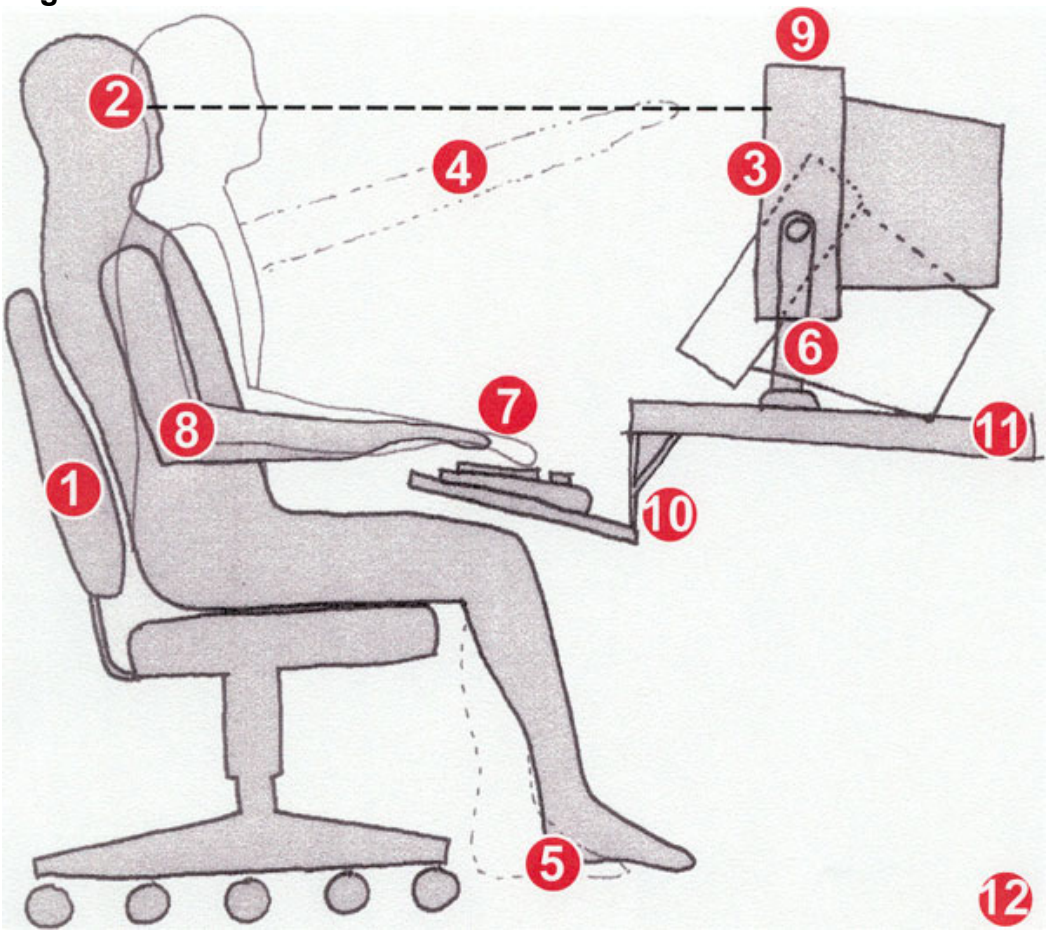
SUPPLEMENTAL SECTION

ADDITIONAL RESOURCES ON WORKSTATION DESIGN AND SETUP

Figure #1: Ideal Workstation

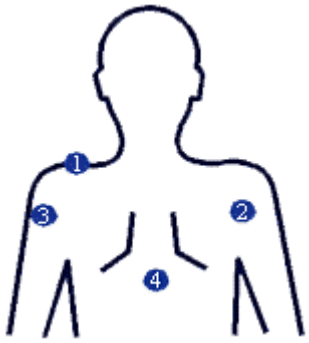


1. Use a good chair with a dynamic chair back and sit back in this
2. Top of monitor casing 2-3" (5-8 cm) above eye level
3. No glare on screen, use an optical glass anti-glare filter where needed
4. Sit at arms length from monitor (18-30 inches)
5. Feet on floor or stable footrest (Knees at near 90 degrees)
6. Use a document holder, preferably in-line with the computer screen
7. Wrists flat and straight in relation to forearms to use keyboard/mouse/input device
8. Arms and elbows relaxed close to body (Elbows at 90 to 92 degrees)
9. Center monitor and keyboard in front of you
10. Use a negative tilt keyboard tray with an upper mouse platform or downward tiltable platform adjacent to keyboard
11. Use a stable work surface and stable (no bounce) keyboard tray (29-30 inches in height)
12. Take frequent short breaks (micro breaks)

SECTION #1: COMFORT AT YOUR WORKSTATION

You can hopefully eliminate some of the sources of you pain and discomfort by following some of guides presented below by examining different portions of your body and by adjust your workstation accordingly to find your comfort zone. Certain postures and positions will result in pain and possible injury but because of individual body characteristics and other subjective factors you may have to experiment with a series of adjustments that best suit you type of body and the work you are performing.

Shoulders (Areas 1-4 describe the location of your discomfort)



(1) Top of shoulder: shoulders kept raised

Probable cause of discomfort	Possible correction
a. Work surface too high	Lower keyboard or desk; raise chair and support feet
b. Elbows bump armrests	Remove or lower armrests; change chair
c. Backrest too high	Adjust backrest
d. Worker is tense	Drop shoulders, hang arms loosely

(2) Behind shoulder: shoulders pulled back

a. Same as #1	See 1a through 1d
b. Keyboard too close	Push keyboard away so that arms hang vertically
c. Incorrect posture	Sit upright with head in line with body
d. Forward lean	Raise visual task to straighten upper back; see #5

(3) Outer shoulder: elbows positioned away from body

a. Same as #1	See 1a through 1d
b. Work too far to one side	Reorganize desk to bring work closer to midline of body so arms hang vertically

(4) Between shoulder blades: arms held forward

a. Keyboard or work too far away	Bring work closer so arms hang vertically

Neck (Areas 7-8 indicate location of discomfort)

(5) Base of neck: forward lean

Probable cause of discomfort	**Possible correction**
a. Documents too low	Raise documents; use a document holder
b. Screen too low	Raise screen so that top is at, or just below, eye level

(6) Upper back: hunched over work

a. See #5	See 5a and 5b
b. Chair too low or high	Adjust chair

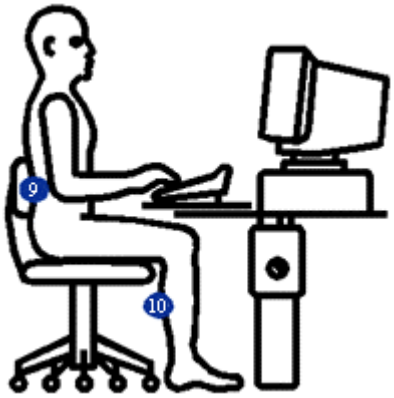
(7) Top of neck: chin juts forward

a. Visual task too high	Lower visual task, or slightly recline
b. User wears bifocals	Switch to trifocals or separate prescription for VDT distance

(8) One side of neck: head constantly turned

a. Main visual task to one side	Bring work closer to center; alternate placement of work to either side; use document holder

Back and legs (Areas 9 & 10 indicate areas of discomfort)



(9) Lower back: inadequate back support

Probable cause of discomfort	Possible correction
a. Backrest too high or low	Adjust backrest to firmly support the small of the back (lumbar region)
b. Backrest not used	Adjust backrest forward to support lower back; change chair
c. Forward slump	See #5 and #6
d. Buttocks not to rear of chair	Move backrest forward; sit back
e. Chair too high	Lower chair

(10) Lower leg: leg circulation cut off

a. Feet not supported on floor	Lower chair and/or work surface; use footrest
b. Seat pan too deep	Change chair
c. Front of cushion not rounded	Change chair
d. Chair too high	Lower chair

Forearm, hand and wrist (Areas 11-13 indicate areas of discomfort)

(11) Forearm upper surface: hand held up

Probable cause of discomfort	Possible correction
a. Wrist on table or keyboard when keying	See 1a through 1d; use wrist support
b. Keyboard angle too steep	Adjust keyboard angle
c. Wrist held stiff	Relax work style
d. Lack of mini-pauses, job variety	Relax and vary tasks, drop hands when not keying data

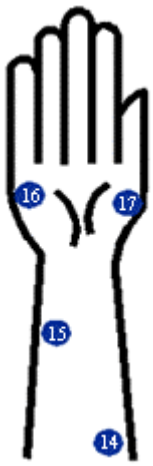
(12) Outer surface: hand held sideways

a. Elbows stuck out	See 1a through 1d
b. Keyboard at wrong angle	Turn keyboard to straighten wrists
c. Wrist is bent to reach function or cursor keys	Move arm, don't bend wrist

(13) Hand (little finger end): bending wrist and stretching

a. Over-stretching	See 12c
b. "Hammering" action (striking keys with hard pressure	Relax work style

Forearm and hand



(14) Forearm flexor muscles: banging keys

Probable cause of discomfort	Possible correction
a. Lack of training	Use tactile/auditory feedback; use lighter touch

(15) Flexors (outer/ulnar side): hand held sideways

a. Lack of training	See 12a through 12c; move arm, avoid bending wrist

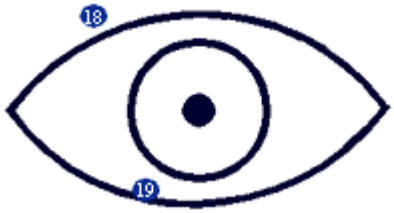
(16) Little finger: over-stretching or banging

a. Over-stretching fingers	See12c
b. "Hammering" action (striking keys with hard pressure)	Use different finger; relax work style

(17) Thumb muscle: sustained pressure

a. Repeatedly hitting space bar	Modify action to make space bar repeat when held down
b. Folding paper using thumb to crease	Use back or side of hand, folding block or blade
c. Writing with awkward thumb angle	Replace pen; add rubber grip

Eyes (Areas 18 & 19 indicate areas of discomfort)



(18) Eyes: awkward head position

Probable cause of discomfort	**Possible correction**
a. Head juts upward to peer at screen	Vision not corrected or improper prescription; bifocal wearer may need separate single-prescription glasses
b. Worker sits close to screen	Vision not corrected; eyeglass wearer may need separate prescription for VDT-related tasks
c. Worker sits away from screen	Vision not corrected; eyeglass wearer may need separate prescription for VDT-related tasks

(19) Eyes: squinting

a. Screen appears to be fuzzy	Check vision/prescription; check for sources of glare; clean screen; check for computer malfunction
b. Staring at screen	Blink regularly, more often if wearing contacts

*Adapted from IBM website

SECTION #2: ADDITIONAL RESOURCE MATERIAL

Ideally you should start by working smarter. Sitting in a fixed position for long periods of time can be uncomfortable and fatiguing. Shifting your position and occasionally stretching or changing your routine by doing other tasks can help keep you alert and reduce muscular discomfort.

Some of the key points are to make sure that you:

- Adjust your seat so that you are comfortable, with your back supported, your feet flat on the floor and there is no pressure behind the knees.
- Change position, stand up or stretch whenever you start to feel tired.
- Use a soft touch on the keyboard and keep your shoulders, hands and fingers relaxed.
- Organize your work area so that all work material and tools are within easy reach and at a comfortable level.
- Use a document holder, positioned at about the same plane and distance as the display screen.
- Batch work; do a variety of tasks where possible.
- Keep your head in line with your body, with your head slightly forward.
- Adjust your display to a comfortable viewing height, with the top of the screen at or just below eye level.
- Rest your eyes by occasionally looking off into the distance.
- Include vision care in your health program; advise your eye care specialist that you use a VDT, including the frequency of use, sitting distance from screen and angles of visual tasks.
- Avoid glare by positioning your screen away from light sources, e.g. sunlight from window or overhead lights. Use a glare filter, if needed.
- Adjust the screen for contrast and brightness.
- Clean the screen.

Notify your manager if discomfort persists.

Posture

Prolonged work in the same position, whether seated or standing, can cause discomfort. Where possible, movement should be incorporated into the task to prevent discomfort and fatigue.

Standing

Here are some guidelines for optimum posture for standing jobs:

Avoid having operators stand still in one place for unduly long periods of time. The activity of the leg muscles acts as a pump and assists the veins in returning blood to the heart. Prolonged standing stops this pumping action and this causes swelling of the

lower extremities. Provide a rubber or padded mat where prolonged standing cannot be avoided. This should reduce fatigue and improve comfort.

Sitting

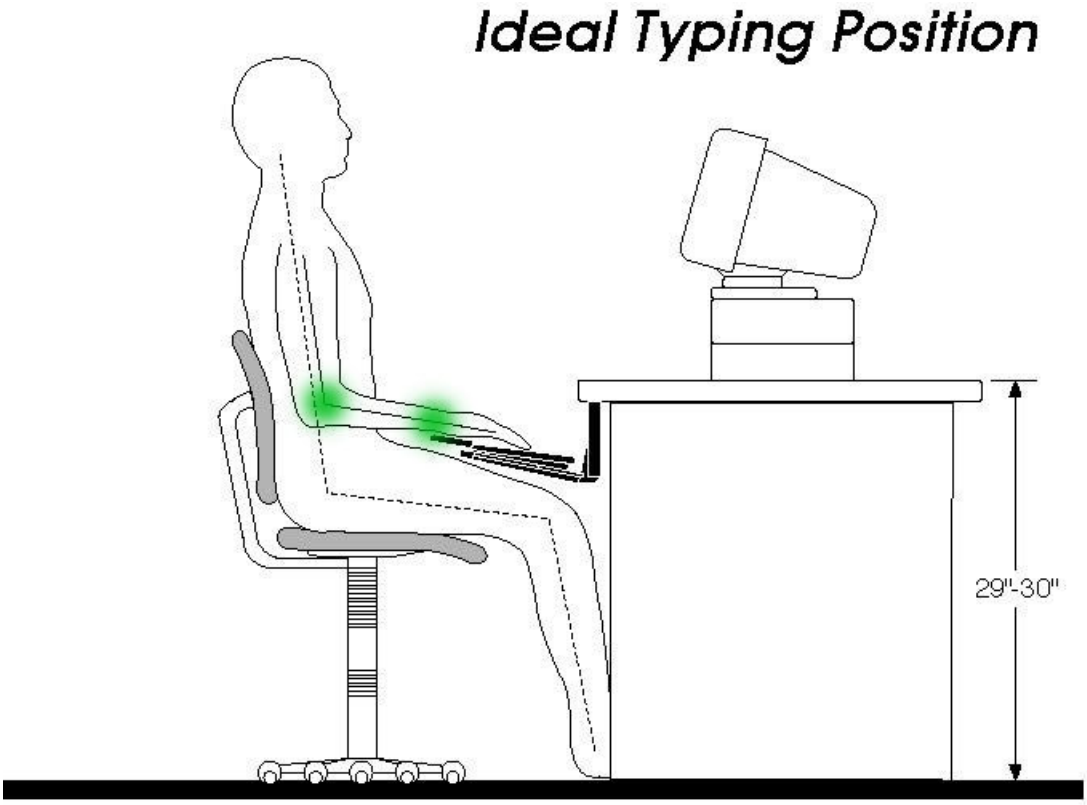
A well-designed chair for the operator is one of the most important parts of a workstation. It can favorably affect posture, circulation, the amount of effort required to maintain a position, and the amount of pressure on the spine.

The following recommendations should be followed:

- The seat should adapt to the user, not vice versa.
- Chairs should be stable and fully and easily adjustable from the seated position.
- Seat pans and backrests should be upholstered and covered in a material, which absorbs perspiration. A 20 mm compression is about firm enough.
- Seat pan height should be adjustable and should transfer the user's weight through the buttocks, not the thighs.
- Backrests should adjust up/down and backward/forward or flex with body movement for good lumbar support. A forward tilt of the seat pan may relieve body stress in certain applications since it allows the backrest to follow the person when performing varied tasks.
- Where mobility is required, wheels or casters should be fitted to the chair (hard casters for soft floors and soft casters for hard floors). Special consideration should be given in certain cases, for example, where a slippery floor makes it difficult to keep the chair in the desired position. Where wheels or casters are fitted, chairs should preferably have five legs. This offers improved stability and reduces the risk of tipping over.
- The front of the seat should be of a "waterfall" design in order to provide sufficient clearance for the flesh of the thigh and to prevent reduction of blood circulation.
- For tasks requiring frequent lateral movements, seats should swivel.
- Holding the same-seated position for long periods of time causes fatigue. The diagram on seat posture illustrates what has been normally accepted as the best posture for sitting for long periods. However, individual preferences must be permitted, and it is therefore important that chairs be well designed and adjustable.
- In order to achieve satisfactory posture it may be necessary to adjust the workstation height. This is the reason that typewriters and computer terminals are often placed on a lower work surface at secretarial workstations.
- Footrests should be provided where chair or workstation height adjustments cannot be made sufficiently to allow the relief of pressure under the thigh from the seat. These should be angled and covered with a non-slip surface to provide comfortable support for the feet.
- Headrests should be considered for operators where the head must be tilted forward or backward for prolonged periods. A common application is the use of optical viewing tools such as microscopes. The head is relatively heavy. If the head is not kept straight, the pull of gravity will cause stress and strain in the muscles of the neck.
- Handrests should be provided for intricate tasks such as fine assembly or inspection. With the weight of the arm supported, the hand is stabilized improving hand dexterity and comfort.

- Armrests should be provided when tasks require the arm to be held away from the body. The further the arm is held away from the body, the greater the fatigue and subsequent decrease in manual control. Armrests should be padded and covered with an absorbent non-slip material.

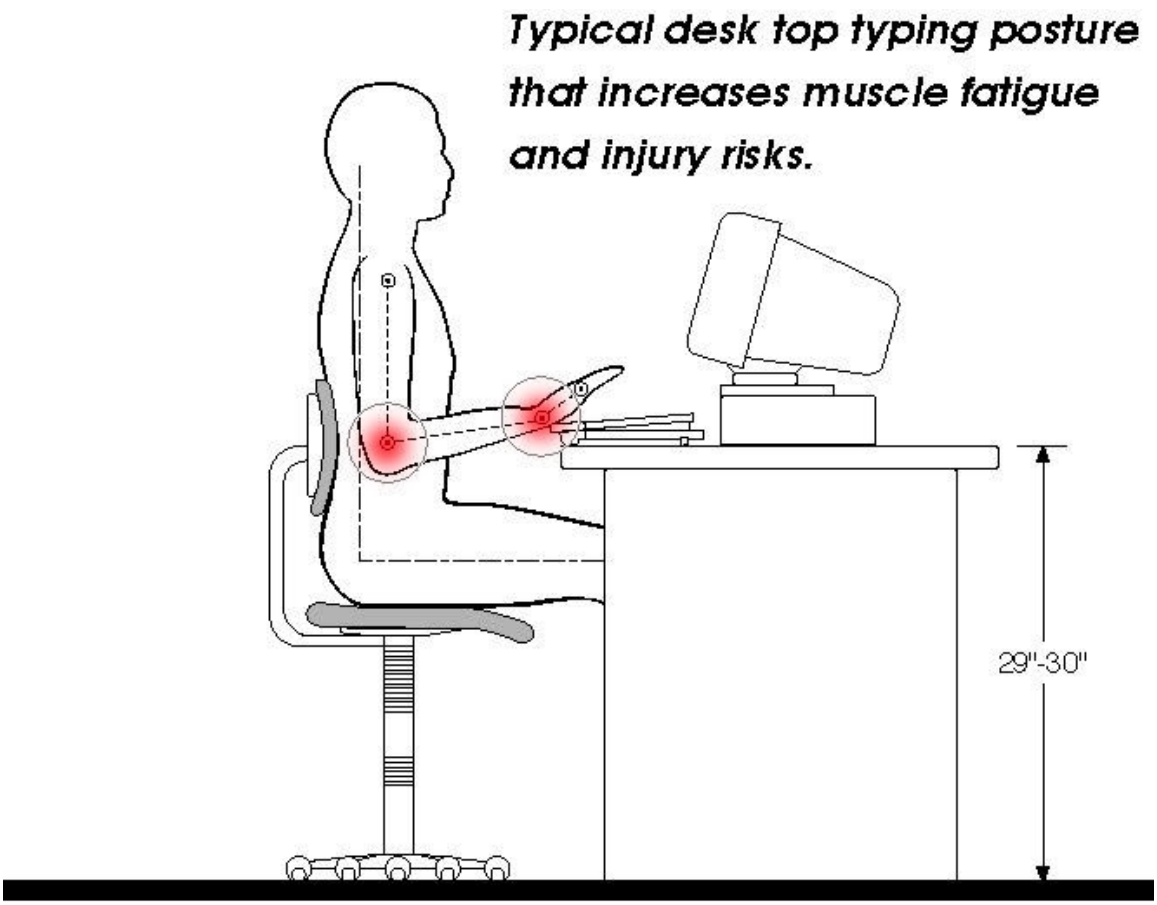
Workstations should be designed in such a way that all objects and tools, which require frequent access, are located within acceptable reach distances. The design should account for individual variations (anthropometrics).



1. Near 90^0 at hips*
2. Near 90^0 at elbow, forearm nearly parallel, to floor **wrist in neutral** (not bent up) position*
3. Near 90^0 at knees with feet flat on the floor or a foot rest*

The chair is an important base of workstation operations. You need a chair that provides good lumbar (lower back) support, is adjustable in height of seat pan from floor and has at least a 5-wheel base. Chairs with less than 5 wheels are prone to tipping over and injuring the occupant.

*Note these positions are slightly variable. The human body is not designed to be tightly locked into any one position for a long period of time. You should vary the positions occasionally. A future article will feature simple exercises you can do at your workstation to relieve stress and stimulate circulation.



Most desktops are too high for keyboard placement. Desktop placement of keyboard is acceptable only if you can maintain correct positioning or only use your keyboard occasionally.

Note in the sketch above that the person's position is not correct, because the elbows are bent further than a 90-degree angle, and the wrists are hyper-extended (bent up too far) as well. These are the areas highlighted in red.

How to Setup Your Workstation:

Good ergonomic practice is important to get the most from your personal computer and to avoid discomfort. This means that the equipment and the workplace should be arranged to suit your individual needs and the kind of work that you do.

Work Surfaces

Among the work surfaces of a workstation are key tops of the keyboard, the image surface of the display, the surface of the source document, the writing surface, the wrist support surface and the arm support surface. Tasks related to each of these may require different adaptations of the body. For example, proper keyboard location depends on how often the keyboard is used, whether the keying activity is a one- or two-handed task and how often visual guidance is required to locate specific keys during the task.

Text entry requires equal use of both hands for keying, so the keyboard should be directly in front of the user and at a comfortable height. Data entry, however, typically requires one hand for keying (usually numeric) and the other for maintaining a source document reference position or manipulating source documents. For data entry, it is best to place the keyboard directly in front of the keying hand and leave a large area free for the activity of the other hand. There should be sufficient work surface space to perform the task.

Display Location

The location and orientation of the visual display terminal depend on the lighting characteristics of the work area, the viewing distance and angle, task sequence and glare control.

The requirements in ANSI relate to a minimum viewing distance:

"The minimum design viewing distance shall be equal to or greater than 30 cm (12 inches)"

Character size, also previously discussed, determines both the minimum and maximum distance between the screen and the user's eye. In practice, many users prefer a viewing distance of between 35 and 50 cm, or even longer if large characters are displayed. The greater distance is recommended, as it will lessen the probability of visual discomfort since it requires less convergence likely to cause eyestrain.

Proper display height is related to eye position. A comfortable line of sight is 10 degrees or more below the horizontal. The display screen itself subtends a large angle with respect to the eye position. Hence, the display should be located so that the normal line of vision falls in the upper half of the display.

The tilt angle of a display should consider the trade-off between reduction in the angular size of the symbols and glare, or reflections from the surface of the display. The first several degrees of tilt away from a plane normal to the line of sight has a minor affect on the angular size of the characters, as can be seen in the following, but may have a significant effect on glare.

Screen surface orientation in degrees away from a plane normal to the line of sight	**Percent reduction of the angular height of the symbol**
5	0
10	2
15	3
20	6
25	9

Direct reflections from overhead light sources on the surface of the display may be annoying. This may happen even with displays that use an anti-glare treatment. As the display inclination is brought forward, the probability of annoying specular reflections from overhead light is reduced. If the screen is located near the vertical and below eye height, specular reflections from overhead light should not reach the eye at all.

In the course of a day's activities, people assume many different postures. Many slouch forward, some cross their legs, sit on one leg, or lean backward in their chairs. Shifting one's posture periodically seems to be a natural and necessary activity whether at work,

play, or even rest. Furniture, therefore, needs to provide clearances sufficient to accommodate postural flexibility. The space under work surfaces is of particular importance, and the ANSI Standard discusses that subject in great detail. Figure 50 is adapted from the ANSI Standard and shows the minimum knee space under a work surface required for comfortable seating by the 95th percentile male. Obviously, that clearance will be adequate also for smaller persons, but perhaps it should be emphasized that the measurements are the minimum clearances required for the large male. The minimum depth from the user's edge of a work surface is 38.0 cm (15.0 inches) at the knee level. At the floor level the depth is given is 59.0 cm (23.5 inches). The minimum width is 50.8 cm (20.0 inches) and the minimum height of the clearance envelope is 66.5 cm (26.2 inches), measured from the bottom of the support surface to the floor.

Workplace Organization

The way you organize the elements of your workplace to fit your individual needs is probably the most important consideration in working comfortably. You can save time and effort throughout the workday by taking a few minutes to think about the best position for your equipment and the most effective use of your space.

Make sure that you:

- Have sufficient desk area, which allows you to position your keyboard, mouse, display, document holder and other items (such as a telephone) in the way that works best for you.
- Organize your desk to reflect the way you use work materials and equipment. Place the things that you use most regularly, such as a mouse or telephone, within the easiest reach.
- Vary your tasks and take periodic breaks. This helps to reduce the possibility of discomfort or fatigue.

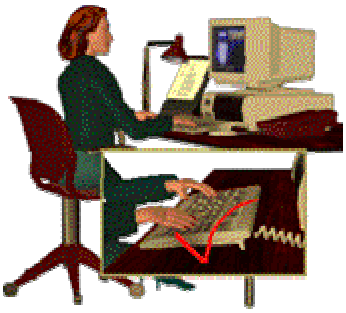
Chair

The chair is one of the most important items in your workplace. It can encourage good posture and circulation and so help you to avoid discomfort. Select a chair that is

comfortable for you; it should be adjustable and provide good back support. You should adjust your chair so that:

- Your thighs are horizontal and there is support for your lower back. If your chair has insufficient adjustment, lower back support may be improved with a cushion.
- Your feet rest flat on the floor when you are seated and using your keyboard. If you cannot do this, your chair is probably too high and you should use a footrest. You should change your sitting position occasionally during the workday. Sitting in a fixed position for too long can induce discomfort.

Keyboard



Comfortable use depends on keyboard height, arm position and touch. You are seated correctly if:

- The keyboard is positioned so that your arms are relaxed and comfortable, and your forearms are roughly horizontal.
- Your shoulders are in a relaxed position, not hunched up.
- Your wrists should be extended straight, not bent up or down uncomfortably.
- If you use a wrist/palm rest, it should NOT be used while actually keying but in between periods of keying.
- Your hands should glide over the keys. Hands remaining in a fixed position cause fingers to over-reach for the keys. Use a light touch for keying, keeping your hands and fingers relaxed.
- Place the mouse close to the keyboard so that you can use it without stretching or leaning over to one side.

Display

Most displays feature a variety of adjustments, which enable you to set up your equipment in a way most comfortable to you:

- Make sure that you position the screen to minimize glare and reflections from overhead lights, windows and other sources.
- It may be helpful to put an anti-glare filter on the front of the screen when it is impossible to avoid reflections or adjust lighting.
- Adjust the display so that the top of the screen is slightly below eye level for comfortable viewing.
- Position yourself and the display to achieve and maintain a comfortable viewing distance, usually about 20 to 24 inches (50 to 60 cm).
- Keep your head in a comfortable but upright position.
- Set the contrast and brightness of the screen at a comfortable level. As the light in the room changes, adjust the contrast and brightness, if necessary.
- Clean your screen, anti-glare filter and eyeglasses on a regular basis.

Consult your vision care specialist if you experience eye fatigue or discomfort.

Stretching Exercises

Shifting your position and occasionally changing your routine by performing different activities and/or stretching exercises can be extremely useful in eliminating ergonomic-related discomfort.

- Stretching Exercises

Some of the more common stretching exercises that you can perform at your desk are listed below. In addition, don't forget that keeping yourself in good physical condition through a regular exercise program will keep you healthy both at home and at work.

- **General:** Stand up and stretch your arms over your head
- **Eyes:** Rest your eyes by occasionally looking into the distance and/or closing them for a few seconds.
- **Neck:** Turn your head slowly to the left for 5 seconds and then to the right for 5 seconds. Repeat several times.
- **Shoulders:** Let your arms relax at your side and then raise your shoulders, rotating them up and back in a circular motion. Repeat several times.
- **Upper Back:** Make sure that your chair is stable. With feet flat on the floor, clasp your hands behind your head and slowly arch your back, bending your head backward. Hold up to 5 seconds.
- **Wrists:** With your hands held in front of you, gently rotate your wrists so that the fingertips form circles in the air. Repeat several times.
- **Fingers:** First clench both fists and hold for 5 seconds. Then spread fingers as far as you can and hold for 5 seconds. Relax and repeat several times.