

At Pratt & Whitney Rocketdyne (PWR), the majority of the employees are design engineers. They commonly work at their computers from six to ten hours a day using a computer aided drafting (CAD) system. It is rare to view an employee resting from the activities they perform on the computer. Each engineer is provided a cubicle, workspace, computer (including the monitor, mouse, and keyboard), and a chair. These items are the minimum amount of equipment required for each employee to complete his/her daily tasks. One example of a common computer aided drafting environment is shown in Figure 1. The employee that utilizes this desk space is approximately 5'7".



Figure 1. Standard equipment

Workspace

Each cubicle workspace is adjustable by 10 inches, from 28 to 38 inches in height. This desk is located 33 inches from the ground. The workspace extends two legs of the 8' X 8' cubicle. Attached to each workspace is a keyboard tray which is adjustable through various heights and angles to the comfort of the employee. This keeps the employees arms and wrists in a safe work environment throughout the day.

Chair

The chair given to each employee is a Herman-Miller Ergon 3 design and adjustable by height, arm rests, backrest, and seat pan. This is not considered standard equipment, but to keep workplace injuries at a minimum due to poor posture managers order an ergonomic chair when an individual is hired into the organization.

Computer Equipment

The computer provided is a Dell M70 laptop workstation. It comes with a docking station so that a regular keyboard, mouse and monitor can be used. Figure 1 showed this configuration. The monitor is a Dell flat panel 20" LCD. The keyboard is the standard model that is included with any Dell computer. The mouse is a Logitech MX 310 Optical Mouse which includes two top buttons, a scroll wheel, and two side programmable buttons.

Improving the Current CAD Workstation Configuration

"The most effective and efficient way to reduce the number and severity material-handling injuries is to design equipment ergonomically, so that job demands are matched to human capabilities" (Kroemer, et. al, 2001, p. 538). Our body was not built to sit in front of a CAD station 6 to 10 hours per day with very little physical activity.

An ergonomic checklist found in Appendix A can be filled out to determine how to simply adjust one's workspace. This can also be used in the home office to help avoid injury during those hours on the computer. If stress or strain is occurring at a particular location the checklist provides simple solutions. If those solutions do not help with the pain, new equipment may be needed.

Each of the components of the workspace; chair, monitor, mouse, keyboard, desk, footrest, and wrist rests is discussed and evaluated.

Chair

"One of the most important pieces of equipment to many workers is their chair. Typically chairs are not one-size-fits-all and can be a source of poor ergonomics" (Tapp, 2003, p. 17). There are three components of this device: the seat, backrest, and armrests.

Seat – This supports the weight of the employee throughout the work day. It should be made of soft material to avoid pressure points.

Backrest – This supports the lower back and helps maintain the employee's posture throughout the day. The backrest should be adjustable to create the most comfortable position for the employee keeping the back and legs at a 90 degree angle.

Armrests – The armrests should be "supporting the weight of the hands, arms, and even portions of the upper trunk" (Kroemer, et. al, 2001, p. 434). These must also be adjustable to ensure the comfort of the employee.



Figure 2. Herman Miller Ergon 3 Chair (Herman Miller, 2006)

The Ergon 3 Chair that PWR provides its employees contains all the features that are needed to provide a safe and comfortable work environment. The correct chair that is properly adjusted will help the employee maintain the proper posture at his or her workspace. Employees that work with poor posture can obtain back injuries. “Work-related low back disorders (LBDs) continue to pose significant occupational health problem that can affect the quality of life of the industrial population” (Zurada, Karwowski, & Marras, 2004, p. 292)

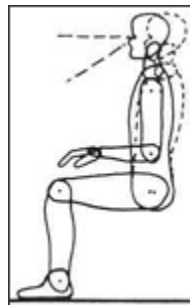


Figure 3. Correct posture at a workstation (OSHA, 2006)

Monitor: LCD vs. CRT

An LCD screen provides “a brighter, flicker-free screen with perfect geometry and virtually no glare reduces eye strain” (Viewsonic, 2006). These improvements over a CRT monitor help with the eye strain suffered by the employees that is caused by staring at a monitor for hours at a time. According to Hedge, “visual search times for text targets embedded in a screen of text are 22% faster for LCDs than CRTs, and also faster for low contrast, small characters, eye fixation times are 9% shorter and 15% fewer eye fixations are needed to read the same information from an LCD versus a

CRT, LCSs have been shown to allow for greater postural variety during computer work” (2003, p. 1).

“The size, dimensions and weight of an LCD allow it to fit into locations that a CRT can't—even mounted on a wall” (Viewsonic, 2006). The monitor shown in Figure 1 does not take up as much desk space as the CRT monitor which allowed room for the laptop to sit to the side of the monitor. If a CRT monitor was in this configuration, the laptop and docking station would have to be moved to a different (less convenient space on the desktop).

The DELL monitor provided by PWR is shown in Figure 3. It helps reduce eye strain of the employees and is the best choice for the CAD application.



Figure 4: Dell 20" Monitor (Dell, 2006)

One of the improvements PWR can do to help its employees work more effectively without as many mouse clicks is to provide dual monitors to the CAD users. The docking stations allow for two video monitor hookups. There is sufficient space on the cubicle desktops for two 20" monitors to fit side-by-side. This allows the employees to view both CAD models and the databases used to create the parts list simultaneously.

Mouse

The movements with a CAD system require frequent movement of the arm and wrist to place the mouse in the desired location on the monitor. If the user does not have the ideal ergonomic setup or does not use the proper arm movements to direct the mouse in the desired location it can lead to repetitive motion injury (RMI). RMI occurs from the stress and strain placed on body parts while completing the same motion throughout the day. One common type of RMI is carpal tunnel syndrome. Untreated these injuries can lead to lost time for the organization.

The best mouse for the CAD workstation is the Evoluent Vertical mouse. As shown in Figure 4, this mouse keeps the arm in the neutral position. This limits the amount of twisting in the arm and the side-to-side movement of the wrist. These benefits of the vertical mouse over the traditional mouse can reduce the amount of strain on the arm and wrist during operation of the mouse.

Just as the type of mouse is important, so is the position. “The mouse should be kept close to the right side of the keyboard (for a right-hander) so that hands and arms do not have to reach too far away from the body” (Tapp, 2003, p. 17). Ideal positioning of the mouse also reduces the amount of strain on the arm and wrist.

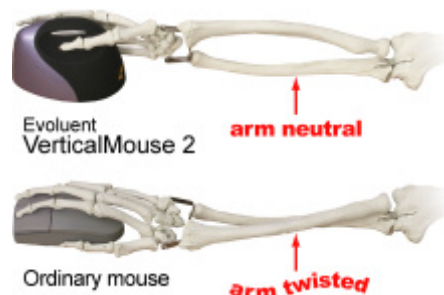


Figure 5. Evoluent vs. Ordinary Mouse (Evoluent, 2006)

Keyboard

Although there is nothing technically wrong with the keyboard provided by PWR, it is not the most ergonomic of designs. The straight design leads the user to twist his or her wrists to reach all of the keys. Another flaw is the location of the number pad. It is on the left hand side, so for right-handed users the arm directing the mouse has to be placed farther away from the body. This can cause strain in the shoulder, arm and wrist.

Figure 6 shows the Goldtouch keyboard which is adjustable by height and pivots about the top. This allows the user to adjust the keyboard to match the desired height and location of the keys to the natural position of his or her body. Notice there is no keypad on this device to allow the mouse to be in the most comfortable position for the user.



Figure 6. Goldtouch Keyboard (Amazon, 2006)

As an addition to the Goldtouch Keyboard the number pad can be purchased. This can be placed at comfortable position for the user. It is not frequently used in the CAD environment, so having it connected to the keyboard is not a necessity.



Figure 7. Goldtouch Numeric Keypad (Keyovation, 2006)

Desk

The workspace desk height should be fully adjustable for the employees. The one provided by PWR is modular and adjustable for employees of all heights. To determine the correct height for the employee, one must start with the most comfortable position in the chair and measure to the underside of the elbows. This will give an approximate dimension of where the height should be for comfortable keyboard and mouse use. In the example in Figure 1 with the keyboard tray, the desk can be placed in the position that the height of the monitor is comfortable for the employee.

The desk should also provide enough space for employee to work comfortably with the keyboard, mouse and any documents needed while the computer is in use.

Footrest

The footrest is not a necessary part of the workspace. It may be required if the desk height and proper chair position cannot be attained for the employees body height. The footrest allows the employee's thighs to be horizontal and reduce stress and strain on

the legs. It also helps the employee maintain an ideal posture while at the computer to avoid lower back injury. Figure 8 shows an example of an adjustable footrest.



Figure 8. Adjustable Footrest (Fellows, 2006)

Wrist Rests

Wrist rests are not a necessity for keyboard users, but some employees find them very useful to keep their wrists from tilting at an awkward angle. “Employees should not type with their hands laying on these rests but instead should use them when they have pauses in their typing” (Tapp, 2003, p. 17). This allows for ease of movement of the arms and wrists when typing. Figure 9 shows the Goldtouch wrist rests for their adjustable keyboard. This allows the wrist rests to be positioned in alignment with the keyboard setting.



Figure 9. Wrist Rests (Keyovation, 2006)

Concluding Thoughts

The ergonomic checklists in Appendix A can be used to determine if your workstation or home office setting might cause or lead to any injury related to working on a computer for long periods of time throughout the day.

Regardless of the size of an organization, it is extremely important to consider ergonomics for the employees. The costs of the products to avoid repetitive motion injury is significantly less than having an employee with a RMI that has to take time off of work and use workman's compensation to pay for costly medical expenses.

Appendix A: Ergonomic Checklist

Ergonomics Self-Evaluation Checklist

CLEAR FORM

PRINT FORM

Employee Name: _____ Job Title: _____ Date: _____

Building: _____ Floor: _____ Column: _____ Manager: _____ Budget: _____

NOTE: If the height of your keyboard is adjustable, start with "LEGS AND FEET". Then work through the sections in order without re-adjusting your chair height. If your keyboard is not adjustable (e.g. your keyboard sits on your desk), start with "BACK", work through the sections in order and finish with "LEGS AND FEET". It helps to ask for assistance from a co-worker who can observe your posture as you work.

Recommended Position or Practice	Yes	No	Recommended Solution	Comments
LEGS AND FEET				
Feet flat on floor or resting on footrest.			Adjust chair height such that feet are comfortably on floor or footrest. Obtain a footrest, if necessary.	
Lower legs vertical (or slightly extended out) while seated.			Adjust chair height and angle to maintain recommended position. Obtain a footrest, if necessary.	
Thighs horizontal (or slightly downward) while seated.			Adjust chair height and angle to maintain recommended position. Obtain a footrest, if necessary.	
No pressure on the back of the legs or knees from seat pan.			Adjust chair height or angle of seat pan to relieve pressure. ① Obtain a small seat pan chair, if necessary.	
Sufficient clearance for legs under work surface.			Adjust chair height, request that work surface be raised, and/or clear obstructions from under the desk (CPU, wastebasket).	
BACK				
Back firmly against backrest.			Sit with back against backrest (obtain a chair with a smaller seat pan, if necessary) or adjust backrest angle. Locate keyboard, mouse, and monitor close to you. Do not lean forward unnecessarily.	
Back erect or slightly reclined while seated.			Adjust chair backrest angle. ①	
Lower back supported by chair lumbar support.			Adjust chair back height so that the thickest part of the chair back is at your beltline. ① Obtain supplementary lumbar pad if necessary.	
SHOULDERS AND ARMS				
Shoulders relaxed, not "hunched".			Adjust chair height or adjust keyboard and mouse height. ② If necessary, request work surface be raised or lowered. Adjust height of armrests, if possible.	
Upper arms vertical and close to the sides of the body.			Position keyboard and mouse close enough to prevent reaching out. If your computer is in a corner, use a wrist rest (i.e. WorkRite wrist rest) to span desk surfaces to move keyboard closer.	
Forearms horizontal while keying or mousing.			Adjust chair height or adjust keyboard and mouse height. ②	
Reaching is minimized by placing mouse and other frequently used objects close.			Rearrange items to place frequently used objects within easy reach (5S). Move mouse next to keyboard. ③	
Telephone is not held by shoulder when talking on the phone and keying or writing.			Hold the telephone in your hand or obtain a telephone shoulder rest. If 30% or more of your time is spent on phone, a telephone headset may be considered.	

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Figure A: Pratt & Whitney Rocketdyne Ergo Checklist Sheet 1 (PWR, 2006)

Recommended Position or Practice	Yes	No	Recommended Solution	Comments
HANDS AND WRISTS				
Wrists straight while keying or using the mouse or trackball. (Top of the hand should be in line with forearm.)			Adjust angle of keyboard and/or mouse. Maintain wrists in a posture similar to playing a piano.	
Wrists not resting on work surface or wrist rest during keying or mousing.			Keep wrists above work surface or wrist rest (if used). (Wrist rests are for resting hands and wrists during pauses in keying or mousing. Wrists must not be "planted" on the rest.)	
Light touch is used to press keyboard keys, and grasp and actuate mouse.			Apply only enough pressure necessary to actuate keys. Hold the mouse lightly and use only enough force to actuate the buttons.	
Entire arm is used to move mouse, not just the wrist.			Do not plant wrist or forearm on the work surface or wrist rest. Use larger muscles in the arm and shoulder to move the mouse. Keep the wrist straight.	
HEAD AND NECK				
Top of screen at or slightly below eye level.			Raise or lower monitor height as necessary. Lower the monitor by removing anything from under the base. Raise the monitor with a monitor stand or Xerox paper. ④	
Head erect or slightly forward.			Raise or lower monitor height as necessary. Lower the monitor by removing anything from under the base. Raise the monitor with monitor stand or Xerox paper. ④	
OTHER ISSUES				
Screen is free of glare from sunlight, task lighting, overhead lighting, and reflections.			Orient screen 90 degrees to windows. Close window shades. Place screen in vertical plane. Turn off or reposition task lighting. If above recommendations are unsuccessful, obtain a monitor visor.	
Brightness and contrast optimized.			Adjust monitor controls for brightness and contrast.	
Position changed frequently throughout the day.			Change body positions while seated. Stand up and stretch throughout the day and vary your tasks if possible.	

[CLEAR FORM](#)

[PRINT FORM](#)

NOTES:

- ① If you cannot adjust your chair adequately to fit you and your current chair has less than three levers, a new chair may be requested. If your chair has three levers, contact your Ergonomics Focal or Site Ergonomist for help in adjusting your chair or determining other options.
- ② Some furniture systems will accommodate adjustable/articulating keyboard trays. Contact your Ergonomics Focal, Facilities Focal, or Facilities Project Administrator/Building Coordinator for help in determining if a keyboard tray can be installed on your furniture type.
- ③ If you have an articulating keyboard tray, contact your Ergonomics Focal or Site Ergonomist to help you determine to best way to position your mouse next to your keyboard.
- ④ If bifocals are worn, the screen should be lower or glasses without bifocals worn during computer use.

Figure B: Pratt & Whitney Rocketdyne Ergo Checklist Sheet 2 (PWR, 2006)

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