MONTANA
TECHNOLOGICAL UNIVERSITY

Visual Ergonomics for Computer Users

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Greetings and welcome to the information era where paper is not king. Using the computer screen/monitor intensively to read documents poses challenges and stresses to those users not experienced by those who read paper files at their desk or in the comfort of their home.

Your priority **MUST** be good visual ergonomics to preserve your ability to complete the computing tasks assigned. While I will touch on elements of workstation design that relate to upper extremity and spine health; your **"seeing power"** is paramount. Eye fatigue is the number one complaint for those using computers and read online for extended periods and intensively.

This short document is intended to provide **“basic” but “essential”** information about computer ergonomics and some thoughtful recommendations that can be employed without much effort.

The Chair:
The chair is the most important piece of office equipment that will affect your comfort while performing seated work.

- **Get the best chair that you can!**
- The goal is to comfortably support your buttocks, legs, back and possibly arms.
- The features should match your preferences.
- **The chair should be adjustable!**
- Adjustments should be easy to accomplish.
- Please see primer for details related to features.

The Workstation:
The workstation should be set up around your chair, not the reverse! After you are "very happy" with the comfort level of your chair, adjust the workstation according to your reading and use preferences.

- The goal is comfort and ease of use.
- The monitor should be set at the same distance that you read paper text.
- The monitor is usually placed between 18" - 30" from the viewer (average 24”).
- Use black lettering on a white background or the reverse (Good contrast).

- Set your browser view, text size to larger or largest (Easy reading – I use 125%)
- Place the monitor screen directly in front of you; **do not put** the screen to one side of the workstation.
- The top of the monitor screen should be at or slightly below the level of your eyes.
- The normal angle of viewing is usually between 20° - 65° downward (average 350).
- Don't wear your bifocals; use your reading glasses if needed.
- The monitor screen should be placed perpendicular to outside light sources to reduce glare (right angle to the major light or window).
- The keyboard should be placed comfortably in front of the user so that the arms remain relaxed at the sides. (Don't reach out from the body, keep it close ~10-12")
- A 90° to 100° arm / forearm angle is recommended (Shoulder and arm down 180^0).
- The keyboard is often placed 25" - 28" from the floor. (Adjustable is best – find your preferred height.)
- The mouse should be placed on a separate, moveable platform to the side of the keyboard. Reaching outward to use a mouse for extended time will cause fatigue in the arm, shoulder and neck. (You should not reach beyond the keyboard).
- Use a document holder placed close to the monitor screen if you are reading paper/book/printed materials.
- Careful of wrist/arm rests, people push down with an average of 3 - 8 lbs of pressure; it takes only 1 psi to cause impairment of circulation to tissue. Contact stress can lead to tissue stress, strain and injury in the upper extremity (You should hover above the keyboard).
- If you choose to use a wrist wrest, consider the gel filled ones. Broader tissue to surface contact distributes stress over larger areas reducing adverse effects.

The Lighting:

- The lighting is the most important factor in your "Staying Power" at the computer.
- The goal is uniform lighting on the monitor screen.
- **Avoid glare** at all cost; glare will result in fatigue causing Eye Strain!
- The iris controls the size of the pupil to allow light in the eye so, uniform light reduces the amount of dilation, constriction and fatigue.
- Glare (uneven lighting) will cause you to accommodate to the varied light intensity and lead to fatigue.
- Don't wear white clothing when computing, it creates glare. You should not see your reflection in the screen; that's indirect glare (Dark clothing is better).
- Avoid direct and indirect glare: Headlights and/or Reflected light.
- Locate your monitor perpendicular to external light sources (Strong light sources or windows).
- If windows are in front or behind you, use shades, blinds or drapes to shield yourself and/or the monitor.
- Place office lighting at least 60° from your line of sight (Avoid direct glare).
- Use diffused, indirect, louvered or filtered light from above (Avoid indirect glare).
- Keep the room dim (Low-level illumination is best for sustained computer use).

- Low-level illumination will provide the best contrast. Older eyes may want more light, that's an individual preference; yield to the need and adjust accordingly. Task lighting may be used for reading or directed light.
- Antiglare screens (micromesh or microlouvers) degrade contrast and may be a trade off for types of eye strain.

The Person:

- Be comfortable!
- Remember that neutral postures are the least stressful. Sit straight up, arms relaxed at your sides, forearms flexed with hands and wrists pronated (palm down).
- Find your best distance from the monitor terminal (Usually 18" - 30", average 24")
- ***Take a visual break every 15 minutes***! Look away from the screen and let your eyes relax and focus on something far away in the distance. ***Blink like the dickens!***
- People blink 21 x/minute when reading paper and only 7x/minute when reading from a monitor; it is believed that blinking less causes dry eyes leading to EYE STRAIN!
- Use a wetting agent if needed (Visine works for me!).
- Take a break every 30 minutes - vary your posture - get up - stretch - move your body. Humans are dynamic creatures by nature, not static!
- Check the stretching exercises provided. Humans need to move frequently to alter mechanoreceptor input, reduce fatigue and facilitate efficient circulation and feel better. This is good physiology.
- Don't bang at the keys, press with enough force to depress the key and no more, that's wasted energy and results in fatigue.
- Keep your shoulders relaxed. Bring that keyboard and mouse in close to you.
- Keep your head and neck centered over the gravity line - that reduces stress to the neck and upper back muscles. If you allow yourself to slouch, this causes muscles to contract leading to fatigue, soreness and headaches.
- Make your environment comfortable - temperature - fresh air - sounds (music on or off per your preference).

Resources:

Many books and online references are available online. If you would like more, please don't hesitate to send me a note at: dgilkey@mtech.edu

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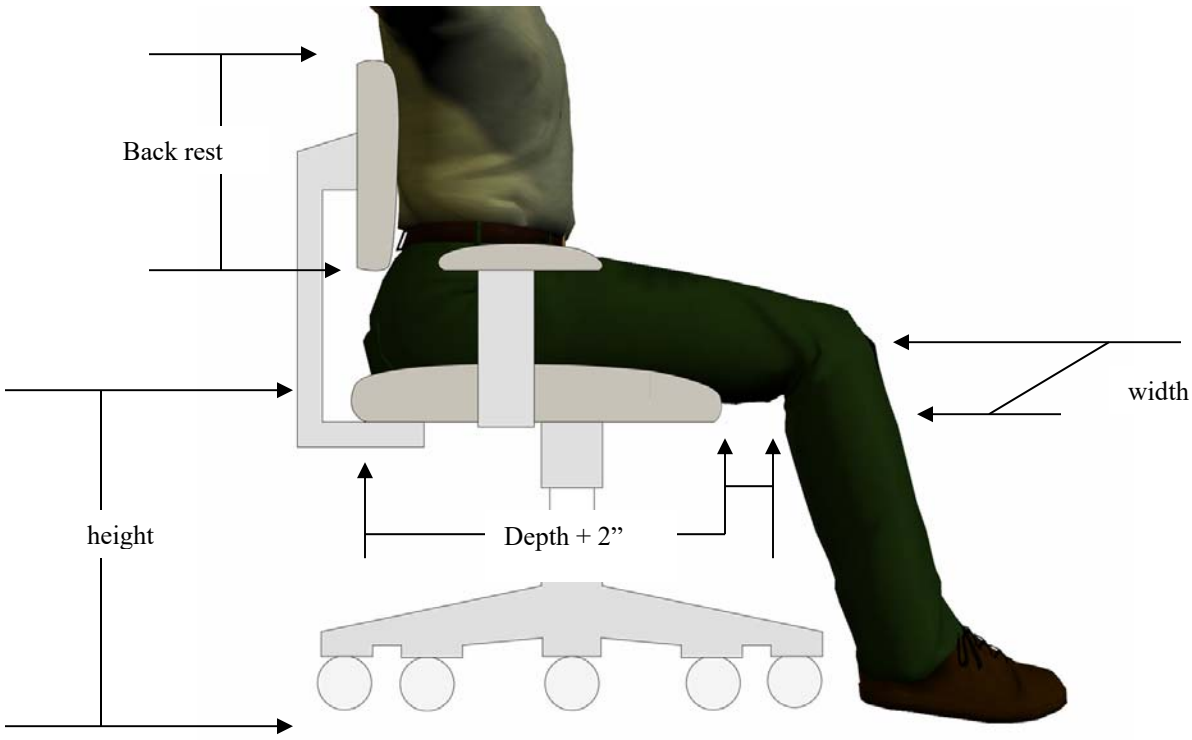
Ergonomic Chair Fitting Exercise

Office Ergonomics

Please complete the following measurements and provide recommendations. The chair should be the beginning of workstation design. Users, adjust your workstation to your well-fitted chair!



Name: _____ Date: Evaluator: _____

Office chair design features: 5 poster base, padded seat pad, fabric covered, waterfall front edge, adjustable height, seat pan tilt, back support and optional arm rests.

Essential Personalized Measurements and Recommendations:

Seat pan depth_____(Select a pan deep enough so that buttocks and thighs are supported with ~2” gap behind the knee)

Seat pan width_____(Select seat pan that provides enough “room” to fit the person without compression of hips or restriction of movement)

Chair height_____ (Important - adjust for level thighs with feet on the floor or w/footrest)

Back rest_____(The back rest should be at least 10” high and adjust to fit firmly against the users back for support)

Other Features: (User preference prevails)

Seat pan tilt 0^0 - 15^0 Level is recommended however some users prefer positive or negative tilt.

Arm rests (optional) If present, they must be padded, soft and adjustable. Some users prefer arm rests while others do not.

Foot rests (optional) Used to level thighs when seated due nonadjustable work surface.

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Office Chairs - An Ergonomic Primer

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1) Introduction

The office chair is the most frequently used piece of office equipment. An ergonomically designed chair is an essential item for all computer workstations. Experts have identified several features characteristic of well-designed ergonomic office chairs. With increasing numbers of computer users in the workforce, the computer office chair has received great attention. It is presently estimated that 110 million American workers spend some time each day using a computer and keyboard. Approximately 105 million workers use the office chair, computer, keyboard, and pointing devices as their primary work equipment each day, all day, and up to 8 hours per day or more. Computer use has been linked to several types of injuries known as "Upper Extremity Repetitive Stress Injuries" (UE-RSI's), "Cumulative Trauma Disorders" (CTDs), or "Work Related Musculoskeletal Disorders" (WRMSDs). RSIs, CTDs, and WRMSDs are associated with the upper extremities (UE) or arms, forearms, wrists, hands, and fingers as well as the neck, back and lower extremities (LE) or legs. Common CTDs associated with computer input devices include Carpal Tunnel Syndrome (CTS), Tendonitis, and Tenosynovitis effecting the hands, wrists, and forearms as well as Neck Tension Syndrome, Low Back Pain (LBP), and LE pain. The Bureau of Labor and Statistics (BLS) reported that the incidence of such disorders has increased 770% between 1981 and 1991 (BNA, 1995). Several studies have clearly shown a definitive link between CTDs and computer use (NIOSH, 1997). Ergonomics is the premier science which concerns itself with humans at work and the many aspects of the "Human Computer Interface" (HCI). Studies clearly demonstrate a scientific basis for ergonomic design of office chairs. The following is an overview of ergonomic issues related to office chairs.

2) Definitions and Terms:

A) Office Workstation Chair – The "office chair" has taken many forms in recent times with a wide array of workstation designs available for users. The "standard" office chair sits upright on a base, has a seat pan, chair back, and possibly arm rests. Modifications to these basic elements include recumbent, sit-stand, and kneeling designs. This primer addresses features related to the "standard" upright office chair.

B) Seat Pan – The seat pan is where you sit. It is the seat of the chair and provides the primary contact surface for sitting upright. The seat pan is available in a variety of sizes, shapes, and materials. Seat pans may be hard or soft, adjustable or fixed in position. Seat pan depths and widths are typically between 15" to 19".

C) Seat Height – This refers to the relative height from the floor to the seat pan. Height ranges are typically between 15” to 20”. Seat height may be adjustable or fixed.

D) Chair Back – The chair back supports the user from behind. Chair back sizes range dramatically from “low-back” (~10”) to “high-back” (~30”) chairs. Chair backs can be fairly straight upright (90^0) to sloping back (120^0) to reduce loads on the lumbar spine. They may be fairly flat or curved with a built-in lumbar support or curve. Chair backs may be hard or soft, adjustable, or fixed.

E) Armrests – Armrests are a feature preferred by some and not appreciated by others. They are intended to support the weight of the UEs while in the seated position. Armrests may be hard or soft, adjustable, or fixed.

F) Chair Base – The chair base provides support for the entire body weight. A typical office chair has a 5-post base for safety and stability.

G) Adjustability – This refers to the changeability of the many features of the office chair. Adjustability is an important feature that may be designed into the chair to alter positions, size, and height of the seat pan, chair back, and arm rests.

H) Seat Pan Tilt – This refers to the relative position of the seat pan compared to level. If adjustable, it may be positioned positive slope, negative slope, or level.

I) Backrest – Seat Pan Angle – This refers to the relative position of the chairback to the seat pan.

J) Waterfall Edge – This refers to the flowing downward of the front edge of the seat pan to reduce pressure on the back of the knee.

K) Impaired Circulation – This describes the loss of normal circulation to body parts such as UE or LE resulting from direct contact pressure or sustained static loading.

L) Spinal Loading – This refers to the amount of force placed on the spine.

3) How Ergonomic Chairs Address These Issues:

A) The features that distinguish “Ergonomic” office chair designs from less optimal chairs are identified below (Lueder, 1994):

1. Adjustable seat height
2. Adjustable back rest
3. Adjustable seat pan
4. Soft seat padding
5. Slightly concave seat shape
6. Seat pan front edge “waterfall”
7. The backrest tilts back easily
8. Padded lumbar support – adjustable
9. Full back support up to shoulders
10. Arm rest – short, padded, and adjustable
11. 5-Prong / leg chair base
12. Casters that roll easily
13. Seating that produces no pressure on knees

14. Preferably anti-static
15. Make all adjustments while seated

B) The Seat Pan – The seat should be slightly concave to fit the contour of the buttock for comfort and even distribution of force over contact areas. Many designs carry this step further and sculpt the pan to fit very comfortably for differing buttock shapes and comfort preferences. The user must try (sample) the different designs to find the most comfortable for him or her. The seat pan dimensions should be in the range stated above (~(15" – 22") x ~(15" – 22")). Each user should sit in the chair to test it for optimal fit, space, support, and comfort. The material should be soft, padded, and durable. The front of the pan should flow downward like a "waterfall". This design ensures no excessive pressure behind the knee causing impaired circulation.

C) Seat Height – This must be adjustable to accommodate the variability of leg lengths. Most ergonomically designed chairs adjust to a height between 16" and 20", maybe 25" vertically. When properly seated, the thigh should be parallel to the floor. The seat height is the first adjustment to be accomplished in fitting the chair to the user. The proper height adjustment establishes the placement of the remainder of office and computer equipment for the overall workstation layout. Some users prefer their seat low with the thigh slanting backward and downward to the hips. This is preferable to adjusting the seat too high, which can cause increased pressure behind the knees and impair circulation to the LE. In the event the seat is adjusted too high for a user to place feet squarely on the floor a footrest may be appropriate.

D) Seat Pan Tilt – This should be adjustable 15^0 (+/-) from level to suit user's preference. Most users prefer a level seat but others prefer a positive or negative slope for comfort or special needs. The ergonomically designed chair accommodates users with adjustability.

C) Backrests - Ergonomic features of backrest (aka - Seatback / Chairback) design include size, shape, and adjustability. The backrest should be large enough to cover the entire width of the back. A minimum of 12" is recommended for width. Seat back height preference varies dramatically from user to user. Some users prefer chair backs designed for only lumbar support, these commonly range from 6" to 10" in height. In that case, the lumbar support should be centered at L 3-4 vertebrae. A lumbar support should also have at least 4" of adjustability to allow centering in the back. However, many ergonomic chairs are designed with full-length chair backs that support from lower back to the top of the shoulders. In full-length designs, backrests should be contoured to fit the "S" shaped curves of the spine, not entirely flat or straight.

D) Backrest - Seat Pan Angle – This important angle should be adjustable for the individual user's preference. The angle between the seat pan and chair back should be adjustable between 60^0 to 100^0 when the user is seated with thighs parallel to the floor and legs properly supported vertically. This angle permits the user to sit slightly forward, straight up, or recline back depending on the type of computing performed, support needed, and comfort desired.

E) Armrests - Ergonomic armrests are optional features. Individual preference prevails in deciding to buy a chair equipped with such a feature. Armrests, like wrist rests, aid in supporting UE weight and thus help maintain comfort, endurance, as well as normal circulation by decreasing static load to muscles contracted to lift and hold limb position

during computing. Muscles that contract vigorously quickly use their energy supply and starve for more oxygen and sugar. Using armrests reduce the amount of contraction necessary to hold the limb in position thereby reducing the use of oxygen and energy. Armrest users report enhanced performance including less fatigue, increased comfort, and better endurance with sustained computing. Armrests should be placed at least 18.5" apart and made of soft or padded material. An ergonomically designed armrest should be adjustable vertically and not impair circulation due to direct pressure to contact areas but distribute that load over broad areas comfortably. Armrests should adjust between 2" and 4" vertically to accommodate user's preference.

F) Chair Base – An ergonomically designed chair has a solid, safe, and stable 5-post chair base. It should be made of strong materials to support up to five times the body weight. The chair base should also be equipped with quality casters to permit easy maneuvering on office floor surfaces. Specific casters are available for carpeted Vs. hard floors. Users are recommended to purchase the appropriate caster for the floor surface used. Do not assume that casters are universal for all surfaces unless reported by the manufacturer.

G) Adjustability – Adjustability is the "hallmark" of ergonomics. Chair adjustments should be easy, intuitive, and accomplished while sitting in the chair. Leuder (1994) defined "ease of adjustability" as the following:
    1. Adjustments from the standard seated position.
    2. All users can understand adjustment labels and instructions.
    3. Adjustment controls are easy to find and interpret.
    4. Tools are not required to make adjustments.
    5. Adjustment controls provide immediate feedback.
    6. The adjustment controls are logical, intuitive, and consistent.
    7. A minimum amount of motion and effort is required to successfully make adjustments.
    8. Adjustments may be made with one hand.
    9. Adjustments are intrinsically reinforcing.

H) Spinal Loading – Protracted use of office chairs commonly cause fatigue to the back. Ergonomic chairs are designed to support the spine. Aspects of ergonomic design can reduce spinal loading by properly fitting the user and providing reclined positioning. Support to the lumbar spine is accomplished by a properly fitting backrest adjusted to the optimum position. Reclining the backrest reduces spinal loading. Users are advised to test the many features of ergonomic chairs to identify the best combination of features that meet their needs.

Summary:

A) General Ergonomic Considerations:
Office chairs are the most frequently used piece of office equipment. They are often taken for granted; yet, a properly designed office chair is an essential piece of equipment for anyone working in a seated posture for extended periods of time. Ergonomic designs optimize human interaction and preserve health and well-being. Ergonomic office chairs are a critical component of an overall workstation design. Ergonomically designed office chairs offer a number of features to accommodate the human body's shape, size, capabilities, limitations, and comfort. A well-fitted chair must be selected as though it

were a piece of clothing. Sampling the "fit" is recommended to ensure the optimal user-equipment interface.

B) Price – chair prices range widely based upon quality and features. Chairs are likely to cost between $250 – $750 each. Higher-end units will cost $1,500 and higher and very expensive chair can go as high a $5,000.

References:

1. Bureau of National Affairs. (1995). 770 percent increase. Occupational Safety and Health Reporter, 36, p.1794.
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3. International Business Machines. (1991). Human Factors of Workstations with Visual Displays. (4th. ed.). IBM: Somers, NY.
4. Leuder, R. (1994). Seating, posture, and ergonomics. In Sweere, J. (Ed.) Chiropractic Family Practice. (p.21-2:1- 2:9). MD: Gatherspburg. Aspen Publications.
5. National Institutes for Occupational Safety and Health. (1997). Musculoskeletal Disorders and Workplace Factors. NIOSH Pub No. 97-141.
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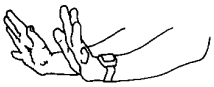
DESK STRETCHES

These are stretches to do at your desk.
This program will take 2 1/2 – 3 min.

- Breathe easily
- No bouncing or forcing
- No pain!
- *Feel* the stretch
- Relax
- See Stretching Instructions, pp. 77–84

1
5 sec, 3 times
p. 82

2
5 sec, 3 times
p. 82



3
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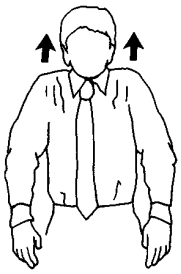

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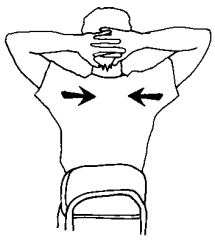


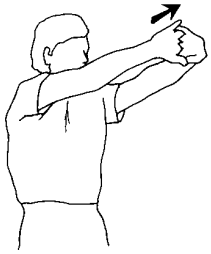
5
5 sec
p. 84

6
5 sec
each side
p. 84

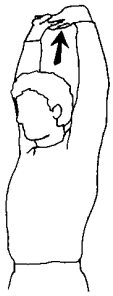
7
5 sec
p. 84

8
10 sec
each arm
p. 81

9
10 sec
p. 82



10
10 sec
p. 81



11
9 sec
each side
p. 82

12
10 sec
p. 79

- Prolonged sitting at a desk or computer terminal can cause muscular tension and pain.
- Taking a few minutes to do a series of stretches can make your whole body feel better.
- Learn to stretch spontaneously throughout the day whenever you feel tense.
- Don't just do seated stretches, but do some standing stretches too. Good for circulation.

From the book:

Photocopy this page and keep it in your desk drawer.

(GREAT) Gilkey Rapid Ergonomic Assessment Tool #4 - The ABCs of VDT Workstation Assessment

Assessment Ratings, Observations, and Comments

Physical Body Postures	***VDT Moniter***		
Head / Neck	Distance		
T-Spine	Angle		
L-Spine / Buttocks	Up - Down		
Upper Extremities	Side - Side		
Arms	Screen Glare		
Forearms	Screen Filter		
Wrists / Hands	Room Light Contrast		
Lower Extremities	Screen Contrast		
Thighs	Room Light Contrast		
Legs / Feet	***Keyboard***		
Foot Rest	Reach		
Forces	Angle		
Static vs. Dynamic	Adjustability		
Chair	Wrist Rest		
5 - Post	***Mouse***	Sum scores =	
Arm Rests	Reach		
Seat Height	Forearm Support	Risk rating =	
Seat Pan	***Document Holder***		
Depth / Tilt	Distance	Divide by total items applicable	
Backrest	Angle		
Size / Tilt	Adjustability		
Adjustability	***Environmental Factors***		
Worksurface	Temperature		
Height	Lighting		
Reach	Diffusers		
Width	Task Lights	Ventilation	
Adjustability	Noise	IA Quality	
Organization	Vibration	Stress Levels	

Assessment Ratings	**Company Name**	**Employee**	**Glasses**
A = Acceptable =1	**Address**	**Workstation**	**Date**
B = Beware = 2		**Department**	**Time**
C = Change Immediately = 3	**Contact #**		

Tray 4–A. Symptoms Survey Form

Symptoms Survey: *Ergonomics Program*

Date _____/_____/_____/

_____ Plant _____ Dept # Job Name _____

_____ Shift _____ Hours worked/week _____ years _____ months Time on THIS Job

Other jobs you have done in the last year (for more than 2 weeks)

_____ Plant _____ Dept # _____ Job Name _____ months _____ weeks Time on THIS Job

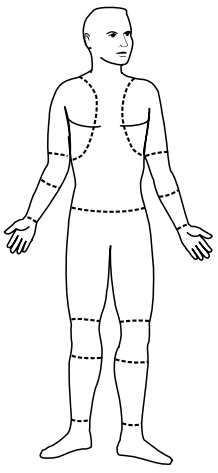
_____ Plant _____ Dept # _____ Job Name _____ months _____ weeks Time on THIS Job

(If more than 2 jobs, include those you worked on the most)

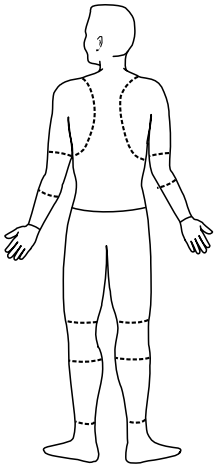
Have you had any pain or discomfort during the last year?

☐ Yes ☐ No (If NO, stop here)

If YES, carefully shade in area of the drawing which bothers you the MOST.



Front



Back

(Continued)

Tray 4–A (Continued).

(Complete a separate page for each area that bothers you)

Check Area: ☐ Neck ☐ Shoulder ☐ Elbow/Forearm ☐ Hand/Wrist ☐ Fingers
☐ Upper Back ☐ Low Back ☐ Thigh/Knee ☐ Low Leg ☐ Ankle/Foot

1. Please put a check by the words(s) that best describe your problem

☐ Aching	☐ Numbness (asleep)	☐ Tingling
☐ Burning	☐ Pain	☐ Weakness
☐ Cramping	☐ Swelling	☐ Other
☐ Loss of Color	☐ Stiffness	

2. When did you first notice the problem?_____ (month)_____ (year)

3. How long does each episode last? (Mark an X along the line)

_____/_____/_____/_____/_____/
1 hour 1 day 1 week 1 month 6 months

4. How many separate episodes have you had in the last year?_____

5. What do you think caused the problem?_____

_____

6. Have you had this problem in the last 7 days? ☐ Yes ☐ No

7. How would you rate this problem? (mark an X on the line)

NOW

_____
None Unbearable

When it is the WORST

_____
None Unbearable

8. Have you had medical treatment for this problem? ☐ Yes ☐ No

8a. If NO, why not?_____

8a. If YES, where did you receive treatment?

☐ 1. Company Medical Times in past year _____

☐ 2. Personal doctor Times in past year _____

☐ 3. Other Times in past year _____

Did treatment help? ☐ Yes ☐ No _____

9. How much time have you lost in the last year because of this problem?____ days

10. How many days in the last year were you on restricted or light duty because of this problem?
____ days

11. Please comment on what you think would improve your symptoms

_____

_____

_____

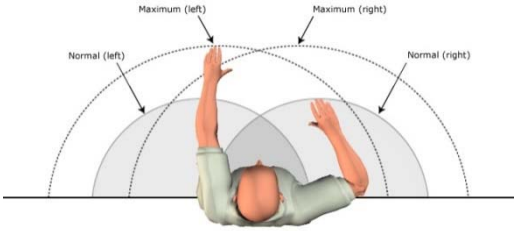
_____

Ergonomic - Seated Workstation Evaluation Sheet

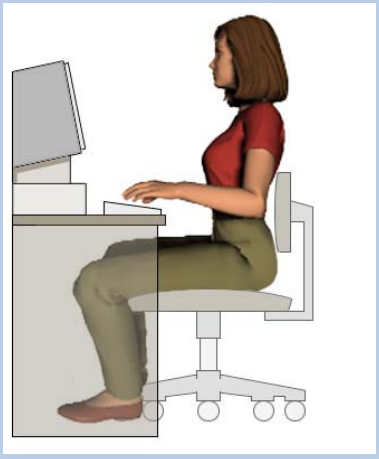
Score Your Observations/Measurements: Name:_____
1 = Good, 2 = Some Concern, 3 = Great Concern

Chair
Chair Stability _____
Seat Pan Depth _____
Seat Pan Width _____
Height _____
Backrest _____

Posture
Head _____
Spine _____
Arms _____
Forearms _____
Thighs _____
Legs _____
Feet _____



Workstation Organization
Reach _____
Equipment _____
Clutter _____
Document
Stand _____



Workstation Interface
Terminal _____
Keyboard _____
Keyboard Tray _____
Mouse _____
Mouse Platform _____

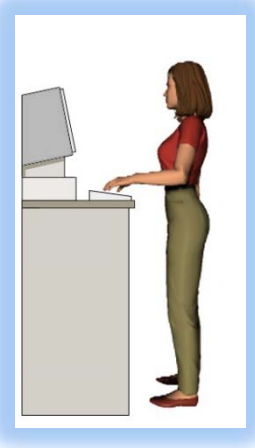
Environment
Temperature _____
Air _____
Noise _____
Lighting _____
Other _____

Sum scores / by the number of items evaluated = _____ Risk Rating
Date: _____ Evaluator: _____

Ergonomic - Standing Workstation Evaluation Sheet

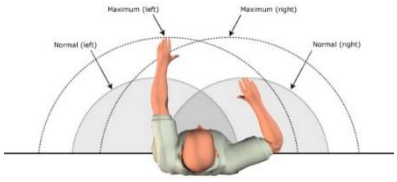
Score Your Observations/Measurements: Name:_____

1 = Good, 2 = Some Concern, 3 = Great Concern



Posture

Head _____
Spine _____
Arms _____
Forearms _____
Thighs _____
Legs _____
Feet _____



Workstation Organization

Reach _____
Equipment _____
Clutter _____
Document
Stand _____

Workstation Interface

Terminal _____
Keyboard _____
Keyboard Tray _____
Mouse _____
Mouse Platform _____

Environment

Temperature _____
Air _____
Noise _____
Lighting _____
Other _____

Sum scores / by the number of items evaluated = _____ Risk Rating

Date: _____ Evaluator: _____