossary

Adaptation: The process by which an individual is able to tolerate small departures from the optimal design of objects and environments with which the person interacts. An example of adaptation is the process by which the eye adjusts to the brightness or dimness of a room. Another example is the tolerance of a chair that may be a little too high or a little too low, but is still considered acceptably comfortable.

Administrative Controls: Procedural control measures that when implemented will eliminate or reduce the severity of the musculoskeletal disorder (e.g., adjustment of work pace, use of rest periods and assignment to a different work station).

Accommodation: A process of altering the methods of work and the working environment to enable a person, despite functional limitations, to fulfill the productive objectives of the job being performed. (Ontario Human Rights Code).

Anthropometry: The study and measurement of the dimensions of the body and other physical characteristics.

Anthropometric Dimensions: The dimensions of the human body, of which there are two main types: 1) static anthropometrics, the skeletal dimensions of the body; and 2) dynamic anthropometrics, the distances measured when the body is in motion or engaged in a physical activity.

Awkward posture: Any position of the body while performing work activities that is associated with an increased risk for injury. (See **Musculoskeletal Disorders**)

Biomechanics: The study of the body's physical response to static or dynamic motion, and the effects of internal and external forces that affect that response.

Carpal Tunnel Syndrome: A chronic disorder of the hand and wrist, due to a compression of a nerve; usually caused by repetitive work that puts stress on the wrist joint and heel of the hand. Symptoms can include tingling and numbness in the hand, as well as a loss of dexterity and strength in the hand.

Control: A physical device that allows for a human operator to interact with a machine or perform a task. An example of a control is a keyboard, with which an operator can use to manipulate the functions of a computer. Another example of a control is a light switch.

Control/Display Compatibility: The degree to which relationships between controls and displays are consistent with user expectations For example, a person may have expectations concerning the movement of a control and its expected effect on a display based on a previously formed stereotype of that movement.

Deviation: Movement of a body part towards the extreme in its range of motion; usually associated with risk of injury.

Engineering Controls: Mechanical measures such as the physical modification of the work station by providing adjustable chairs, tables and/or tools.

Ergonomics: The study of the relationship between workers and their environment, in particular their relationship with the equipment and tools used to perform their tasks.

As it relates to computer workstation: The study of the design and arrangement of equipment so that people will interact with the equipment in healthy, comfortable, and efficient manner. As related to computer equipment, ergonomics is concerned with such factors as the physical design of the keyboard, screens, and related hardware, and the manner in which people interact with these hardware devices. (Courtesy of Dictionary.com)

External stress: Stress on the human system caused by an aspect outside of the body, such as the task itself, the physical environment, work-rest schedules and social relationships.

Fatigue: A loss of work capacity that results when the body depletes its energy stores and is unable to maintain a steady level of performance.

Focused attention: Attending to one information source, while disregarding other sources of information.

Frequency of use principle: The notion that the arrangement of equipment, displays, and controls should be laid out in such a way that the most frequently used components are in the most accessible positions.

Glare: Extraneous light from any source can affect visual performance. Glare may reduce contrast and cause a decrease in visual acuity.

Grip span: The distance a hand must span in order to grip an object.

Human factors: Considering design and engineering in order to better match the capabilities, limitations, and needs of people.

Local fatigue: Fatigue of one part of the body, such as the wrist, resulting from stress to that area.

Lumbar: The lower end of the spine, often known as the “small of the back”, is known as the lumbar spine. It is an area that may be strained or tired when an individual is seated for extended periods. Office chairs, backrests, or back pillows may be designed to provide lumbar support.

Musculoskeletal Disorder (MSD): Any physical disorder that results from or is aggravated by the cumulative effect of biomechanical stress to tendons, tendon sheaths, synovial lubrication of the tendon sheaths and related bone, muscles, the nerves of the hands, wrist, elbows, shoulders, neck and back. Some examples include carpel tunnel syndrome, pinched nerves, or sciatica.

Neutral posture: A posture aligning the body, minimizing physical stress, maximizing comfort, and reducing risk of musculoskeletal disorders.

Occupational Injury: An occupational injury can be any injury resulting from a work-related event. Some examples that may be related to ergonomic concerns are:

- Carpal tunnel syndrome (CTS)
- Sciatica
- Tendonitis
- Low back pain

Performance specification: Describes the ideal function of a system or tool. Indicates the functions necessary for the item to successfully meet objectives.

Radial deviation: A wrist posture characterized by an inward bend of the wrist.

Risk Factors: Factors contributing to an increased risk of problems. Some conditions of a work environment or system may increase physical stress, including awkward postures, repetitive strains, or poor lighting.

Sit-stand working surface: A work surface that allows a worker to adjust the height so that they may perform work seated or standing in order to vary posture and relieve stress and discomfort on various muscular groups.

Static load: When a body remains immobile for long period of time, physical stress may increase. The static load is the amount of stress occurring without movement.

Tendonitis: Inflammation of the tendons, which connect muscles to bones in some parts of the body, may result in a condition known as tendonitis.

Usability: Ease of use, or usability is an important criteria when evaluating tools or controls from an ergonomic perspective. Many factors, including the location, size, shape, and adjustability may affect usability.

User interface: The user interface is the element of the control or system where the human and machine interact. It may be a visual display terminal, a control panel, or another mechanism. The human inputs information and the machine provides feedback. A transfer of information occurs through the user interface.

VDT: A computer monitor may also be called a Video Display Terminal.
Workplace Ergonomics Program: A program that may be instituted by a corporation or organization as a service to employees. Professional ergonomic evaluations may be used to evaluate, prevent and manage work-related musculoskeletal disorders. The main elements of an ergonomics program often include workstation analysis, training, and education.

Work Practice Controls: Modifications in the manner an employee performs the physical work activities of a job that decrease or control exposure to MSD hazards.

Workstation: The area where a worker completes tasks or jobs. May be an office, a desk, or other workspace. More than one type of work may happen at a single workstation.

Wrist flexion: A posture where the hand and the wrist are curved downward. Wrist flexion creates friction and tendon stress, leading to fatigue and injury.

1.0 What is Ergonomics?

The word ergonomics is comprised from two Greek words; "*ergos*" (work) and "*nomos*" (laws); therefore, we have the laws of work. Ergonomics can be defined as the science of matching work or tasks to the body.

Ergonomics can be further defined as the design of the workplace, equipment, machine, tool, product, environment and system taking into consideration a human's physical, physiological, biomechanical and psychological capabilities.

1.1 The benefits of Ergonomics

- Increased productivity
- Improved health and safety
- Increased job satisfaction
- Increased work quality
- Increase in overall employee morale
- Decreased discomfort, injuries, illnesses, and workers' compensation costs
- Decreased absenteeism and turnover
- Less likelihood of WSIB or MOL fines

2.0 Reporting Procedure and Assessment Process

2.1 Experiencing Discomfort - Workstation

Any college employee experiencing regular or increasing discomfort while performing their work tasks should notify their manager immediately. The worker will be asked to complete the Office Ergonomic Self-Assessment Tool (for workstations). This assessment tool identifies key areas of computer workstations that are routinely maladjusted of a poor design, causing workers pain and discomfort, which can lead to an MSD injury.

Once complete, the worker will then review the self-assessment tool with their manager and apply the general recommendations provided. If the recommendations do not provide relief, the worker should notify their manager, and Occupational Health and Safety should be contacted.

Occupational Health and Safety will conduct an inspection of the workstation and ensure that the recommendations outlined in the Self-Assessment Tool have been applied correctly, and make further suggestions. Occupational Health and Safety will provide the worker and his/ her manager with a detailed report outlining additional suggestions to improve the work conditions including: obtaining different equipment, modifying the workstation set-up, and training, improving posture and taking regular breaks. Should these recommendations still not improve the workers' discomfort, an external ergonomic assessment performed by an ergonomist will be requested, with the approval of the worker's manager.

2.2 Experiencing Discomfort - Other Tasks/Equipment

If a worker experiences discomfort as a result of a task other than from working at a computer workstation, they should immediately report it to their manager. The worker should contact Occupational Health and Safety to discuss next steps. An internal assessment of the task or equipment can be conducted to identify the risk factors, depending on the circumstances, and preliminary recommendations can be made. Alternatively, an external ergonomic assessment may be conducted by an ergonomist, with the approval of the worker's manager.

2.3 Known or Suspected Injury

Any college employee who knows of or suspects they have a musculoskeletal disorder should have it diagnosed by a health care professional or their personal physician at the first sign of discomfort. Employees must also alert their manager of the injury immediately. The employee and the manager will fill out an Online Quick Report Form and submit to Occupational Health and Safety.

2.4 Internal Ergonomic Evaluations and Ergonomics Assessments

An internal ergonomic evaluation assesses the worker, the tools used for the job or task, and whether the tools and processes are suited for the work in order to improve processes and remove risk factors that least to MSD injuries, and allow for improved performance and productivity, while minimizing the risk of injury. This process identifies problem jobs or job tasks and risk factors associated with them. This essential preliminary step helps to determine what portion(s) of the workstation is the source of the greatest problems. All employees who wish to have an internal ergonomic evaluation or ergonomic assessment should discuss their concerns with their manager.

Step 1

Workers who are experiencing pain or discomfort should first complete the Ergonomic Self-Assessment Tool. This document will walk worker through the proper steps to take to optimally set-up or adjust their work stations in order to eliminate the potential for an injury. This form should be reviewed with the employee's manager, particularly if any of the recommendations suggested require modification to the existing workstation or purchases. Follow-up should be done between the worker and the manager after 2 weeks of the self-assessment or after any modifications or adjustments have been made.

It is recommended that step 1 be applied for workers who change workstations, receive new workstations/ equipment, or return after a significant absence.

Step 2

If the recommendations have not eliminated the discomfort, the worker should consult with their manager and have them request an internal assessment from the Occupational Health and Safety Department. This assessment can be requested by contacting the Occupational Health and Safety Officer at extension 2560.

Step 3

If additional expertise are required to further assessment ongoing issues, an external ergonomic assessment can be requested. An ergonomics assessment can be initiated the following methods:

- By HR in order to provide accommodation of an injury;
- By a physician;
- By the Manager.

2.5 Risk Factors

The following is a list of risk factors that are major contributors to workplace ergonomic-related injuries:

2.5.1 Repetition

- Occurs when the same or similar movements are performed frequently.
- Repetition can also occur when different tasks are performed if those tasks have the same movements.
- Injury may result from repetition when the tissues do not have adequate time to recover.

2.5.2 Force

- Force is the amount of physical effort required by a person to do a task or maintain control of tools or equipment.
- A pinch grip produces 3-5 times more force on the tendons in the wrist than a grip with the whole hand.
- With excessive force the muscles are contracting much harder than normal, this can lead to stress on the muscles, tendons and joints.

2.5.3 Duration

- Continuous tasks for long periods of time will contribute to muscle fatigue.
- This fatigue can lead to discomfort and even injury.

2.5.4 Recovery time

- It is important to have adequate recovery time, to avoid fatigue and injury.
- Employees are encouraged to alternate tasks or take micro breaks when they feel to onset of pain and fatigue.

2.5.5 Awkward Posture

- Is a deviation from the “neutral” body position

- A “neutral” body position is safest and most efficient position in which to work.
- Awkward posture puts stress on muscles, tendons and joints.

2.5.6 Static Posture

- Static posture occurs when one position is held for a prolonged period of time.
- During a static posture the muscles will become fatigued from a lack of blood, oxygen, and nutrient, flow. This will cause lactic acid to build up.
- This fatigue can lead to discomfort and even injury.

2.5.7 Contact Stress

- Contact stress is caused by any sharp or hard object putting localized pressure on a part of the body.
- Contact stress will irritate local tissues and interfere with circulation and nerve function.

2.5.8 Environmental

- Environmental conditions such as extreme heat or cold can place stress on tissues.
- Extreme cold constricts blood vessels and reduces sensitivity and coordination of body parts.
- Excessive heat can result in increased fatigue and heat stress.

2.5.9 Vibration

- Exposure to vibration can occur while using power tools or while driving equipment.
- Vibration from power tools can place stress on the tissues of the fingers, hand and arms.
- Whole body vibration from driving puts stress on the spinal tissues.

2.5.10 Psycho Social

- Stress, boredom, job dissatisfaction and anxiety can contribute to the possibility of developing a MSD.
- Psycho-social issues can create increased muscle tension and reduce a person’s awareness of work technique.

2.5.11 Increased computer use

- Due to an increase in technology, we can now accomplish most of our tasks via the computer.

2.5.12 Aging workforce

- Now that the Ontario government has passed the bill to abolish mandatory retirement and the flack of succession planning we will continue to an increase with an aging workforce.

2.5.13 Leaner workforces

- With globalization and the increasing competitiveness between countries to attract industries, management is constantly focused on doing more with less.
- When you combine leaner workforces with aging workforces, companies are initiating more and higher WSIB costs.

2.5.14 More high-tech industry

- High-tech industry has grown to exponential levels and although the industry has taken a dramatic hit, it continues to rebound back and flourish.
- With more high-tech jobs, comes the increase use of computers

2.5.15 Non-work related issues

- Diabetes, increase in weight, Rheumatoid Arthritis, Crone's Disease, Thyroid Disease, or had a prior joint injury, hobbies and sports are all potential contributing factors to workplace ergonomic-related injuries.

2.6 Workplace Ergonomic Related Injuries

A workplace ergonomic-related injury is any physical disorder that results from or is aggravated by the cumulative effect of biomechanical stress to tendons, tendon sheaths, synovial lubrication of the tendon sheaths and related bone, muscles, the nerves of the hands, wrist, elbows, shoulders, neck and back. Workplace ergonomic-related injuries are also known as musculoskeletal disorders (MSDs), Repetitive Strain Injury (RSI), Cumulative Trauma Disorder (CTD) and Repetitive Motion Injury (RMI).

MSD injuries contribute to almost half of all lost-time injuries, causing serious pain and suffering for workers. MSDs and ergonomic injuries have lengthy recovery periods and often reoccur, are more easily re-aggravated, particularly if precautions to prevent injuries are not taken.

Work-related MSDs include 3 types: muscle injury, tendon injury and nerve injury.

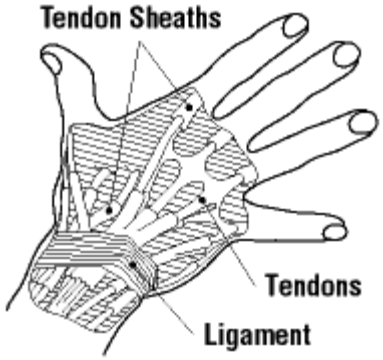
2.6.1 Muscle Injury

When muscles contract, they use chemical energy from sugars and produce by-products such as lactic acid which are removed by the blood. A muscle contraction that lasts a long time reduces the blood flow. Consequently, the substances produced by the muscles are not removed fast enough, and they accumulate in the muscles. The accumulation of these substances irritates muscles and causes pain. The severity of the pain depends on the duration of the muscle contractions and the amount of time between activities for the muscles to get rid of those irritating substances.

2.6.2 Tendon Injury

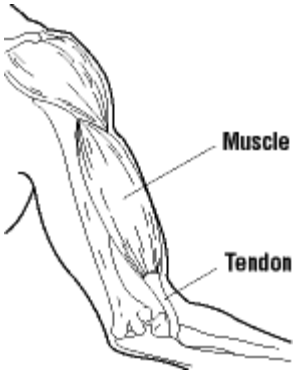
Tendons consist of numerous bundles of fibers that attach muscles to bones. Tendon disorders related to repetitive or frequent work activities and awkward postures occur in two major categories --tendons with sheaths (Fig. 1), found mainly in the hand and wrist; and tendons without sheaths (Fig. 2), generally found around the shoulder, elbow, and forearm.

The tendons of the hand are encased in sheaths through which the tendon slides.



Finger tendons and their sheaths

The inner walls of the sheaths contain cells that produce a slippery fluid to lubricate the tendon. With repetitive or excessive movement of the hand, the lubrication system may malfunction. It may not produce enough fluid, or it may produce a fluid with poor lubricating qualities. Failure of the lubricating system creates friction between the tendon and its sheath, causing inflammation and swelling of the tendon area. Repeated episodes of inflammation cause fibrous tissue to form. The fibrous tissue thickens the tendon sheath, and hinders tendon movement. Inflammation of the tendon sheath is known as tenosynovitis.



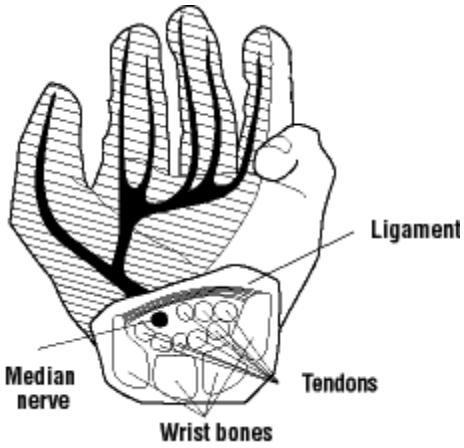
Tendon, muscle, bone unit

When inflamed, a tendon sheath may swell up with lubricating fluid and cause a bump under the skin. This is referred to as a ganglion cyst.

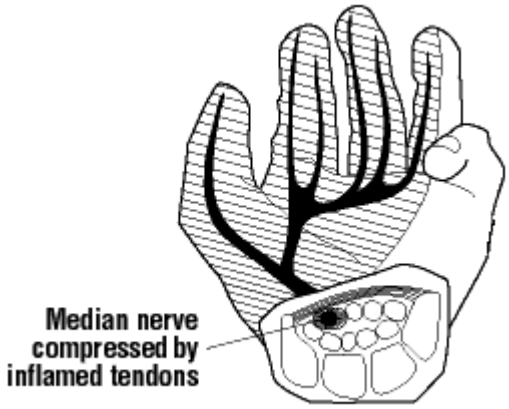
Tendons without sheaths are vulnerable to repetitive motions and awkward postures. In fact, when a tendon is repeatedly tensed, some of its fibers can tear apart. The tendon becomes thickened and bumpy, causing inflammation. Tendonitis is the general term indicating inflammation of the tendon. In some cases, such as in the shoulder, tendons pass through a narrow space between bones. A sac called the bursa filled with lubricating fluid is inserted between the tendons and the bones as an anti-friction device. As the tendons become increasingly thickened and bumpy, the bursa is subject to a lot of friction and becomes inflamed. Inflammation of the bursa is known as bursitis.

2.6.3 Nerve Injury

Nerves carry signals from the brain to control activities of muscles. They also carry information about temperature, pain and touch from the body to the brain, and control bodily functions such as sweating and salivation. Nerves are surrounded by muscles, tendons, and ligaments. With repetitive motions and awkward postures, the tissues surrounding nerves become swollen, and squeeze or compress nerves.



Wrist in natural condition



Wrist showing symptoms of Carpal Tunnel Syndrome

Compression of a nerve causes muscle weakness, sensations of "pins and needles" and numbness. Dryness of skin, and poor circulation to the extremities, may also occur.

2.6.4 Symptoms of an MSD Injury

Pain is the most common symptom associated with WMSDs. In some cases there may be joint stiffness, muscle tightness, redness and swelling of the affected area. Some workers may also experience sensations of "pins and needles," numbness, skin colour changes, and decreased sweating of the hands.

MSDs may progress in stages from mild to severe:

- **Early stage:** Aching and tiredness of the affected limb occur during the work shift but disappear at night and during days off work. No reduction of work performance.
- **Intermediate stage**: Aching and tiredness occur early in the work shift and persist at night. Reduced capacity for repetitive work.
- **Late stage:** Aching, fatigue, and weakness persist at rest. Inability to sleep and to perform light duties.

Not everyone goes through these stages in the same way. In fact, it may be difficult to say exactly when one stage ends and the next begins. The first pain is a signal that the muscles and tendons should rest and recover. Otherwise, an injury can become longstanding, and sometimes, irreversible. The earlier people recognize symptoms, the quicker they should respond to them.

The table below outlines occupational risk factors and symptoms of the most common disorders of the upper body associated with MSDs.

MSD Related Disorders and Risk Factors

Identified disorders, occupational risk factors and symptoms		
Disorders	**Occupational risk factors**	**Symptoms**
Tendonitis/tenosynovitis	Repetitive wrist motions Repetitive shoulder motions Sustained hyper extension of arms Prolonged load on shoulders	Pain, weakness, swelling, burning sensation or dull ache over affected area
Epicondylitis (elbow tendonitis)	Repeated or forceful rotation of the forearm and bending of the wrist at the same time	Same symptoms as tendonitis
Carpal tunnel syndrome	Repetitive wrist motions	Pain, numbness, tingling, burning sensations, wasting of muscles at base of thumb, dry palm
DeQuervain's disease	Repetitive hand twisting and forceful gripping	Pain at the base of thumb
Thoracic outlet syndrome	Prolonged shoulder flexion Extending arms above shoulder height Carrying loads on the shoulder	Pain, numbness, swelling of the hands
Tension neck syndrome	Prolonged restricted posture	Pain

(Courtesy of CCOHS: https://www.ccohs.ca/oshanswers/diseases/rmirsi.html)

2.7 Treatment for MSD Injuries

The treatment of an MSD injury can vary, but may involve several approaches including:

- Restriction of movement
- Application of heat or cold
- Exercise
- Medication and surgery

2.7.1 Restriction of Movement

The first approach to treating an MSD is to avoid the activities causing the injury. This often requires work restrictions. In some cases, transfer to a different job should be considered. A splint can also be used to restrict movements or to immobilize the injured joint. However, the use of splints in occupational situations requires extreme caution. If used inappropriately, splints can cause more damage than good. Splints are usually used for two reasons: to mechanically support a joint where an excessive load on the joint is anticipated, or to restrict the movement of the injured joint.

In the occupational context, splints should not be used as a mechanical support for the joint. Instead, the job should be redesigned to avoid the extreme load on the worker's joint in the first place. To be effective, the use of splints to immobilize an affected joint also requires that the work activity that caused the injury be stopped or changed. If injurious work continues, then the worker is exposed to risk of injury to other joints that have to compensate for the one that is splinted.

2.7.2 Application of Heat or Cold

Applying heat or cold seems to relieve pain and may accelerate the repair process.

Cold reduces pain and swelling and is recommended for injuries and inflammation (tissue that is swollen, red, hot and inflamed). The use of ice it is not recommended in case of muscle pain (spasm) because cold temperature will contract the muscle even more. Application of ice on painful muscles is recommended only immediately after an injury occurred, and only for a few days.

Heat is recommended for muscle pain relief. Heat increases the flow of blood which facilitates the elimination of lactic acid build up. It is not recommended for injuries with significant inflammation and swelling.

2.7.3 Exercise

Stretching is beneficial because it promotes circulation and reduces muscle tension. However, people suffering from an MSD should consult a physical therapist before exercising. Stretching or exercise programs can aggravate the existing condition if not properly designed.

2.8 Preventative Measures

Hazards are best eliminated at the source; this is a fundamental principle of occupational health and safety. In the case of MSDs, the prime source of the hazard is the repetitiveness of work. Other components of work such as the applied force, fixed body positions, and the pace of work are also contributing factors. Therefore the main effort to protect workers from an MSD should focus on avoiding repetitive patterns of work through job design. Where elimination of the repetitive patterns of work is not possible or practical, prevention strategies involving workplace layout, tool and equipment design, and work practices should be considered.

2.8.1 Job Rotation

Job rotation is one possible approach. It requires workers to move between different tasks, at fixed or irregular periods of time. But it must be a rotation where workers do something completely different. Different tasks must engage different muscle groups in order to allow recovery for those already strained.

However, job rotation alone will not be effective in reducing MSDs if not combined with the proper design of workstations, and it will not be effective while the high pace of work persists.

2.8.2 Workplace Design

The guiding principle in workplace design is to fit the workplace to the worker. Evaluation of the workplace can identify the source or sources of an MSD. Proper design of the workstation decreases the effort required of the worker to maintain a working position. Ideally, the workstation should be fully adjustable, providing a worker with the options to work in standing, sitting or sitting-standing positions, as well as fitting the worker's body size and shape.

2.8.3 Tools and Equipment Design

Proper design of tools and equipment significantly decreases the force needed to complete the task.

Providing the worker with the proper piece of equipment for tasks saves a lot of muscular effort in awkward positions. This can range from a hand tool to the proper office chair.

Good tools, maintained carefully and where necessary, frequently changed, can prevent muscle strain.

2.8.4 Work Practices

A well-designed job, supported by a well-designed workplace and proper tools, allows the worker to avoid unnecessary movements of the neck, shoulders and upper limbs. However, the actual performance of the tasks depends on the individual.

Training should be provided for workers who are involved in jobs that include repetitive tasks. Workers need to know how to adjust workstations to fit the tasks and their individual needs. Training should also emphasize the importance of rest periods and teach how to take advantage of short periods of time between tasks to relax the muscles, and how to consciously control muscle tension throughout the whole work shift.

Increased communication and support together with an increased ability of the worker to organize his/ her tasks (where possible) are work practices that improve worker’s satisfaction and have a positive impact on reducing the risk of MSDs.

3.0 Adjusting the Workstation

When designing, relocating or setting up a new workstation, the configuration, the equipment and layout are completely disregarded.

By applying ergonomic principles to the office setting, risk factors are minimized, productivity is increased, and overall workplace quality is improved. The workstation must be adjusted to promote a neutral position while a person works. When adjusting a workstation, keep in mind that all of the equipment interacts. Making one adjustment may alter another.

The following is a list of items that are associated the workstation, which need to be properly adjusted and selected to suit the individual, to eliminate the potential for discomfort or injury:

- Sit-stand workstations
- Document Holder
- Chair
- Keyboard/ keyboard tray
- Mouse
- Monitor
- Workstation set-up (how the work surface items are placed to reduce reaching)
- Laptop
- Eye Strain
- Lighting
- Telephone
- Environmental Factors
    - Air Quality
    - Temperature

3.1 Sit/Stand Workstations

Sitting for long periods without the opportunity to stand up and move around is another way in which employees are exposed to static loading of tissues, primarily in the lumbar area of the back. It can also affect the upper back, neck and legs. The problem is exacerbated where awkward postures are also present. Without an opportunity to provide those muscle groups with a rest by changing posture or position, the muscles can become fatigued which will result in pain and discomfort.

Standing is a natural human posture and by itself poses no particular health hazard. However, working in a standing position on a regular basis can cause sore feet, swelling of the legs, varicose veins, general muscular fatigue, and lower back pain, stiffness in the neck and shoulders, and other health problems. These are common complaints among sales people, machine operators, assembly-line workers and others whose jobs require prolonged standing.

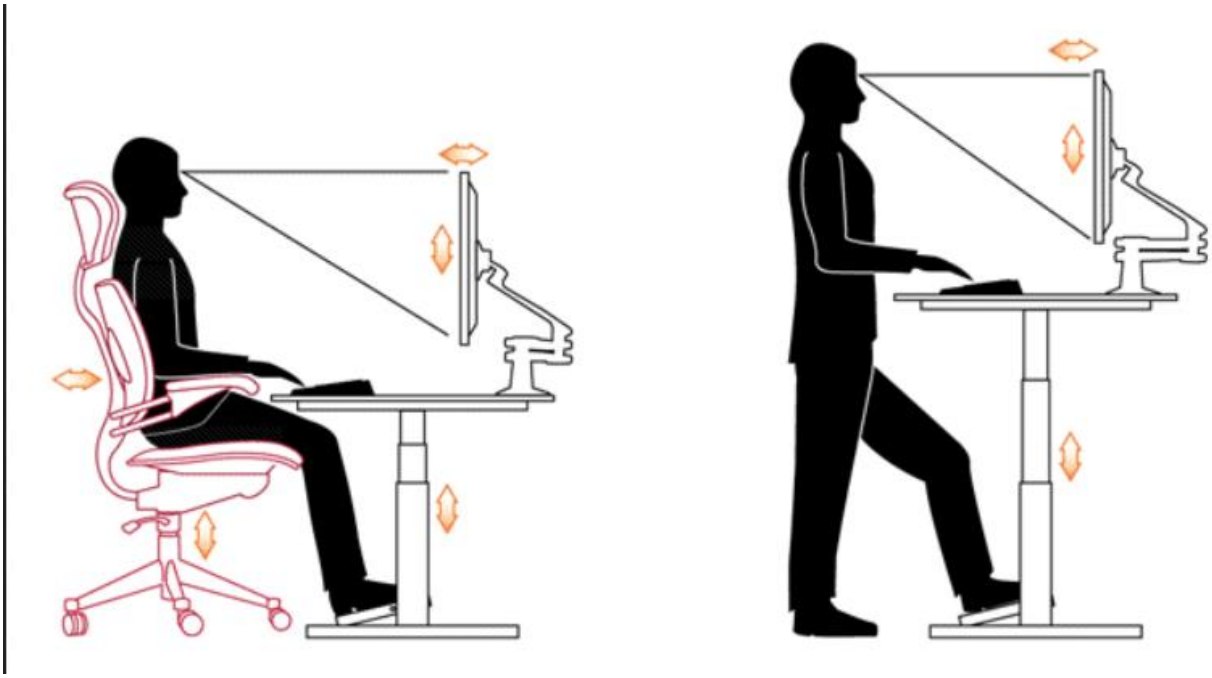
In a well-designed workplace, the worker has the opportunity to choose from among a variety of well-balanced working positions and to change between these positions frequently.

Being able to adjust the working height is particularly important to match the workstation to the worker's individual body size and to the worker's particular task. Adjustability ensures that the worker has an opportunity to carry out work in well-balanced body positions. If the workstation cannot be adjusted, platforms to raise the shorter worker or pedestals on top of workstations for the tall worker should be considered.

Organization of the work space is another important aspect. There should be enough room to move around and to change body position. Providing built-in foot rails or portable footrests allows the worker to shift body weight from one leg to the other. Elbow supports for precision work help reduce tension in the upper arms and neck. Controls and tools should be positioned so the worker can reach them easily and without twisting or bending.

Where it is possible, a seat should be provided so that the worker can do the job either sitting or standing. The seat must place the worker at a height that suits the type of work being done. For work that requires standing only, a seat should be provided in any case to allow the worker to sit occasionally. Seats at the workplace expand the variety of possible body positions and give the worker more flexibility.

The benefits from greater flexibility and a variety of body positions are twofold. The number of muscles involved in the work is increased which equalizes the distribution of loads on different parts of the body. Thus, there is less strain on the individual muscles and joints used to maintain the upright position. Changing body positions also improves blood supply to the working muscles. Both effects contribute to the reduction of overall fatigue.



3.1.1 Footrests

In the vast majority of situations you should not need a foot support to be able to sit comfortably on your chair. When seated comfortably at your desk, your feet should be flat on the floor and the thighs parallel to the floor. However, if you do need a foot support then choose a free-standing floor-mounted support that allows you to rest your feet out in front of you in a comfortable manner.

Workers who use a standing workstation should have a footrest to support one foot at a time and rotate between feet every 20 minutes. This takes pressure off of the back and legs.

3.1.2 Workstation Layout

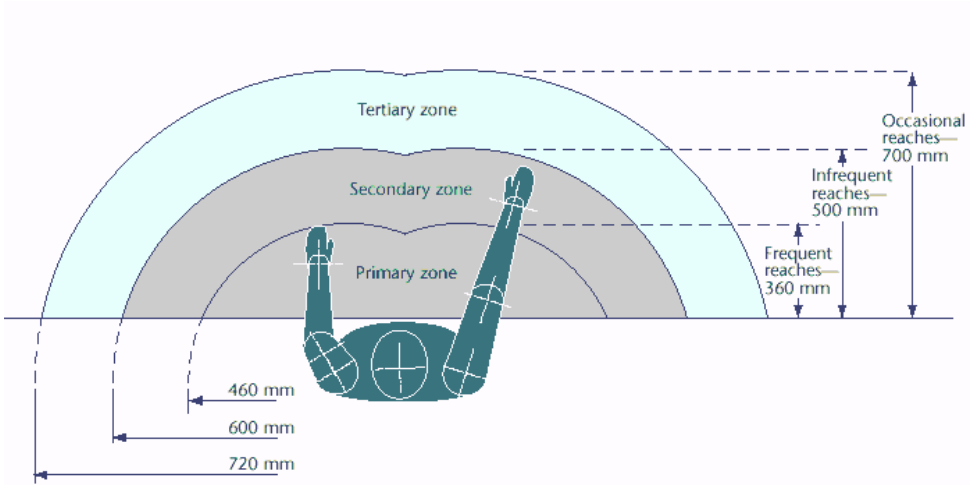
The optimum location of equipment on the work surface is determined by the tasks performed, their frequency and duration, equipment used, space allowances and acceptable **reach limits**.

Primary Zone
In this zone, the operator can comfortably reach objects pivoting at the elbows; typically within a radius of 5" to 7" from the center edge of the table surface. This reach zone requires the least amount of time to access and involves little, if any, muscle stress.

Secondary Zone
This reach zone requires arm extension, using the rotary joint and shoulder movement without any body or trunk movement. Normally within a radius of 15” to 18” from the CRP (Center Radius Point) of the operator’s body

Tertiary Zone
In this zone, full arm and full trunk movement are needed to reach the area 24” to 30” from the operator’s CRP. This zone represents a substantial reduction in efficiency over the first two as it requires more body and head movement.

The Reach Envelop diagram below clearly depicts reach areas in a horizontal plane.



Reach Envelope – General guideline for reaching. (Picture from CSA Z412-00 Guideline on Office Ergonomics)

3.2 Document Holder

If you work from or read from paper documents while using a computer, it is highly recommended that workers use a document holder in order to position the documents on your workstation to prevent neck and shoulder pain. The document holder should be placed in close proximity to your monitor so that you can view the document and the monitor at the same time, to avoid twisting and bending in awkward angles, as well as reduce eyestrain. Keeping documents at the same distance as your screen minimizes the refocusing your eyes do when switching between the two. Positioning the documents (and the monitor) directly in front of you minimizes the number of times you need to turn or swivel your head. Lastly, placing documents at roughly the same level as your monitor means you don't have to tilt your head as much to view them. All of these can be helped by a copyholder. There are three major types:

3.2.1 Screen-mounted document holders

These attach to the side of your computer monitor and suspend the paper document in the same vertical plane. This kind of holder is good for single sheets of paper or lightweight documents.

3.2.2 Freestanding document holders

Although a number of different designs are available, most of these have a sloping surface that angles the document in the same plane as your computer screen. You can adjust the angle and/or height on certain models. Some are designed for lightweight documents (a single sheet of paper), while others can support large books. Whatever the design, this kind of holder should be placed close to the side of the computer monitor at the same distance as the screen. Because the visual field curves to either side, you can also rotate the document holder slightly at an angle to the screen to follow this curve.

3.2.3 In-line document holders

This kind of document holder places documents between the keyboard and computer screen at an angle that follows your field of vision, which naturally curves down. In-line document holders eliminate side-to-side head movements and let you look from the screen to document and vice versa. These document holders are very useful if you work with oversized documents, such as wide-legal paper or wide-format computer printouts.

3.3 The Office Chair

A well-designed chair allows the user to sit in a balanced position. Buying an ergonomic chair is a good beginning but it may not bring the benefits expected. The key to purchasing a suitable chair is adjustability. The chair should be adjustable so that it can be customized to suit the needs of the individual. The actual sitting position

depends on an individual's personal habits; he or she has to learn and practice how to sit properly.

Also, remember that the chair is only one of the components to be considered in workstation design. All the elements such as the chair, footrest (if needed), keyboard, work surface, document holders, task lighting and so on need to have flexibility and adjustability to be "designed in."

3.3.1 How to Choose an Office Chair

The following items help you make a more informed decision. When you are selecting your chair, keep in mind the chair should at least meet the following criteria:

- **Chair Height**
  The chair height should be easily adjustable. A pneumatic adjustment lever is the easiest way to do this. A seat height that ranges from about 16 to 21 inches off the floor should work for most people. This allows the user to have his or her feet flat on the floor, with thighs horizontal and arms even with the height of the desk.

- **Adjustability**
  You should be able to adjust the height of the seat pan so that the front of your knees is level or slightly below level and your feet are firmly on the ground. In most cases there should be no need for you to use a footrest. The mechanism to adjust seat height should be easy to reach and operate when you are seated.

- **5 Pedestal Base**
  If the chair mobility is important to help you to do your work, the chair should have at least a 5 pedestal base with casters that glide freely over the floor surface. You may also want to choose a chair that swivels easily.

3.3.2 The Seat

- **Seat width and depth**
  The seat should have enough width and depth to support any user comfortably. Usually 17-20 inches wide is the standard. The depth (from front to back of the seat) needs to be enough so that the user can sit with his or her back against the backrest of the ergonomic office chair while leaving approximately 2 to 4 inches between the back of the knees and the seat of the chair. The forward or backward tilt of the seat should be adjustable.

- **Fit**
  When you sit in the chair the seat pan should be at least one inch wider than your hips and thighs on either side. The seat pan should not be too long for your legs otherwise it will either catch you behind the knees or it will prevent you from leaning fully back against the lumbar support. Most ergonomic chairs have a seat pan with a waterfall front that prevents the seat from catching you

behind the knees. The seat pan should also be contoured to allow even weight distribution and it should be comfortable to sit on.

- **Adjustability**
  In most situations this is not an essential feature. In some situations it can be helpful to change the tilt of the seat pan to help to maintain a balanced seated posture.

- **Comfort**
  If the seat pan is made from low-density foam then continuous use can cause it to become permanently deformed and then it will not provide adequate cushioned support. The seat pan should continue to provide comfort after sitting for 60-20 minutes. Insufficient cushioning and inappropriate contouring can cause discomfort, imbalance and hip and back fatigue.

- **Seat material**
  The material on the office chair seat and back should have enough padding to be comfortable to sit on for extended periods of time. Having a cloth fabric that breathes is preferable to a harder surface. Chairs can be covered in a variety of upholstery materials, each of which has benefits and concerns. Vinyl and vinyl-like coverings are easy to clean and spill resistant, but they don't breath and if the chair begins to heat up under the thighs uncomfortable amounts of moisture can accumulate. Cloth upholstery is the most common covering, but this is less resistant to spills and more difficult to clean. A cloth covered seat pan can also become warm and moisture laden, and cloth covered foam seat pans can be a significant source of dust mite allergen. When selecting your char covering think about cleaning and maintenance issues and plan appropriately.

3.3.3 The Back

- **Lumbar support**
  Lower back support in an ergonomic chair is very important. The lumbar spine has an inward curve, and sitting for long periods without support for this curve tends to lead to slouching (which flattens the natural curve) and strains the structures in the lower spine. An ergonomic chair should have a lumbar adjustment (both height and depth) so each user can get the proper fit to support the inward curve of the lower back.

  If the chair will be used by multiple users then this level of adjustment may be required. If the chair has a fixed height lumbar support and it feels comfortable when you sit back against this, and you will be the primary user of the chair then a fixed lumbar support may be acceptable. It is extremely important to keep the natural “S” curvature of the spine aligned.

- **Backrest**
  The backrest of an ergonomic office chair should be 12 to 19 inches wide. If the backrest is separate from the seat, it should be adjustable in height and angle. It should be able to support the natural curve of the spine, again with special attention paid to proper support of the lumbar region. If the office chair has the

seat and backrest together as one piece, the backrest should be adjustable in forward and back angles, with a locking mechanism to secure it from going too far backward once the user has determined the appropriate angle.

- **Hip room**
  insufficient hip room can make you sit too far forwards on the seat pan so that you will not have enough thigh support.

- **Adjustability**
  Movement of the back while you are sitting helps to maintain a healthy spine. Look for chairs that allow you to easily recline, that provide you with good back support in different recline postures, and that have a back that tracks where your back is. Locking the chair backrest in one position generally isn't recommended or beneficial to users.

- **Swivel**
  Any conventional style or ergonomic chair should easily rotate so the user can reach different areas of his or her desk without straining.

- **Adjustability**
  Are the armrests broad, contoured, cushioned and comfortable? While sitting you should be able to easily adjust the height of the armrests and move the armrests closer together or further apart in order to achieve a neutral posture in the arms and wrists.

3.3.5 Adjusting the Chair

You can have the best ergonomic chair on the market, however if it is not properly adjusted, you will not get the full benefit.

1. Stand in front of your chair and adjust the height so that the highest point of the seat, (when horizontal), is just below the knee cap.

2. Sit in the chair and adjust (if necessary) so that both feet are flat on the floor.

3. Check the clearance between the front edge of the seat and the lower part of the legs (your calves) fits 2-3 fingers (or approximately 5 cm/ 2 in). The back of your knees/ calves should not make contact with the chair.

4. Adjust the back rest forward and backward as well as up and down so that it fits the hollow of your lower back.

5. Sit upright with your arms hanging loosely by your sides. Bend your elbows to an 90 degree angle and adjust the armrest(s) height until they barel touch the undersides of the elbows.

6. Tilt the seat pan forward or backwards as necessary.

3.3.6 Adjusting the Armrests

- Armrests are an important aspect to properly adjusting your chair. Always remember when adjusting armrests ensure that they are not too high or too low. This will help to avoid awkward postures.

- **Too low** may cause you to lean over to the side to rest one forearm. This can result in uneven and awkward postures, fatiguing the neck, shoulders, and back and cause discomfort.
- **Too high** may cause the shoulders to remain raised, which can result in muscle tension, pain and fatigue in the neck and shoulders.
- **Too wide** can cause you to reach with the elbow and bend forward for support. Reaching pulls the arm from the body and can result in muscle fatigue in the shoulders and neck.
- **Too close to the body** can restrict movement in and out of the chair.
- **Too large** or inappropriately placed may interfere with the positioning of the chair. If the chair cannot be placed close enough to the keyboard, you may need to reach and lean forward in your chair. This can fatigue and strain the lower back, arm, and shoulder.

Armrests that are made of hard materials or that have sharp corners can irritate the nerves and blood vessels located in the forearm. This irritation can create pain or tingling in the fingers, hand, and arm. The best armrests will allow you to rest the area of your forearm that lies halfway between your wrist and elbow, without compressing any part of the arm. Look for those with at least height and width adjustment features. Research studies have shown that armrests provide many benefits, such as:

- Reduced postural strain to the upper body
- Reduced muscle loads in the upper arms, shoulders, and neck
- Reduced loads on the spine (by redistributing the weight of your upper body)
- Reduced forearm exhaustion while typing (when your forearm gets tired, you tend to increase wrist extension)
- Reduced key forces while typing (the amount of force with which you hit the keys plays a role in CTD development)

3.4 The Keyboard & Tray

When creating an ideal typing posture, it is essential to properly position your keyboard and mouse to ensure a comfortable workstation. Not only will a properly positioned keyboard and mouse help you with comfort but it will also help prevent potential musculoskeletal disorders such as tendonitis and carpel tunnel syndrome Ergonomic keyboards are designed to minimize muscle strain and other MSD-related injuries. Ergonomic keyboards for two-handed typing are constructed in a V-shape to allow right and left hands to type at a slight angle which is more natural to the human form.

3.4.1 Placement

When placing the keyboard on your desk or keyboard tray, position it directly in front of you at about bellybutton level to avoid any twisting of your neck or torso.
A keyboard tray may be needed if the work surface or chair cannot be properly adjusted to appropriate height. The keyboard tray should:

- Be adjustable in height and tilt,
- Provide adequate leg and foot clearance, and;
- Have adequate space for multiple input devices (for example, a keyboard and mouse).

Keyboards or working surfaces that are too high or too low can lead to awkward wrist, arm, and shoulder postures. For example, when keyboards are too low you may type with your wrists flexed upwards, and when keyboards are too high, you may need to raise your shoulders to elevate your arms. Performing keying tasks in awkward postures such as these can result in hand, wrist, and shoulder discomfort.

3.4.2 Height

The keyboard's vertical position should be maintained within the recommended range. The tilt of the keyboard may need to be raised or lowered using the keyboard feet to maintain straight, neutral wrist postures while accommodating changes in arm angles. Ultimately, once adjusted, the keyboard tray should allow the user to type without any bend in the wrist and maintain a neutral posture.

3.4.3 Neutral Keyboard Posture

To ensure a neutral keyboarding posture is kept, conduct the following:

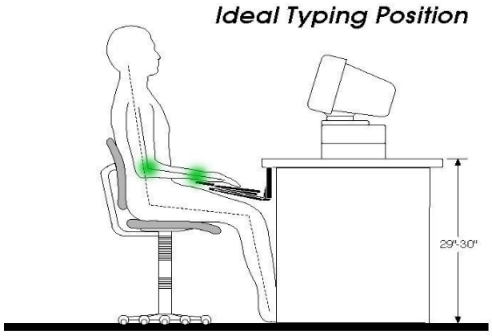
- Upper and lower back well supported by chair
- Chair height set so that the chair seat does not compress the back of the knees
- Feet firmly planted on a surface for support (floor or footrest)
- Head balanced on neck (not tilted back or too far forward)
- Upper arms close to body and relaxed (not abducted to the side or flexed forward)

Sitting so that the:

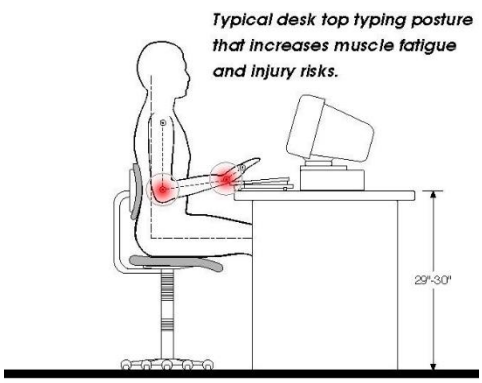
- Angle formed by the shoulders, hips, and knees is >90 degrees
- Angle formed by the shoulder, elbow, and wrist is >90 degrees
- Angle formed by the hips, knees, and feet is >90 degrees
- Wrists at a neutral position, level with forearm (<15 degrees deviation)
- Chair armrests not directly compressing any part of the forearms or elbows

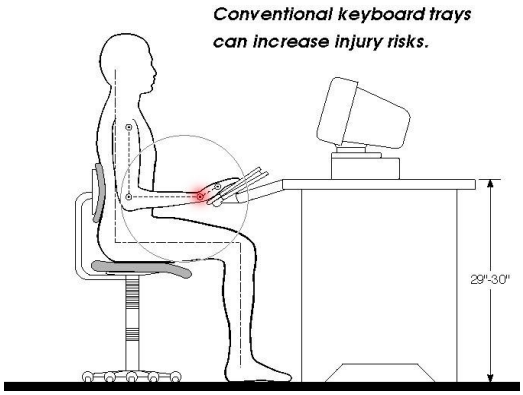
3.4.4 Ideal Typing Posture

In the ideal typing posture both static and dynamic muscle loads are minimized. This posture is achieved when the keyboard is below seated elbow height and the keyboard base is gently sloped away from the user so that the key tops are accessible to the hands in a neutral posture. In this position the arms, shoulders, neck and back can relax, especially during brief rest pauses. Also, in this slightly reclined sitting position the low back rests against the lumbar support of the chair, the elbow angle is opened to promote circulation to the lower arm and hand, the abdominal angle, and the popliteal angle (behind the knees) are opened to promote blood circulation. The feet rest firmly upon the floor.



Less than Ideal typing postures





3.5 The Mouse

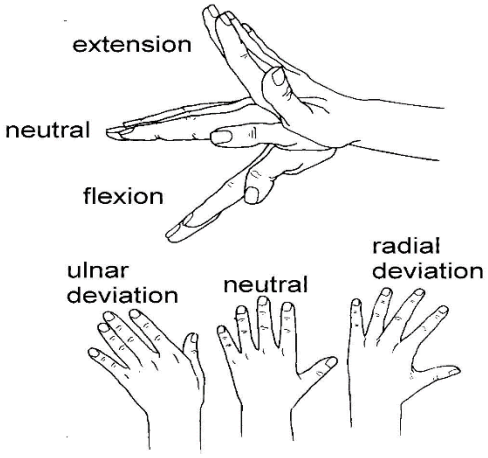
The mouse, like the keyboard, is a critical element to the computer workstation. The computer mouse is by far the most popular and widely used of all pointing devices. It is important to note that the computer mouse can cause users similar problems as a keyboard tray would. Similar symptoms may include:

- Sore fingers or hands;
- Wrist pain or problems;
- Arm and shoulder discomfort or injuries.

To avoid such problems, it is important to look at all aspects of the mouse and how it is used in the workplace.

3.5.1 Deviated Hand Postures

Repeated forceful movements made by the hands while in deviated postures (flexion, extension, ulnar radiation, and radial radiation) are known to dramatically increase the risks of developing musculoskeletal disorders, especially Carpel Tunnel syndrome. Ulnar and radial deviations contribute to CTDs, but it is flexion and, particularly, extension that are the real culprits.



When it comes to preventing deviated hand postures:

- Keep their body and wrist posture in neutral positions while sitting and keyboarding.
- Have an appropriate workstation configuration.
- Take breaks at appropriate intervals.

3.5.2 Selecting a Mouse

If you were to open up a computer catalogue and look for a new mouse, you would find a wide range of computer mice out there today. The question is which mouse should I choose, and why?

When selecting a mouse consider the following:

- ***Size*** – Choose a mouse that fits comfortably in your hand; ensure the mouse fits comfortably in the palm of your hand while your fingers loosely curl around the mouse, and the buttons are easy to use. Avoid holding the mouse with the and in a claw-like manner. People often don't realize that mice may come in different sizes. Companies commonly produce smaller mice as accessories for notebook users, who are constrained to small desks or tray tables - but these also work nicely for users with smaller hands.

- ***Shape*** – Find a mouse with a "contoured" or asymmetrical grip; recent studies have shown that symmetrical mice are a better choice. Mice with a slightly wider base may help improve your grip on the mouse and your comfort while using it. Try to avoid using mice that require you to place the heel of your hand on the desk.

- ***Features*** - Consider the use of a mouse with multiple buttons. This allows the user to perform certain keystrokes, decreasing the amount the user may have to do by hand, therefore lessening the risk of a musculoskeletal disorder. Users that tend to spend long periods of time surfing the web or editing documents, you may want to try a mouse with a trackball. Scrolling with a trackball instead of the entire mouse can help reduce repetitive arm motions and their resulting discomfort, but beware-this may lead to discomfort in your fingers!

3.5.3 Different Types of Mice

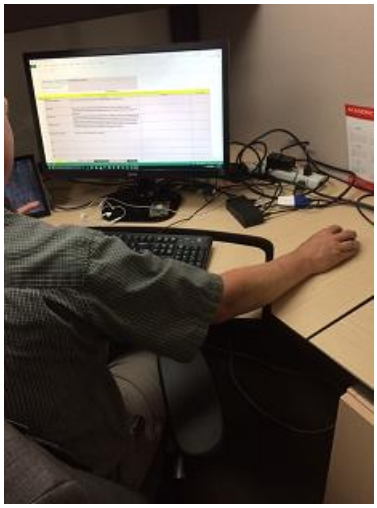
As previously mentioned, there are several different models of mice available. Users should try the different model and choose the one that best fits their needs. The following is a few of the different models.

Type of Mouse	Description	Features
	Conventional Mouse	• Typically 'tear drop' shaped and symmetrical on each side. • Comes in various sizes.
	Trackball Mouse	• Uses a ball to move the cursor. • Allows the arm and hand to be held in one place. • Useful in workstations with limited space as the mouse does not need to move (you move the trackball only).
		• Keeps the hand and wrist in a neutral 'hand-shake' position. • Moves the whole arm instead of just the wrist when mousing.
	Joystick Mouse	• Keeps the hand and wrist in a neutral position. • Moves the whole arm when mousing.
	Pen and tablet mouse	• Can be used by left or right hand • Used for special applications such as graphic design • The pen allows the worker to hold it as

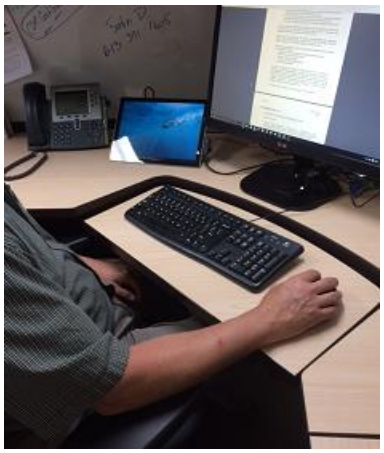
Type of Mouse	Description	Features
		if it were a pen, for more control
	Center pointing devices/ Roller bars	• Allows both hands to be kept in a neutral position in front of the body. • Fewer movements between switching from typing and mousing.
	Foot Pedal Mouse	• Gives the users the ability to move the cursor and click the mouse buttons with their feet. • Used by people with disabilities or with high-back or neck problems.

3.5.4 Placement of the Mouse

Placement of the mouse is very critical. When using a mouse ensure you position the mouse immediately on the right or left of the keyboard. Also, ensure the mouse is on the same level surface as the keyboard. Avoid scenarios like that in Figures 16 and 17. Users should strive to position their mouse as close to their body as possible, this will help minimize the development of musculoskeletal disorders.



Incorrect! The user is reaching for mouse, he is resting his arm on the desk and his elbows are unsupported. The mouse and keyboard are at different heights.



Correct! The mouse and keyboard are at the same height so that the user does not have to reach.

The mouse and keyboard should be used at the same level and in such a way that prevents the user from having to rest their forearm or wrist on the work surface or the edge of the desk.

3.5.6 Proper Mouse Usage

The following tips will help computer users avoid a mouse-related musculoskeletal injury. It should be noted that the most important thing to keep in mind when applying ergonomics is postural variation. By varying their posture, a user can minimize their risk of injury.

- **Mouse grip**: Hold the mouse gently to move it over a mousing surface.
- **Mouse from the Elbow**: Don't skate or flick the mouse with your wrist. Make controlled mouse movements using your elbow as the pivot point and keep your wrist straight and neutral.
- **Optimal mouse position**: Sit back in your chair, relax your arms then lift your mousing hand up, pivoting at the elbow, until your hand is just above elbow level. Your mouse should be positioned somewhere around this point. Don't use a mouse by stretching to the desk or out to the side of a keyboard.
- **Right-handed users**: Use a position-adjustable, flat-mouse platform and adjust this to a position that is one to two inches above the keyboard and over the numeric keypad; you can easily move the platform out of the way if you need to access the numeric keypad keys. If you need to access the numeric keypad or if you do not have space for an over-the-keyboard mouse platform, then use an angle-adjustable mouse platform that is immediately to the right side of the keyboard. Position this mouse platform so that it slopes downwards and is close to the side of the keyboard; this will enable you to use the mouse in a neutral wrist position. Position adjustable mouse platforms are commercially available.
- **Left-handed users**: If you are using a left-handed keyboard with the numeric keypad on the left side, you can use an over-the-keyboard mouse pad as described above. If you want to mouse with your left hand but have a right-handed keyboard, then you do not need to use an over-the-keyboard platform because this will obscure some of the alphabetic keys. In this situation it is best to use an angle-adjustable mouse platform that is immediately to the left side of the keyboard, and to position this platform so that your left wrist is neutral as described above.
- **Protect your wrist**: The anatomy of the wrist is curved away from any contact surface. (You can easily see this by resting your hand/arm on a flat surface—you'll see light under the wrist and can probably even pass a thin pen under it.) The forearm is shaped liked this for the wrist to remain free of surface-pressure contact.
- **Avoid restricting circulation**: For many people there are exposed blood vessels near the skin at the wrist, which is where the pulse is often taken. Any pressure in this region will disrupt circulation into the hand and this will increase the risks of injury.

3.5.7 Wrist Rests

For tasks that involve working with shoulders raised, elbows held out, arms held forward and wrists held up (as in typing, micro-electronics assembly, etc.), any means of reducing muscular tension is important in preventing musculoskeletal injuries.

One's personal preference for using or not using a wrist rest is a very significant factor. Workers who choose not to use them while actually performing their tasks may opt to just use them for a rest break, between tasks. An adjustable workstation which is suited to the individual using it is essential.

The aim is to keep your wrists in a neutral position (not bent up or down). If used, any rest device should be selected as part of an ergonomically-designed workstation. When choosing a rest, ensure that:

- Your hands and wrists should move freely and be elevated above the wrist/palm rest while typing. When resting, the pad should contact the heel or palm of your hand, not your wrist.
- Reduce bending of the wrists by adjusting other workstation components (chair, desk, keyboard) so the wrist can maintain an in-line, neutral posture.
- Match the wrist support to the width, height, and slope of the front edge of the keyboard (keeping in mind that the goal is to keep wrist postures as straight as possible).
- Provide wrist/palm supports that are fairly soft and rounded to minimize pressure on the wrist. The support should be at least 3.8 cm (1.5 inches) deep.
- **Avoid restricting arm movement**: When a softly padded wrist rest (especially one that is rounded) or a soft chair armrest are used, the forearm becomes locked into position. This encourages people to make mouse movements by flicking their wrists, which also increases intra-carpal pressure.
- **Keep the mouse free-moving**: The base of the palm is the part of the body designed to support the hand when resting on a surface. For keyboard use a broad palm support is best. However, mouse use is different than keyboard use. With a keyboard the best posture is for users to float their hands over the keyboard when typing and then to rest on the palm support in micro breaks between typing bursts. With mousing this doesn't happen. A mouse is used by moving its location over a surface, and resting usually occurs when mouse movements stop but with the mouse still being held in the hand. Mouse movements should be made using the elbow as the pivot point, not the wrist. Anything that impairs free movement of the forearm/hand and mouse will increase injury risks.
- **Mouse shape**: Choose a mouse design that fits your hand but is as flat as possible to reduce wrist extension. Don't use a curved mouse. Use a symmetrically shaped mouse. Consider a larger mouse that encourages arm rather than wrist movements.
- **Load sharing**: You can load share between your right and left hands by using the mouse for some of the time with each hand. For this you need to choose a mouse platform that can easily be configured to the left or/and right or a keyboard platform that can accommodate two mouse platforms, and a symmetrical shaped mouse that can be used by either hand.
- **Other input devices:** Whether you choose a different mouse design, a trackball, a joystick, a pen, a touch pad or some other input device, make sure that your position this comfortably, and that your wrist is in a neutral position when using the device

3.6 The Computer Monitor- Setup and Positioning

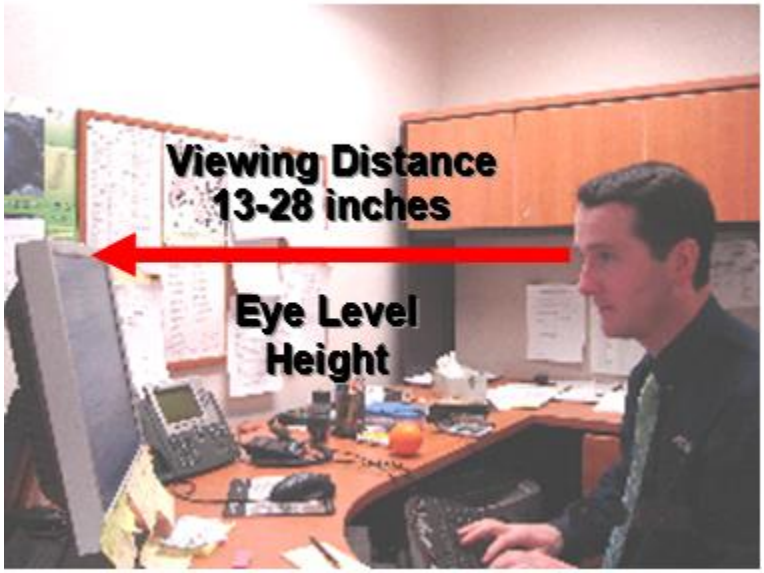
Similar to other types of equipment in a workstation, a monitor can contribute to the risk of musculoskeletal injuries. Proper setup and positioning is imperative to preventing eye strain, muscle fatigue in the neck, shoulders and upper back.

3.6.1 Center the Monitor

When the user sits down at their workstation they should be facing directly in front of the monitor. It is important to avoid scenarios where the user must look off to the side to view the monitor. These scenarios tend to cause neck and shoulder pain due to awkward postures.

3.6.2 Viewing Distance

When placing your monitor, it is recommended that you have a viewing distance of 13-28 inches. Sitting too close or too far from the monitor can cause eyestrain.

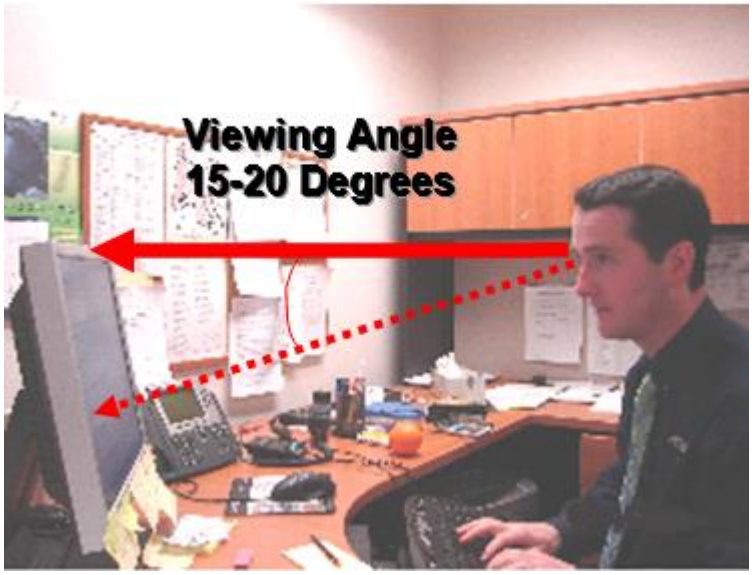


3.6.3 Height of Monitor

The ideal viewing height is to have your eyes level with an imaginary line across the screen, about 1inch below the top of the monitor. This can be accomplished in one of two ways - either by lowering your monitor or raising your chair. If your screen is too low, you'll find yourself tilting your head forward to view the monitor (a common cause of neck pain). If it's too high, you may have to tilt your head back, leading to neck and shoulder pain.

3.6.4 Viewing Angle

Tilt the screen so that the base is slightly closer to you than the top. This enables you to view the entire screen and the display more clearly. Tilting the monitor downward is not recommended.



3.6.5 Monitor adjustments for bifocal, trifocal, and progressive lenses

If you wear bifocals, trifocals, or progressive addition lenses, it's especially important to properly adjust your monitor height. Avoid tilting your head back to view the screen through the lower portion of your glasses; this could lead to muscle fatigue in you neck and back. Instead, try lowering your monitor. If that does not work, you may want to consider obtaining glasses that are specially made for computer use. Do not position your monitor too high that you have to tilt your head back to view the screen.

3.7 Laptops

Laptops have seen a significant growth in popularity over the past couple of years. Unfortunately due to the design of the laptop, it makes them inherently problematic and contravenes almost all ergonomic principles.

3.7.1 User Frequency

Are you an **occasional user** who works on your laptop for short periods of time or are you a **full-time user** with the laptop as your main computer? Occasional users will have less risk of problems than full-time users. All users should pay some attention to how they use their laptop, but full-time users may have more problems.

3.7.2 Laptop Posture - as indicated above, laptops violate basic ergonomic design requirements, so using a laptop is a tradeoff between poor neck/head posture and poor hand/wrist posture.

3.7.3 Occasional Users - because the neck/head position is determined by the actions of large muscles, you are better off sacrificing neck posture rather than wrist posture. For occasional use:

- find a chair that is comfortable and that you can sit back in
- positioning your laptop in your lap for the most neutral wrist posture that you can achieve
- angling the laptop screen so that you can see this with the least amount of neck deviation

3.7.4 Full-time Users - Laptops are okay to use for short periods of time, however if users plan to use them for prolonged periods, they should consider the following:

- Purchase an external monitor, an external keyboard, and a docking station and arrange your workspace to create a similar layout to a desk top computer.
- Position the laptop or main screen in front of you, so you can see the screen without bending your neck. This may require that you elevate the laptop off the desk surface using a stable support surface, such as a computer monitor pedestal.
- Follow the postural guidelines for working at a computer workstation.

3.7.5 Laptop dimensions

Many laptops offer large screens (15" plus) and can work as desktop replacements (giving the viewing area of a 17" monitor). However, think about where you will most use your laptop to help you choose the best size. The larger the screen the more difficult it will be to use this in mobile locations (e.g. airplane, car, train). There are a number of smaller notebook and ultra-portable laptops on the market. Consider issues of screen size and screen resolution. A small screen (e.g.12.1") will be useful in mobile settings, but if the resolution is high, ensure that the characters on the screen are readily visible and that the input device can easily point to areas on the screen. The smaller the laptop, the smaller the keyboard, so it is important to ensure that you can comfortably type on a keyboard that may be only 75% the size of a regular keyboard.

3.7.6 Laptop weight

If you will be frequently transporting your laptop, think about the weight of your laptop. This includes the weight of the laptop plus the required accessories (e.g. power supply, spare battery, external disk drive, zip drive, etc.). Many lightweight portables

can become as heavy as regular laptops when you add the weight of all of the components together. If your laptop + components weigh 10lbs or more, you should consider using a carry-on bag that you can pull along. If you want a smaller bag and can comfortably carry your laptop, consider a good shoulder bag with an ergonomic design.

3.8 Eyestrain

Eyestrain is when the eyes become irritated and fatigued due to prolonged use, uncorrected defects of vision, or an imbalance of the eye muscles. With the increase in dependency on computers eyestrain has become a more pronounced problem. The following is a list of eyestrain symptoms:

- Headaches
- Loss of focus
- Burning/tired eyes
- Double vision
- Blurred vision
- Neck and shoulder pains

To reduce eyestrain the following recommendations should be followed:

- **Ensure proper set up of your computer monitor**

- **Take breaks.**
  Follow the 20/20/20 rule: If you tend to work on your computer for prolonged periods of time, be sure to take a 20 second break every 20 minutes and look at least 20 feet away. This gives yours eyes a break and chance to adjust focus-and avoid visual fatigue.
- **Blink regularly.**
  We tend to blink less while viewing a computer screen than other types of near work. Remember to blink fully and often (a post-it note on the screen can help with reminders).
- **Keep a clean screen**
  Dust gathers easily on monitor screens. Be sure to periodically use a recommended solvent to remove any accumulated dust or fingerprints, ensuring a clean and visually consistent display.

- **Reduce Glare and Reflections**
  If left uncorrected, glare and reflections can cause discomfort, eyestrain, and headaches. Try to reposition your monitor so that there's no glare on the screen (but avoid putting it in a position that's uncomfortable to view!). If you can't avoid the glare by readjusting your monitor positioning, consider a high-quality glass anti-glare screen.

- **Adjust your font size and color**

The size of your text should be about two or three times the size of the smallest text that you can read. Black text on a white background is usually the easiest to discern when word processing.

- **Have your eyes checked**
  Be sure to have an annual eye examination. Measure your viewing distances and take those numbers to your doctor for the exam.

3.8.1 Bifocals, Trifocals and Single-Focus Glasses

A computer operator who wears bifocals may tilt the head back to view the monitor through the bottom, close-vision portion of the glasses. If bifocals cause discomfort or awkward head positions, several approaches can be taken. The screen should be lowered such that the head is in a neutral position when viewing the top line of text or other material.

Alternatively, one could wear single-focus glasses designed specifically for computer work, with the focal distance chosen for the viewing distance between the worker and the screen. In this case, it is important that a document holder is also used, to position documents at the same viewing distance.

Other options are graduated bifocals, which have no sharp line between the two parts of the lens, trifocals, or the use of reverse bifocal lenses, where the computer screen prescription is in the upper part of the lens.

Computer users should have their eyes checked regularly and discuss their computer use with their optometrists.

3.9 Lighting

Improper lighting for office environments can be a major contributing factor to the following visual discomfort:

- Eyestrain
- Headaches
- Eye irritation
- Blurred vision
- Dry burning eyes

Poor lighting not only affects the ocular system, but it can also cause aches and pains in the neck and shoulder areas. This occurs when users cannot see the monitor properly due to lack of light or too much glare. Ultimately, in an attempt to better read the monitor, the user compromises their posture and will sit awkwardly to view the screen.

3.9.1 Monitor Related Eye Strain

To reduce the risk of eyestrain as a result of prolonged exposure to a computer monitor:

- Adjust the brightness and contrast according to your preference.
- Use a light color for the background.
- Place the monitor parallel (not directly below) with overhead lights.
- Angle the monitor away from lights and windows.
- Make sure that the task lamp illuminates the document and not the monitor.

The following is recommended when evaluating office space for lighting:

3.9.2 Windows and Walls

Block out excessive natural light with blinds or window coverings. This will reduce the amount of light and reduce glare. Walls, furniture and floors should be painted with a matte finish and be a neutral color.

3.9.3 Task Lighting

If the lighting levels are too low, task lighting such as a desk lamp should be used in the areas where it is needed. When positioning your task lighting, ensure that it is not creating glare off of the monitor or any paper documents you are using. A few things to consider when placing your task lighting:

- Position your desk lamp so that the lights sweeps across your viewing area;
- Obtain a lamp that is adjustable and has multiple pivot points;
- Place the lamp opposite to your writing hand to minimize shadows on your work surface;
- Angle the shade away from your eyes and monitor to minimize any direct glare.

3.9.4 Anti-Glare Screens

In general, anything between the operator and screen compromises the quality of the image. It is far better to control glare by proper lighting design and placement of the monitor whenever possible than by use of an anti-glare screen. Many monitors currently available are already equipped with low reflective screens.

3.9.5 Lighting Levels

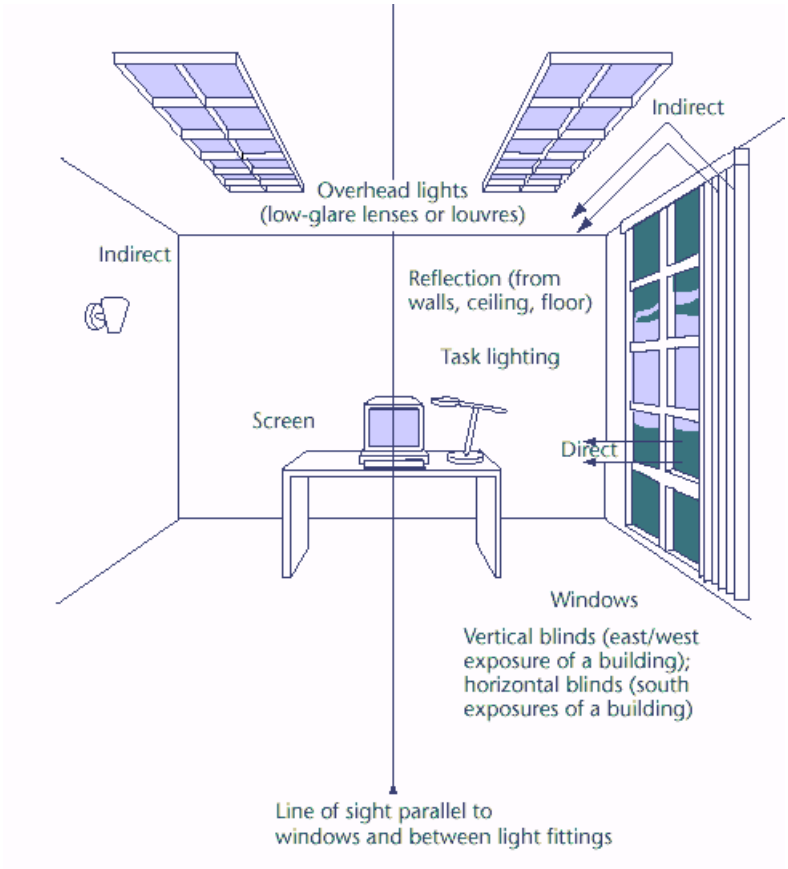
The amount of light falling on a surface is measured in units called lux. Depending on the factors noted above, adequate general lighting is usually between 500 and 1000 lux when measured 76 cm (30 inches) above the floor.*

To reach proper light levels and uniform light distribution in the visual environment, many light fixtures are designed to reflect light off walls, ceilings and objects. The amount of light reflected off a surface can be measured. Suggestions for the percent of light reflected off surfaces in a typical office include:

- Window blinds (40-50%).
- Walls (50% maximum).
- Business machines (50% maximum).
- Ceiling (70-80%).
- Floor (20-40%).
- Furniture (25-45%).

Light fixtures that are too widely spaced or wrongly positioned can create shadows. Objects between the light fixture and work being done can block the light and cast shadows. Likewise, workers sitting with their backs to windows, with light fixtures directly overhead or to the rear, cast shadows on their own work surfaces.

Workstation Placement Relative to Lighting



3.9.6 Light Flicker

Light flicker refers to quick, repeated changes in light intensity - light that appears to flutter and be unsteady. It is caused when the voltage supplied to a light source changes or when the power line voltage itself fluctuates. The severity of the flicker depends on several factors such as:

- How often and regularly the voltage fluctuates.
- How much of a voltage change occurs.
- The kind of light (incandescent, fluorescent, or HID - high intensity discharge lighting systems).
- The gain factor of the lamp [gain factor is a measure of how much the light intensity changes when the voltage fluctuates - (% relative change in light levels) divided by (% relative fluctuation in voltage)].
- The amount of light in the lighted area (ambient light levels).

Lamps operating on AC electric systems (alternating current) produce light flickering at a frequency of 120 Hertz (Hz, cycles per second), twice the power line frequency of 60 Hz (50 Hz in many countries outside North America). Essentially, the power is turning on and off 120 times a second (actually the voltage varies from +120 volts to -120 volts, 60 times or cycles a second and is at zero volts twice in one cycle).

3.9.7 The Effects of Light Flicker

Although humans cannot see fluorescent lights flicker, the sensory system in some individuals can somehow detect the flicker. Ever since fluorescent lighting was introduced in workplaces, there have been complaints about headaches, eye strain and general eye discomfort. These complaints have been associated with the light flicker from fluorescent lights. When compared to regular fluorescent lights with magnetic ballasts, the use of high frequency electronic ballasts (20,000 Hz or higher) in fluorescent lights resulted in more than a 50% drop in complaints of eye strain and headaches. There tended to be fewer complaints of headaches among workers on higher floors compared to those closer to ground level; that is, workers exposed to more natural light experienced fewer health effects.

Flicker is usually a potential problem only with lighting that requires the use of ballasts, like fluorescent lights. Incandescent lights usually do not cause a flicker problem since the light filaments generally do not cool quickly enough (and make the light dimmer) during the "off" time as the voltage changes in the AC power line.

The type of ballast, which controls the electrical supply to fluorescent lights, affects the amount of flicker. Magnetic ballasts change the voltage supplied to the fluorescent lamps but do not alter the frequency - the power line frequency of 60 Hz. The ultraviolet (UV) light produced inside the fluorescent light tube also fluctuates 120 times per second. The phosphorescence (the fluorescent light) resulting from the UV shining on the phosphor coatings inside the light tube is sufficiently stable (i.e., lasts long enough) to even out the variations in the fluorescent light output.

3.9.8 Reducing or Eliminating Light Flicker

Some types of ballasts can reduce flicker considerably. New, energy-efficient electronic ballasts take the 60 Hz supplied power and convert it to a much higher frequency (20,000 - 60,000 Hz). The resulting flicker frequency (twice the supplied power frequency, 40 -120 kHz) is so high that the human eye cannot detect any

fluctuation in the light intensity - essentially flicker-free. An added benefit is that electronic ballasts produce less hum than that emitted by other kinds of ballasts.

To correct flicker:

- Replace bulbs on a scheduled basis. Old bulbs tend to flicker more and they are not as bright.
- Ensure that all parts of the light fixture, especially the ballast, are functioning properly.
- When replacements are needed, upgrade to fluorescent lighting that uses electronic ballasts.

4.0 Eye Breaks

Looking at a computer screen for a while causes some changes in how the eyes work, causes you to blink less often, and exposes more of the eye surface to the air. Every 15 minutes you should briefly look away from the screen for a minute or two to a more distant scene, preferably something more than 20 feet away. This lets the muscles inside the eye relax. Also, blink your eyes rapidly for a few seconds. This refreshes the tear film and clears dust form the eye surface.

5.0 Posture

Good posture is the basis of good workstation ergonomics. Computer-related injuries usually occur gradually and often go unnoticed until there is significant discomfort. The single largest factor in office injuries is poor posture. While improper posture may not result in an injury after a week, a month or even a year, prolonged exposure to improper posture will greatly increase the risk of developing an injury. Although it is possible for these injuries to heal themselves when the ergonomic hazard is removed, cases do exist where individuals have done enough damage to require corrective therapy, in addition to removing the hazard. Good posture is the best way to avoid a computer-related injury.

6.0 Work Habits

One of the biggest problems associated workplace related injuries is the poor work habits workers inherit. Even if a worker has the most ergonomically sound workstation, they are still prone to developing musculoskeletal disorders. There are a number of risks that help contribute to these injuries, the following are a couple of things that computer users should be conscious of:

7.0 Stress

Whether it be stress outside of the workplace or caused by the workplace, stress can pose a significant risk in the development of musculoskeletal disorders. The human body resilience to stress is truly remarkable however it eventually catches up. Here’s how it works, stress or stressful situations cause the user to work and think at a faster pace (i.e. I have to get this job finished before my deadline). This causes the user to use the muscle and body parts at a faster pace than what they are normally used to.

This causes fatigue and lactic acid to build up more quickly. Given the fact that the user may have a limited time in which to conduct this task they tend to ignore fatigue and pain factors which ultimately cause significant problems down the road.

8.0 Repetitive tasks for prolonged periods of time

How many times do users power through repetitive tasks for prolonged periods of time just to meet a deadline? The answer may surprise you. With leaner workforces and an overall mentality to do more with less, musculoskeletal disorders are on the rise. Workers routinely perform mundane and repetitive work for extended periods of time, ignoring pain caused by muscle fatigue. Compound the fact that when users feel this fatigue, they either choose to ignore it, or they change positions putting themselves in an awkward posture. Usually when the user stops what they are doing the fatigue and pain subside, however if the user does this on a continual basis over a couple of years, that is when the repetitive strain injuries (RSI's) and musculoskeletal disorders present themselves. Whenever a user feel s the signs of fatigue or pain of any kind, stop what you are doing and take a break

9.0 Breaks

The risk of developing musculoskeletal disorders while using a computer for prolonged periods is well documented. In order to minimize the risk of developing a musculoskeletal disorder, users should ensure they take regular breaks. The following are a couple types of breaks that users may implement; just remember that breaks and exercises need to be combined with good workstation set-up and/or posture for them to be of most help!

9.1 Micro-breaks

Most typing is done in bursts rather than continuously. Between these bursts of activity you should rest your hands in a relaxed, flat, straight posture.

9.2 Rest Breaks

Every 30 to 60 minutes you should take a brief rest break. During this break stand up, move around, and do something else. Go get a drink of water, soda, tea, coffee, or whatever. This allows you to rest and exercise different muscles and you'll feel less tired.

9.3 Ergonomic Software

Software is available that will monitor your computer time is available. It will prompt you to take a rest break at appropriate intervals, and it will suggest simple exercises. You can purchase this software or you can download simple versions that get the job done just as well.

Voice recognition software lets you talk to your computer using a microphone normally on a headset. This software allows a worker to dictate letters and as he/she talks, the

words appear on the computer monitor. Some **voice recognition software** also allows you to navigate around your computer like what you can do with your mouse. For more information regarding this software, please contact ITS.

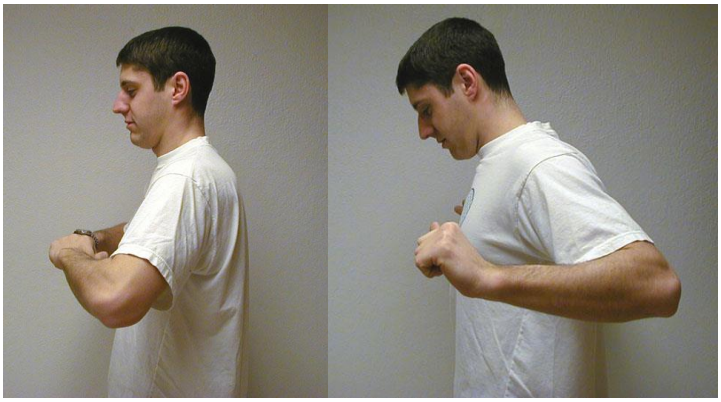
9.4 Exercise Breaks

There are many quick stretching and gentle exercises that you can do to help relieve muscle fatigue. These should be done every 1-2 hours, depending on your needs.

9.4.1 Workstation Exercises (to be done at least once an hour)

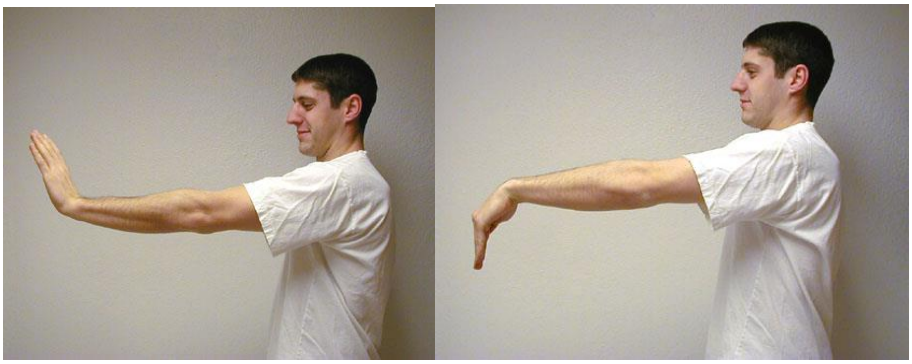
1. **Deep Breathing**: Breathe in slowly through the nose. Hold for 2 seconds, then exhale through the mouth. Repeat several times.
2. **Head and Neck**: Turn head slowly from one side to the other, holding each turn for 3 seconds. Repeat several times

3. **Back**: Start with the arms bent, hands near chest area, and push elbows back. Hold for 5 seconds, then relax. Repeat several times. You can also raise arms in the same fashion, this time close to the shoulders, to work out the upper back.



4. **Shoulders**: Roll shoulders slowly in a circular fashion, while trying to make the circle as big as possible. Take about 5 seconds to complete one circle. Repeat several times.

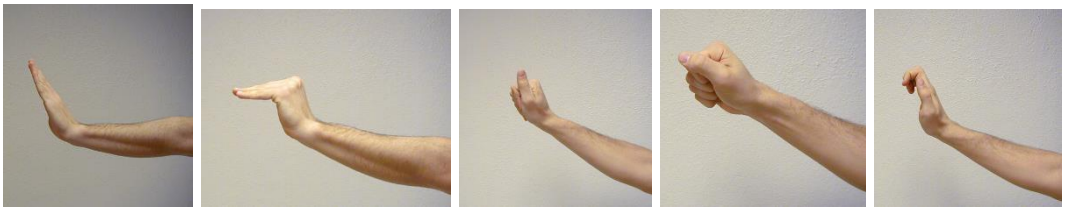
5. **Wrists**: Hold your hands out in front of you. Slowly raise and lower your hands to stretch the muscles in the forearm. Repeat several times.



6. **Fingers and Hands**: Make a tight fist. Hold for a second. Then spread your fingers apart as far as you can. Hold for 5 seconds, then relax. Repeat several times.

a) **Tendon Gliding Exercises**: These relieve tension in the tendons. Do each of the following movements slowly, but do not force any of the positions. Go as far as you comfortably can.
a) Starting Position: Raise your arm, with the hand extended (you can also rest the elbow on a table and extend the hand).
b) Roof: Bend your fingers down to a right angle. Return to starting position.
c) Straight Fist: Touch your fingertips to the base of your palm, keeping the thumb straight. Return to starting position.

d) Hook Fist: Gently make a hook. Return to the starting position.
e) Full Fist: Make a fist. Return to the starting position.



In addition to these exercises, encourage your children to take short breaks (micro breaks) and to do some gentle stretching “or stand up and move around during these brief pauses.

10.0 Telephones

Spending prolonged periods of time on the telephone can lead to neck, shoulder and upper back pain and injuries. Using the proper techniques and equipment will is the key to preventing injuries.

Place your phone on your dominant side and close to your regular work area in such a way as to prevent reaching, twisting or bending.

10.1 Hands-free

Choosing a hands free option allows the worker to maintain the proper posture while on the telephone and performing other duties such as typing or writing. This will prevent workers from cradling the phone between the head and the shoulder. Shoulder rest devices are strongly discouraged as they place stress on the neck and shoulders. Using the speaker phone allows for maximum flexibility to work while talking; however, in some spaces, this may not be practical.
Headsets are another viable option to allow for hands free telephone use while working in order to keep your body posture in a neutral position.

10.2 Mobile/ Smart Phones

Mobile phone use can also contribute to ergonomic issues now that most phones allow the user to access a variety of services such as accessing the internet, email, texts and social media. Typically, user’s heads will tilt forward and downward, which surge causes approximately 10-12 pounds of pressure on the cervical spine. Repetitive increases in stress such as this can lead to injuries.

11.0 Noise

Noise can cause stress and that tenses your muscles which can increase injury risks. Try to choose a quiet place for your workstation, to mask the hum of any fans or other sound sources.

- Work in an environment with a level of noise that is comfortable for you. Working in an uncomfortably loud environment stresses the body and, as a result, the muscles tense up. This tension accelerates injury.
- If using headphones, make sure they are at a comfortable noise level and that they fit properly.

Noise levels commonly found in office environments.

Office	Equivalent noise level dB(A)
Very quiet, small offices and drawing offices	40-45
Large, quiet offices	46-55
Large, noisy offices	55-65

12.0 Indoor Air Quality (IAQ)

Indoor air quality concerns ergonomics in the fact that it may affect the health, comfort and performance of office workers. Office buildings can contain a wide variety of contaminants, however the major air contaminant which are of most concern in an office environment are the following:

- Carbon monoxide
- Carbon dioxide
- Formaldehyde
- Allergens and Pathogens
- Respirable Suspended Particulates (RSP's)
- Moulds
- Asbestos
- Ozone
- Tobacco Smoke

There are a significant number of factors that can affect IAQ, as noted. The following table is an example of a few.

Factors that may affect IAQ:

Factor	Sources	Typical IAQ contaminants from identified factor
Emissions from indoor sources	Interior furnishings and finishes (wood products, carpets, fabrics, paints, adhesives, sealants)	Volatile Organic Compounds, and Formaldehyde
Microbial Contaminants	Plumbing leaks, pipe condensation, flooding	Airborne and surface fungi and bacteria, microbial, and VOC's

Poor Ventilation	Improper HVAC System, Poor maintenance	Carbon Dioxide, Fluctuations in temperature and RH
Office Equipment	Photocopiers, laser printers, air cleaners.	Ozone, Particulates, Ammonia, VOC's

13.0 Temperature

Optimum conditions for the office environment vary depending on the season. Individual comfort levels also vary. If workers are unable to control the temperature in their offices, they should work with their supervisors to implement solutions to ensure that they are comfortable such as fans, heaters, relocation, layering clothing, etc.

The minimum temperature requirement in an indoor space is 18 degrees Celsius, as per Regulation 851, the Industrial Regulations. There is no maximum temperature. If temperatures fall below 18C, the employer is required to take corrective action or provide suitable accommodation to workers until the temperature can be adjusted accordingly. Where a workplace is excessively hot due to environmental conditions, a process or equipment, or as a result of a temporary maintenance issues, managers should consult the Environmental Exposures Standard or follow the Ministry of Labour's Heat Stress Guideline, in order to protect works from heat related illnesses such as heat stress:

https://www.labour.gov.on.ca/english/hs/pubs/gl_heat.php.

According to the ASHRAE standard, the following temperatures are on average found to be comfortable for workers:

Temperature Range:

Summer 22.6 to 27.2 °C
Winter 19.5 to 24.6 °C
} ASHRAE

Relative Humidity: 20-60%

Carbon Dioxide: 600-800 ppm Recommended for Office Environment
Below 1000 ppm for comfort
OH&S Act TLV= 5000 ppm

Outdoor Air Requirement:

Office Space 10 litres/sec/person
Classroom 8 litres/sec/person
Libraries 8 litres/sec/person
} ASHRAE

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