

Chapter III. Work Area Design – Selected Excerpts from Chapter

General Principles of Workstation Design

The following design principles should be considered regardless of the type of workstation, in order to achieve an ergonomically-friendly work environment.

Provide Adequate Room for All Work Materials (as well as the worker)

It is a truism that posture suffers as work area crowding increases. Consider the following during the design / selection of workstations:

- What equipment, tools, etc. will the workstation be required to support during routine and exceptional operation?
- What workstation footprint will be required to support the operation (i.e., Purchase the workstation only after defining how large the workstation needs to be)?
- If the workstation size is a constant, evaluate ways to conserve space at the workstation (refer to Table III.4).

Table III.4. Strategies to Conserve Work Area Space

Workstation Feature	Strategy
Computer	<ul style="list-style-type: none">• Place monitor on swivel arm to remove it from primary work surface.• Replace full-size monitor with flat panel display• Replace full-size keyboard with smaller keyboard<ul style="list-style-type: none">○ Select keyboard without separate numeric keypad (10 key pad) if not required.○ Note in manufacturing environments keyboard may not be required. A mouse or trackball may be sufficient.• Consider touch panel display to eliminate keyboard.• Consider keyboard tray (push in when not needed).• Place CPU in leg well or otherwise off the work table.

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Table III.4. Strategies to Conserve Work Area Space
(continued)

Workstation Feature	Strategy
Hand Tools	<ul style="list-style-type: none">• Eliminate redundant/unnecessary tools• Minimize number of tools required<ul style="list-style-type: none">○ Minimize number of different screws used to assemble a part.○ Heads on (e.g.) screws should incorporate features for more than one type of tool○ Provide tool with interchangeable bits.• Use tool balancer to suspend tool off work surface.• Provide tool holders.
Parts	Provide staging area(s) or utilize Just In Time (JIT) processes so parts do not build up on the workstation.
Documents	<ul style="list-style-type: none">• Provide document holder so documents are not laying flat on the work surface.• Put source documents (maintenance specs, etc.) on the computer (i.e., eliminate hard copy).

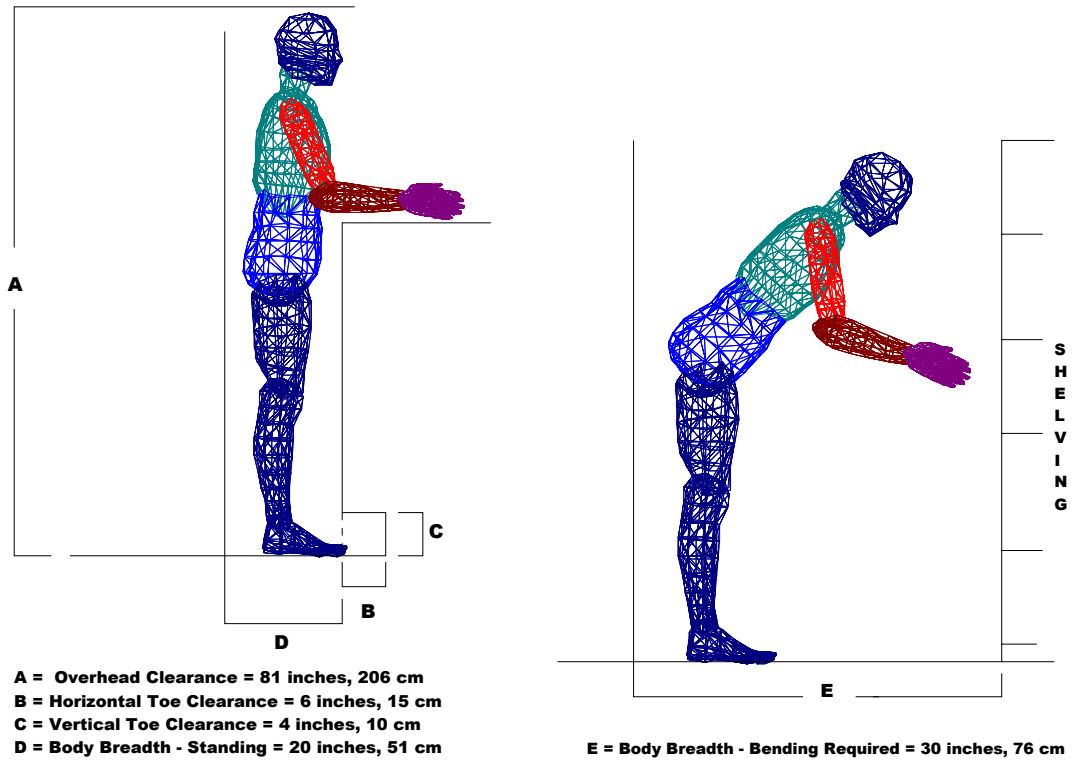
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III C1. Standing Workstation Design Guidelines, cont.

Guidelines,
Cont.

Clearances at Standing Workstations, cont.

Figure III.5. Minimum Recommended Clearances at Standing Workstations



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III C1. Standing Workstation Design Guidelines

Guidelines Standing Reach Distances

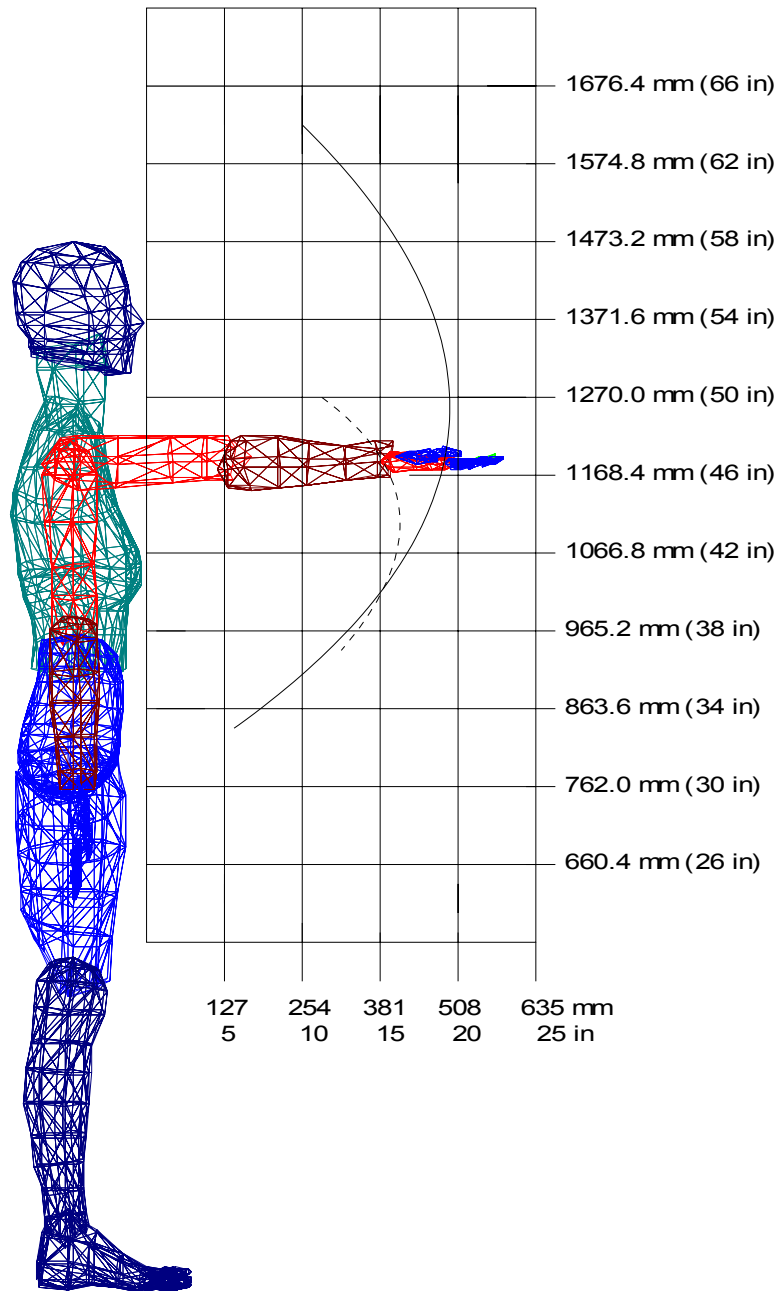


Figure III.7. Reach distances (solid line indicates infrequent Reaches (less than hourly); dashed line indicates frequent reaches (at least hourly))

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III C3. Seated Workstation / Chair Design Guidelines

Chair Design Guidelines

Arm Rests – Yes or No?

There is evidence to suggest that arm rests represent a valuable design feature for chairs. The support provided by arm rests can potentially result in:

- a reduction of pressure on the wrist region,
- a reduction in muscular effort in the arm, shoulder, and neck region.

There are numerous workers who do not like arm rests; the major complaint levied against arm rests is that they “get in the way” of the work table. This typically suggests that the arm rest are not properly sized for the work station. Arm rests should be short enough so that they allow the worker to pull the chair in as close as possible to perform his/her work. Adjustable height/width/angle arm rests are also beneficial in terms of fitting the arm rests to the work as well as the person.

Back Rest

The back rest of the chair may be the single most important feature of the chair. If a chair (i.e., back rest) does not provide good back support, compressive forces acting on the low back area may increase as much as 34% relative to a standing posture (Callaghan and McGill, 2001). Coleman, et, al. (1998) found that owners of adjustable chairs did make routine use of both vertical and horizontal adjustment features, and concludes that a chair without these adjustment features will not accommodate a large percentage of users.

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III C3. Seated Workstation / Chair Design Guidelines

Chair Design Guidelines, Cont.

Lumbar Pads

Coleman, et al. (1998) found that the preferred setting for chairs that had a horizontal adjustment feature to the back rest was approximately 15". This is significantly shorter than the default seat pan depth on many chairs, and suggests that many chairs will not provide adequate low back support due to a too-deep seat pan. A "quick fix" for a chair that does not provide adequate back support for a worker is to place a lumbar pad on the chair (see Figure III.15). There are dozens of manufacturers of lumbar pads of various designs, although home-made solutions such as a rolled-up towel can potentially serve the same function. It should be noted that a lumbar pad is not considered as beneficial as a properly-designed and adjusted chair. It has been argued that a lumbar pad displaces the upper trunk behind the hips, distorting the body's posture and moving the worker away from the work zone. Use of a large-size lumbar pad such as the one shown in Figure III.15 minimizes this argument. Note also in Figure III.15 that the insertion of a lumbar pad changes the seat geometry such that other design features such as arm rests may become less useable.

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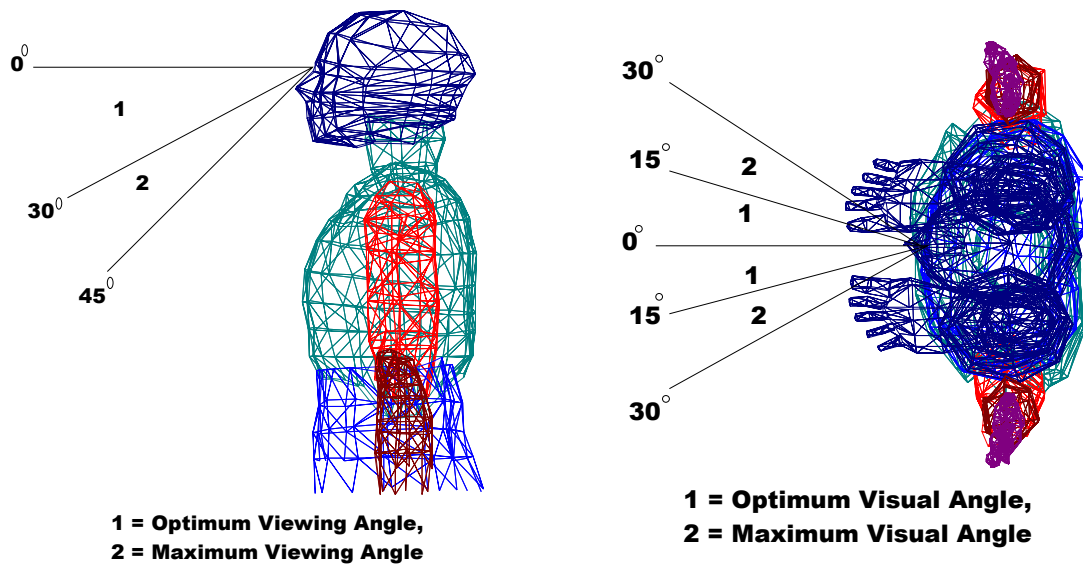
Guidelines

Recommended Viewing Angles (the Primary Viewing Angle)

The optimal viewing area is the range from the horizontal viewing distance down to 45 degrees below horizontal (several authors). Below 45 degrees, neck flexion occurs. Above the horizontal line of sight, fatigue in the eyes, neck, and shoulders increases rapidly. Further, the optimal viewing angle extends 15 degrees to either side of the body midline (mid-sagittal plane).

Figure III.18.

Recommended Viewing Angles



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III E2. Recommended Physical Dimensions for Controls

Guidelines Handwheels

Table III.35. Handwheel Design Guidelines from (1) Humanscale (1981), (2) Amell and Kumar (2001), and (3) Eastman Kodak (1983)

Design Feature	Guidelines		Comments
Force Requirements – 1 Hand Handwheel *	3-20 lbf (1)	<ul style="list-style-type: none"> Wheel diameter 3-4.25" Rim diameter 0.8-1.5" 	<ul style="list-style-type: none"> Handwheel forces measured in field typically greatly exceed the recommended forces. Consider mechanization for valves with high forces. Provide for ongoing maintenance of valves to minimize force requirements. Use a cheater bar.
	13-33 lb (2)	Frequency of use per shift < 5	
	6.6-8.8 lb (2)	Frequency of use per shift 5-16	
	4.5-29 lb (3)	<ul style="list-style-type: none"> Wheel diameter 7-21" Rim diameter 0.8-2.0" 	
Force Requirements – 2 Hand Handwheel *	3-32 lbf (1)	<ul style="list-style-type: none"> Wheel diameter 12-21" Rim diameter 0.8-1.5" 	
	4.5-49 lb (3)	<ul style="list-style-type: none"> Wheel diameter 7-21" Rim diameter 0.8-2.0" 	
	44 lb (2)	Frequency of use per shift < 5	
	13 lb (2)	Frequency of use per shift 5-16	
Design Feature	Guidelines		
Handwheel Diameter (general)	<ul style="list-style-type: none"> Recommended diameter contingent on force requirements as indicated above Torque production directly proportional to handwheel diameter Use large, spoked handwheels to decrease tangential force requirements 		
Handwheel Rim Shape (McMulkin and Woldstad, 1995)	<ul style="list-style-type: none"> Increase coefficient of friction through knurling or zigzag shaped rim Increase diameter of rim Use spoked handwheels 		

* Tangential forces along rim of handwheel

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III E4. Keyboards and Other Data Entry Devices

Guidelines Segmented Keyboard Designs

The research evidence to clearly demonstrate the superiority of segmented keyboards to traditional keyboards is growing, but is still lacking at this writing. Table III.39 summarizes the results from a number of the studies that have compared the two keyboard designs.

Table III.39. Summary of Studies Comparing Segmented Keyboards versus Traditional Keyboards

Study Result	User Posture	User Performance	Comfort / Fatigue *	Reduced Injury Risk / Recovery from Injury
Improvement using Segmented Keyboard	<ul style="list-style-type: none"> • Marklin, et al, 1999 • Zecevic, et al, 2000 • Smith, et al, 1998 		<ul style="list-style-type: none"> • Gerard, et al, 1994 • Cakir, 1995 ** • Strasser, et al 2000 	<ul style="list-style-type: none"> • Tittiranonda, et al, 2000
No Difference Segmented versus Traditional Keyboard		<ul style="list-style-type: none"> • Swanson, et al, 1997 • Smith, et al, 1998 	<ul style="list-style-type: none"> • Swanson, et al, 1997 • Smith, et al 1998 	
Worse using Segmented Keyboard	Harvey and Peper, 1997 ***	<ul style="list-style-type: none"> • Gerard, et al, 1994 • Cakir, 1995 • Zecevic, et al, 2000 		

* Comfort / Fatigue measured using subjective estimates or direct measurement (EMG)

** Found that an adjustable split keyboard was superior to traditional or fixed angle split keyboard

*** Postulate that split keyboard design may increase stresses on shoulder by moving mouse farther away from user. However, please note that a segmented keyboard was not evaluated in the study.