INTEG

MANAGING environments

Preventing and managing discomfort, pain and injury

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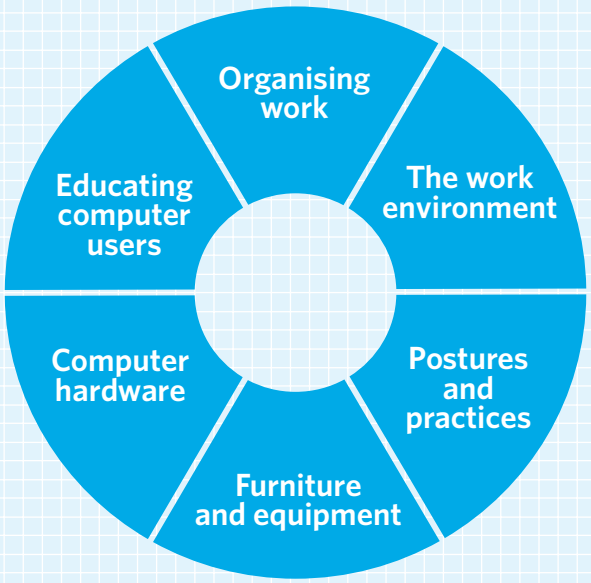
In the past three decades computers have significantly changed the working environment, simplifying and speeding up many tasks across many work areas. However, with these advances have come some potential health issues.

These guidelines describe how managers, health and safety representatives, occupational health and safety personnel, human resource personnel and computer users can work together to achieve a healthy and productive workplace environment. The guidance reflects current knowledge and best practice for the use of computers so you can achieve maximum efficiency, safety and health in your workplace.

FACTORS TO CONSIDER WHEN USING COMPUTERS



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The computer hardware

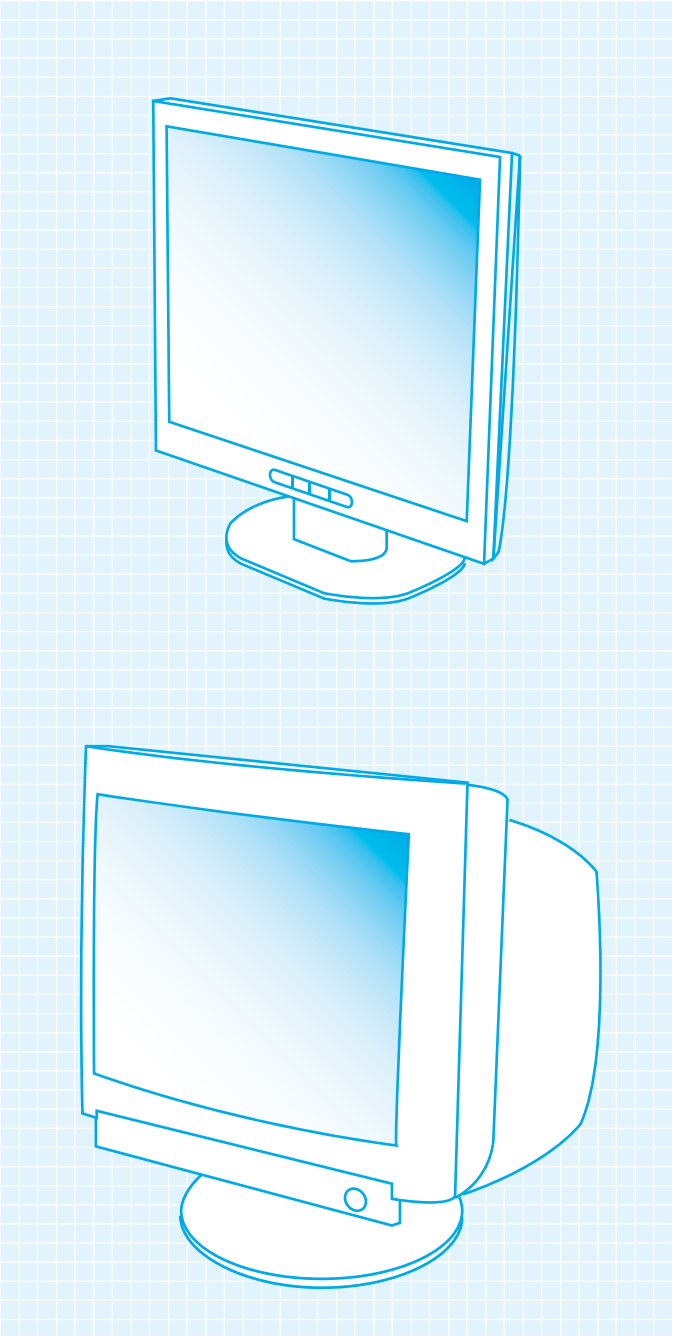
SCREENS

Types of Screen

Two kinds of screen are available: the newer LCD flat-panel screen and the older CRT screen.

LCD screens have certain benefits when compared with CRT screens:

- LCDs take up less desk space than CRT screens and are easier to adjust owing to their smaller footprint, lighter weight and decreased bulk;
- Flat LCD screens are less susceptible to glare than the generally convex CRT creens;
- LCD screens are not affected by flicker or 'swim';
- LCDs increase the total screen viewing area – there is no loss of image quality at the boundaries of the screen as there can be with CRT screens;
- LCDs use less power and produce less heat than equivalent CRTs;
- LCDs provide better screen privacy as they have a narrower viewing angle than CRT screens.



EXAMPLES OF LCD AND CRT SCREENS

‘Older people can experience a number of complex age effects on their eyesight, not all of which are presently understood. For older people, avoid low contrast, low background luminance and small character sizes.’

ISO 9241-303:2008

Although LCD screens are generally considered better than CRT screens, some LCD screens, particularly older models, may have some limitations:

- Moving images may be displayed at a slower speed, which can distort images;
- Screen contrast ratios may be lower than in CRT screens;
- Colour may be less accurate than in CRT screens.

Therefore certain users, such as graphic designers, may prefer the superior colour accuracy, response time and quality of CRT screens.

Important features of a screen include:

- A screen size that is appropriate to the requirements of the individual user and the task being performed. For example, employees involved in graphics or design work may require larger or dual screens;
- Easily adjustable positions, including height, swivel and tilt, so that the user can maintain a comfortable work posture and reduce sources of glare and reflection;
- Easily adjustable brightness and contrast. These settings may need to be adjusted in response to the variability in workstation illuminance throughout the day;
- Sharp and clear screen images;
- No perceived flicker or jitter of the display image;
- Easily readable characters;
- A screen surface that is clean and dust free.

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SCREEN PLACEMENT

There are a number of factors to consider relating to screen placement:

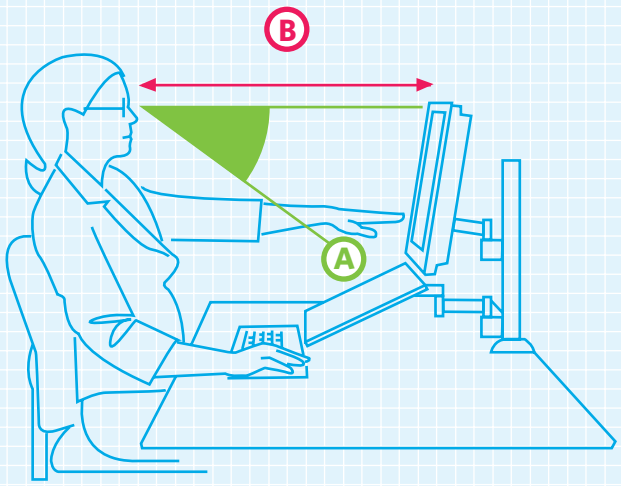
Height (vertical placement)

Eyes are more comfortable with a downward gaze for near work, so a low screen is better for the eyes and neck than a high screen.

Make sure that:

- The top of the screen is at or below eye level;
- The viewing angle of the screen is between 0° and 65° below the horizontal eye level (Figure 19). No part of the screen should fall outside this viewing angle.

RECOMMENDED SCREEN HEIGHT, DISTANCE AND VIEWING ANGLE



RECOMMENDED SCREEN HEIGHT, DISTANCE AND VIEWING ANGLE. **A.** MONITOR HEIGHT V IEWING ANGLE OF SCREEN IS BETWEEN 0° AND 65° BELOW HORIZONTAL EYE LEVEL. **B.** MONITOR DISTANCE AT LEAST 500MM FROM EYES

'A NUMBER OF VIEWING CONDITIONS ARE IMPORTANT FOR ACHIEVING FAST, ERROR FREE AND COMFORTABLE VIEWING. THESE INCLUDE THE VIEWING DISTANCE AND DIRECTION, AND THE REQUIRED GAZE AND HEAD TILT ANGLE.'

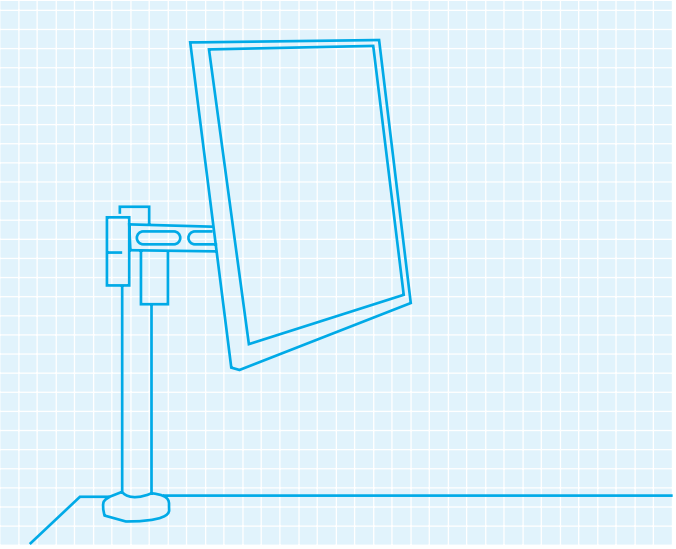
ISO 9241-303:2008

For spectacle wearers

Bifocal, trifocal and progressive lens wearers tend to view the screen through the lower part of their glasses. This often means they tilt their heads back to see the screen, which can result in undue strain being placed upon the neck. This may be problematic when using larger screens.

For this reason , it may be beneficial for them to:

- Replace a large screen with a smaller screen;
- Place their screen lower to obtain a comfortable viewing angle;
- Bring the screen closer and adjust the viewing angle;
- Consider using single-vision lenses with an appropriate focal length for their computer work.



Screen risers and monitor arms

You may need to provide screen risers to achieve a comfortable viewing height if the screen itself is not height adjustable. Users need to be able to adjust screen risers easily while sitting.

You can use monitor arms to allow for the adjustment of computer screens. They may be particularly useful when there is limited space on the desk or at a shared workstation where regular repositioning of the screen may be necessary. If you provide a support arm, make sure it is easily adjustable, mechanically stable and will allow the screen to be viewed at an appropriate distance and angle for each user.

'The viewing distance is dependent upon the task and the visual display and should not be less than 300mm. For visual displays used in offices, a longer viewing distance (400mm to 750mm) is recommended as this leads to less strain on the eyes and allows greater freedom to move the head.'
ISO 9241-303:2008

Horizontal placement

The ideal horizontal position for the screen is directly in front of the user so that their head, neck and torso are not turned to one side. This prevents the user placing unequal strain on one side of the body. However, users working primarily from a printed document can instead place the document directly in front of them, and position the screen slightly off to the side.

For tasks involving this type of work, it is recommended that:

- The screen and document are positioned as close as possible to each other;
- The screen(s) is not placed more than 35° to the left or right of the user.

Eye-to-screen distance

The best viewing distance depends on a number of factors and varies from user to user. The eyes struggle to converge and focus on objects that are too near, particularly if the object is at eye level or above.

- Position the screen between 400mm and 750mm away from the eyes of the user.
- Many users may find larger viewing distances more comfortable;
- Place the screen at a distance at which the user can easily read the displayed text.
- If the user prefers a greater viewing distance, increase the text size or zoom, e.g. from 100% to 150%.

Tilt

The height and tilt of the screen should be easily adjustable to maintain an appropriate viewing angle. The bottom of the screen should be slightly closer to the user's eye than the top as our eyes are accustomed to higher objects being further away. The degree of tilt will always depend on the height of the screen; for example, a tilt greater than 15° will be necessary if the user likes a particularly low screen.

Note that tilting the screen forward to avoid glare problems on the screen is not an acceptable solution to lighting problems. It is recommended that:

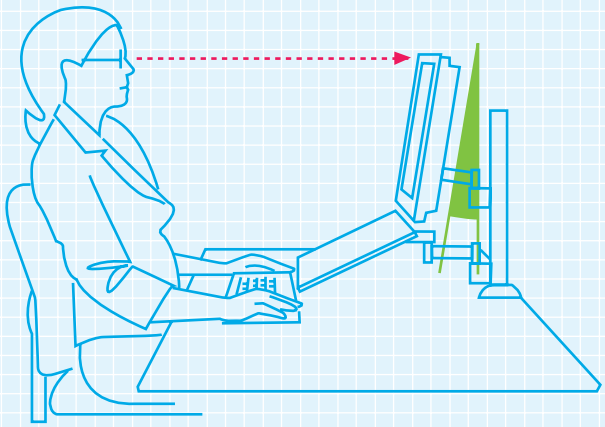
- CRT screens have a minimum tilt adjustability of 0° to 15°;
- LCD screens have a minimum tilt adjustability of 0° to 20°;
- The top of the screen not be closer to the user's eye than the bottom;
- Tilt be adjusted together with the height of the screen.

Swivel

The screen should swivel from side to side at least 45° in each direction.

The bottom of the screen should be slightly closer to the eye than the top

EXAMPLE OF SCREEN TILT



MULTIPLE SCREENS

Increasingly, people use two screens in their normal work. In some specialist work environments (e.g. control rooms), several screens may be used. Two or more screens are often useful when the person uses multiple software applications at the same time, helping to segregate work between screens and reduce the number of mouse operations. Multiple screens may also be used when people work together in groups.

Recommendations when using multiple screens:

- Minimise the gap between screens to ensure a seamless flow between them;
- Screens should be wrapped around the user in a semi-circle so that the distance between the user and screens is kept relatively constant;
- Unless there is a large number of screens they should be positioned horizontally around the person rather than stacked vertically;
- The distance of the screens from the person and the height of the screens should be the same as for one screen;
- Consider adjusting the font size of the text.

When working in groups, you should agree on the position and adjustment of the screens for the different people and agree on the uses and positions of the keyboard and mouse.

Two or more screens are usually better than one large screen and often prove to be more cost effective. When using two or more screens, determine how much time is spent on each screen as this will affect how they are positioned. For screens that are used for the same amount of time, screens should be placed directly in front of the person and as close as possible to each other. Screens that are referred to less frequently (e.g. alarm monitoring) can be placed further to the side, with the primary screen(s) placed central to the person.

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KEYBOARD

Important factors to consider when using keyboards are their design and placement, as well as the postures and techniques the user adopts. The keyboard should allow the user to work with maximum possible comfort and efficiency.

Types of keyboard

The conventional keyboard is rectangular and flat, with alphabetic, numeric and other function keys laid out in a fairly generic way. Older 'standard' keyboards may be thicker (deeper) and angled so that the rear of the keyboard is considerably higher than the front of the keyboard.

Important features of a keyboard include:

- Keyboard thickness of no more than 30mm at the 'asdf...' row of keys;
- An adjustable slope within the range of 0° to 15°;
- Keys with a matt finish to prevent reflections from overhead lighting;
- Key tops with concave or flat strike surfaces;
- Good stability so that the keyboard does not move during use;
- Keys with easily legible characters;
- Appropriate key pressure – not so firm that the user's fingers tire when typing for long periods, or so light that it is too easy to depress a key in error;
- A feedback mechanism to indicate when the keystroke is successful – such as a 'click';
- The same spacing of adjacent keys on keyboards used for fast or continuous input.

'For text input with only little numeric input a keyboard with full-size alphanumeric section but without a numeric section is appropriate because it facilitates a more relaxed and neutral mousing position.'

ISO 9241-410:2008

A key separation (the distance from centre to centre of adjacent keys [centreline spacing]) of 19mm is typical for most keyboards and considered suitable for most adults. Certain users with special needs or keyboards used in certain environments (e.g. cold environments where protection equipment is worn) may require greater distances between keys. Keyboards used by children or females with small hands may require smaller distances between keys (12mm to 14mm), as is often the case with portable or handheld devices with integrated keyboards.

A number of alternative keyboards designed to promote neutral wrist and forearm positions are also available. The suitability of the different keyboard styles will depend on the individual user and the nature of the work tasks. Computer users suffering from physical conditions may benefit from trialling alternative keyboards, or even considering software options such as voice-recognition software.

The keyboard is not the only factor affecting wrist, forearm and shoulder posture. Other important factors include desk and chair height, along with the positioning of the keyboard on the work surface and how the work is organised. These will affect posture regardless of whether a conventional or alternative keyboard is used.

'THE MOST IMPORTANT PROPERTY OF KEYBOARDS FOR ACCOMMODATING THE ANTHROPOMETRIC CHARACTERISTICS OF A USER POPULATION IS THE CENTRELINE SPACING, I.E. THE DISTANCE OF ADJACENT KEYS MEASURED FROM CENTRE-TO-CENTRE.'

ISO 9241-410:2008

Recommendations for keyboard positioning:

The position of the keyboard on the work surface is important as it influences the posture of the entire body. The keyboard should be central, and close enough to the user so they don't have to reach forward to use it. It should be usable with a relaxed and 'neutral' posture.

It is recommended that:

- The alphabetic section of the keyboard be positioned directly in front of the user. The 'g' and 'h' keys are usually considered the centre of the keyboard, and these should be aligned to the midline of the body (in front of the nose);
- The keyboard be at or just below elbow height when the shoulders are relaxed and the arms are hanging by the sides. This is dependent on the chair and desk set-up;
- There be a minimum of 150mm between the keyboard space bar and the front edge of the desk so the user can rest their hands and forearms between keystrokes. This should span the width of the keyboard and may be occupied by a hand-rest (some keyboards have attached hand-rests);
- Keyboard slope should allow the user to adopt a neutral wrist position when typing. A slope of 0° is generally preferable to a 15° slope as it may reduce upward bending of the wrist.

Most flat keyboards are provided with small rear 'legs' that can be clicked into position to provide an angled keyboard, or be left flat. Some keyboard users may even find that they are more comfortable working with the keyboard sloping away from them (a negative slope). A hand-rest is usually provided at the level of the spacebar.

Provided this set-up is used correctly, it may further help to reduce bending at the wrist. Note that the way the user is sitting may alter the keyboard slope needed for a neutral wrist position. In a reclined sitting position, a flat or slightly positive slope may be required to keep the wrists in a neutral position.

EXAMPLES OF KEYBOARD POSITIONING

CORRECT KEYBOARD PLACEMENT: NUMERIC PAD SITS OUT TO THE SIDE AS ALPHABETIC PART IS CENTERED IN RELATION TO THE USER.

INCORRECT KEYBOARD PLACEMENT: THE ALPHABETIC PART OF THE KEYBOARD IS NOT CENTERED IN RELATION TO THE USER.

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The type of pointing device used will be dependent upon the task and user preference. Research suggests that the performance and accuracy of the pointing device change according to the type of pointing device used.

'Input devices should be operable by the use of either hand; alternatively, right and left-handed devices should be available.'

ISO 9241-410:2008

MOUSE AND OTHER POINTING DEVICES

For many computer users, muscular pain and discomfort is often attributed to the use of a mouse or similar pointing device. The design of the device, the placement of it on the work surface and the technique adopted by the user (e.g. the tightness of the grip) are all important factors you need to consider. Users should be encouraged to reduce their use of pointing devices as much as possible.

When using a mouse, care should be taken to avoid postures with fingers 'hovering' over the mouse controls as these postures require sustained contraction of the muscles of the fingers and hand, which can contribute to discomfort. Ideally, the hand should be taken off the mouse when not in use, or the hand should be relaxed and supported.

Where a computer user has a physical condition that is worsened by mouse use, and the use of a mouse can't be avoided, you can:

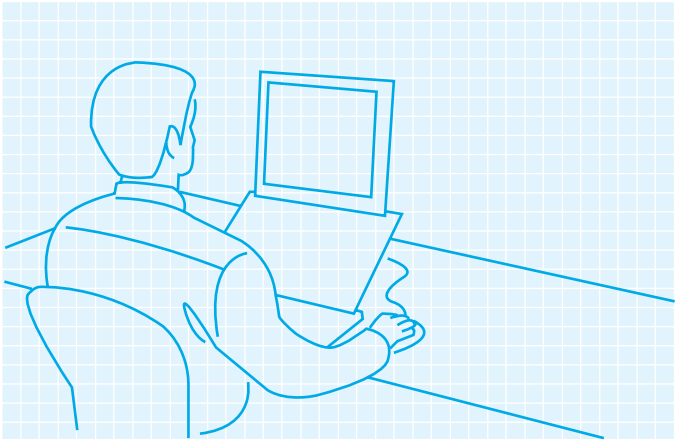
- Consider changing the hand used to control the mouse;
- Encourage regular changes in posture;
- Consider other software options, such as voice-recognition software or keyboard short cuts;
- Consider an alternative pointing device. For certain tasks (e.g. graphics-based tasks) or to accommodate particular user characteristics (e.g. large hands), these may be more appropriate.

RECOMMENDATIONS FOR MOUSE USE:

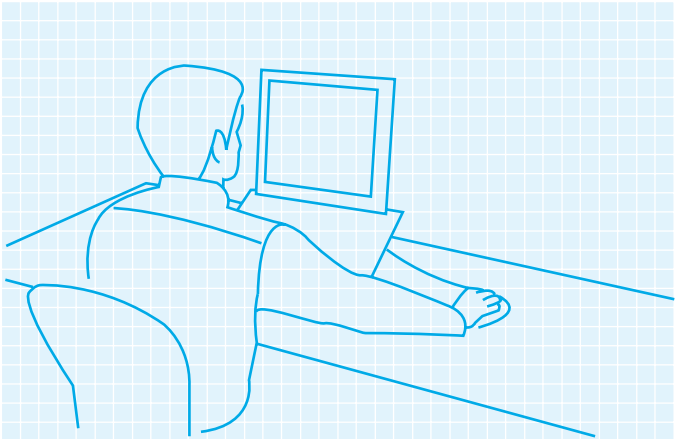
Position

The mouse should be positioned so there is a minimum distance of 150mm between the mouse and the front edge of the desk to allow forearm support. The arm used to operate the mouse should be relaxed and close to the side of the body. The mouse should be at the same depth and at a similar height to the keyboard.

EXAMPLES OF MOUSE POSITIONING



CORRECT MOUSE PLACEMENT



INCORRECT MOUSE PLACEMENT

As the numeric keypads of most keyboards are to the right of the alphabetic keys, right-handed use of the mouse pushes the mouse to the extreme right of the work surface. Alphabetic-only keyboards allow a more midline position. Consideration should also be given to left-handed mouse use, to the left of the keyboard.

Work surface

The work surface on which the mouse is placed should be stable and of a suitable material to allow smooth operation of the device, e.g. mouse pad. The user should avoid placing direct pressure on the underside of the wrist when resting their forearm on the work surface.

Keyboard shortcuts

Users can reduce their mouse use by making use of shortcut keys. These shortcuts are easy to learn and for many functions are faster and easier than using a pointing device. Some applications allow you to assign functions manually to keys that don't have set shortcuts.

Alternating mouse use between hands

Whilst people often default to using their dominant hand when operating a mouse, there is good reason to alternate between hands or always use the non-dominant hand. This may provide a more efficient work set-up and reduce the risk of discomfort, pain and injury.

For mouse use with the non-dominant hand, the mouse should be repositioned to the opposite side of the keyboard. It may also be necessary to adjust the control settings of the mouse, which can often be achieved through software. These settings are often found in the 'Control Panel' under 'Mouse' control settings.

Changes to the mouse settings for non-dominant hand use might involve:

- Changing the mouse setting to the opposite hand so that the appropriate finger carries out the main clicking function;
- Slowing down the double-click speed – usually a drag-and-click control allows the speed to be altered;
- Slowing the speed of the pointer (usually under 'Pointer options').

It is important that computer users learn how to make mouse adjustments quickly and for themselves, as people who set up computers or other users of a shared computer may use different mouse settings. Several adjustments may be required before a user feels comfortable with using their non-dominant hand, but after a short period of time they often become more proficient and can 'speed up' their mouse settings.

MAINTENANCE

ENCOURAGE YOUR COMPUTER USERS TO CLEAN THEIR POINTING DEVICES REGULARLY. MOVING PARTS SUCH AS A MOUSE BALL AND THE SURFACE OF LIGHTS MAY NEED TO BE CLEANED TO GET THE BEST POSSIBLE PERFORMANCE.

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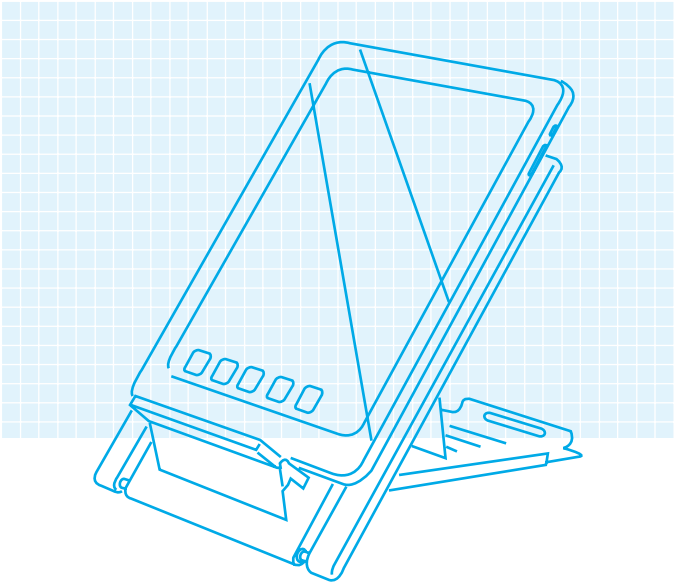
LAPTOPS AND OTHER PORTABLE COMPUTER DEVICES

Portable computers such as laptops, notebooks and netbooks are increasing in popularity. They allow easy and immediate access to computing facilities across a range of work environments, both within and outside the office. However, some aspects of portable computer design can make their extended use harmful to the posture and comfort of the user.

With a laptop, notebook or netbook it is usually impossible to achieve an appropriate screen viewing angle while maintaining correct keyboard posture. Laptop use is associated with shorter viewing distances and greater leaning forward of the head and bending of the neck than when working with a desktop computer.

Portable computer pointing devices – touch pads or 'nipples' (isometric joysticks) – are different from those used with most desktop computers and may be awkward to use. Usually the positions of these devices can't be adjusted, which may encourage fixed working postures, increasing the risk of discomfort, pain and injury.

The use of laptops and notebook computers away from the work environment may be associated with special problems. They are often used in inappropriate workspaces with unsuitable furniture and in a poor working environment.



When used on their own, portable computers should be used for short, intermittent periods of work. For longer periods they should be used with additional, external hardware such as a keyboard, mouse (or other pointing device), screen and/or other laptop positioning equipment. Portable computers on their own may not be suitable replacements for adjustable desktop PCs, unless a means of improving the relationship of the keyboard and screen to the user is provided.

Types of portable computers

When selecting a suitable portable computer, you will probably need to make tradeoffs between portability (particularly weight, but also bulk) and usability (features that make the unit comfortable and practical to use).

If possible, trial the equipment and seek advice from specialists familiar with computers and their use. Colleagues who already have similar equipment and don't experience health issues may be a useful source of information.

Laptops, notebooks and netbooks are the most common types of portable computer. However, there are a number of other, smaller, handheld devices such as palmtops, personal digital assistants (PDAs), PocketPCs and smartphones that can be used as portable computers. The sizes of these products generally make them unsuitable for extended use, although they may be convenient for a range of mobile communication and other computer tasks.

Keep the use of palmtops or similar small devices to a minimum. However, computer users in certain occupations (e.g. parking wardens, freight handlers, courier drivers) may need to use these devices. It is important that you select handheld devices based on the design features required for the tasks. Generally desirable features include:

Generally desirable features include:

- As light as possible;
- Large, easy-to-read display screens and keys;
- Appropriate user-friendly software that reduces unnecessary data input;
- Enhanced glare reduction and waterproofing if used in an outdoor environment.

Important features of a portable computer include:

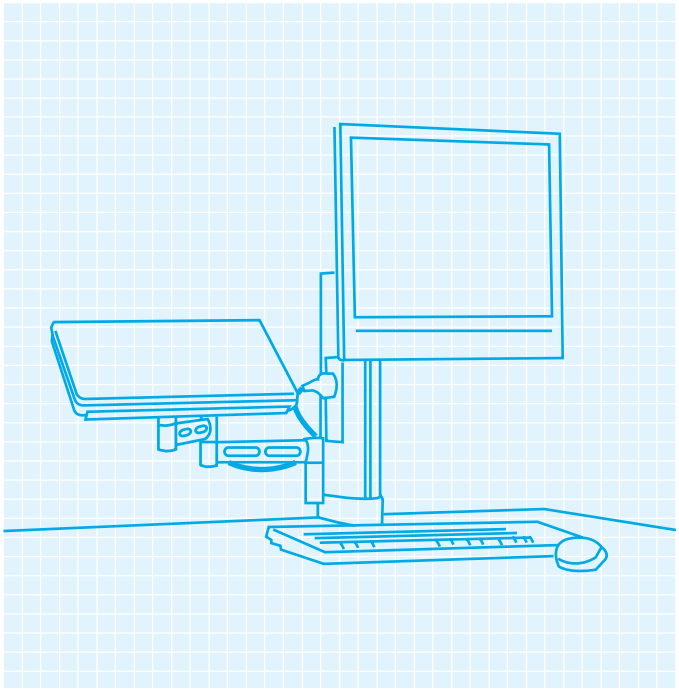
- A height- and angle-adjustable screen or a detachable keyboard. Alternatively, the facility to plug in a conventional keyboard and computer screen, or the use of positioning equipment to place the portable computer screen in an optimal position;
- The facility to plug in an external mouse (or other pointing device);
- As large a screen as possible with a positive polarity display (dark letters on a light background) to decrease glare and enhance readability;
- A non-reflective screen. Some 'brightview' screens may be difficult to use outdoors or where glare and lighting are a problem;
- Large keyboard with key size and spacing similar to those of a desktop keyboard, and a feedback mechanism, such as a 'click', to indicate when the keystroke is successful;
- Keys with a matt finish to prevent reflections from overhead lighting;
- A slope-adjustable keyboard. If it is not adjustable, the slope should be between 0° and 15°;
- A thin keyboard. The height at the 'asdf...' row should be no more than 30mm;
- A sufficient space between the keyboard and the front edge of the laptop to rest the base of the hand when not typing;
- Friction pads on the base of the computer to increase stability;
- Light and durable enough to carry without undue strain;
- A long battery life.

In-office use

Computer users using laptops in the office or work environment where the equipment is used regularly should use them together with regular hardware. The office set-up should mimic a normal workstation.

When plugging a regular keyboard and mouse into the laptop:

- Place the keyboard and mouse on the same level and at a comfortable height on the work surface;
- Raise the level of the screen above that of the keyboard and mouse so that it is at a comfortable viewing height. You can do this by placing the laptop on a platform/riser or angled support stand, or by plugging a regular screen into the laptop.



EXAMPLE OF A LAPTOP WITH DOCKING STATION, EXTERNAL KEYBOARD AND MOUSE

There are various 'docking stations', USB hubs and other systems that allow easy connection of a portable computer to external hardware devices (e.g. separate screen, keyboard and mouse). Some docking stations position the laptop so the screen can be used directly (reducing the need for a separate screen). A discussion with a computer specialist will identify the most appropriate and cost-effective technology for your needs.

Other laptop users position their screens for use via laptop or notebook stands. Some of these are lightweight and portable, while others are larger and more rigid, providing a robust surface that acts like a 'microdesk'. Note that they require the use of a separate keyboard and mouse (or other input device).

Changing portable computer design has seen changes in the access points for cables, discs and other devices, and these items need to be selected with care to ensure a match between the computer and the laptop or notebook stand.

Out-of-office use

When laptops are used away from the office, the working environment is likely to be less than ideal. Out-of-office use is likely to place more strain on the body than when sitting at a regular, well set-up workstation. Users may need to take more frequent breaks of a longer duration and vary their postures more frequently. The use of portable computers in vehicles can be particularly problematic, and careful consideration should be given to suitable equipment and an optimal work environment.

You need to provide users with training in how to:

- Assess the specific workplace and environment with which they are faced;
- Make the necessary adjustments to obtain the safest working set-up, e.g. the chair used, the work surface, mouse placement;
- Vary their posture regularly.
- Temporary modifications to the work environment might include:
  - Placing the laptop and screen on books, files or a laptop bag to lift the screen to a better viewing position;
  - Plugging in a small alphabetic keyboard and mouse;
  - Using a cushion on the seat so the user is at a suitable height to use the computer;
  - When a laptop is used in a stationary vehicle, sitting in the passenger seat to operate the laptop.