Use of display screen equipment by children:

Health and safety guidance for schools:

Teachers' Guide

supported by

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SSERC

Summary

Three main factors act together to cause a risk of injury from working with computers. They are:

- habitual bad posture and technique;
- working for extended periods of time without a break; and
- too great a frequency of working.

Extended use of the mouse seems liable to become the cause of many injuries.

Control measures are largely those of promoting good practice. Everyone must understand what should be done, and how to do it. This guidance shows how. You are urged to take a precautionary approach because, by their very childishness, children need cared for. They may be more prone to musculoskeletal disorders or back pain because their bodies are still growing and because they can often be quite casual about posture.

It is recommended that the risks are controlled largely by influencing children in the way they work. Children should be informed of the harm that can result from bad practices and trained in how best to look after themselves and others.

Instructional training support for pupils and teachers has been prepared for use with this guide.

Disclaimer

The scope of this guidance covers those hazards that were recognized and accepted at the time of its preparation and which, at that time, were considered to be significant. Where opinion is divided on the best means of controlling a risk, this is pointed out.

Produced for the New Educational Development Division of the Scottish Executive Education Department by the Scottish Schools Equipment Research Centre (SSERC)

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SECTION 1: INTRODUCTION

1.1 Scope

This document provides teachers with health and safety guidance on the use of display screen equipment (DSE) by children and adolescents in schools (pre-school, primary and secondary). In the context of this document, display screen equipment is taken to mean desktop and laptop computers.

1.2 Supporting packages

This Teachers' Guide is one of a set of five inter-related packages on the use of DSE by children in schools (Table 1.2). Teachers should make use of the first four packages. Employers and managers should make use of all five.

Package	Format	Purpose
Teachers' Guide	Paper document	Information, instruction and training for teaching staff on health and safety guidance on the use of DSE by children
Teachers' Guide: short format	Leaflet (4 pages, A5 format)	Summary of guidance
Teachers' Training Presentation	PowerPoint presentation	Training for teachers
Pupils' Training Presentation	PowerPoint presentation	Training for pupils and students aged 10-18
Employers' Guide	Paper document	Information for employers and school managers

Table 1.2 The set of five inter-related packages on the use of display screen equipment (DSE) by children in schools.

Of the two PowerPoint presentations, the Teachers' Training Presentation should be used with this document for in-service training whereas the Pupils' Training Presentation is for any teacher to use with pupils and students aged about 10 or over. The aim of both presentations is to train children in good working practices. The one for teachers includes additional information on setting up workstations.

The guidance has been produced for the New Educational Developments Division of the Scottish Executive Education Department by the Scottish Schools Equipment Research Centre (SSERC).

1.3 Overview

Many computer users experience pain or even disability brought about by a combination of bad working practices and overuse. Computer usage is a recognized health and safety hazard. The main risks are musculoskeletal disorders particularly to the upper limbs and back, visual fatigue and mental stress. Some upper limb disorders are sometimes referred to as repetitive strain injury, or RSI. The risks to individual users are often low, but can become significant when computers are used often, for long

periods of time at a stretch, and compounded by a poor design of workstation and bad posture.

In every workplace[1], work with computers by employees should comply with regulations made under the Health and Safety at Work Act known as the Health and Safety (Display Screen Equipment) Regulations. These regulations do not apply to children using DSE in schools, but the provisions therein can act as a guide to good practice. It is on that premise that this guidance is framed. By following this guidance, employers and teachers will be seen to be complying with their duties under Sections 3 and 7 respectively of HSWA.

You will probably appreciate that there exists a lot of health and safety guidance on the use of DSE in the workplace by adults, underpinned by research and case studies. So far, little research has been carried out on the health and safety effects of children using computers. However we are beginning to get evidence of injuries to children (mainly from research by Straker and from reports of symptoms in medical journals). This present generation of children is the first to have worked extensively with DSE. It is therefore more than prudent to take a precautionary approach. It is presumed that:

- the problems that adults can have are also met with by children, and
- guidance for adults should, in general, apply to children also.

There are some additional concerns that are specific to young users, or from working with the entire ability range or wide range in body size.

1.4 Health and safety arrangements

A tripartite scheme is proposed. Firstly, the employer has the duty of care; in this context for ensuring that the workplace, equipment, services and working procedures are in good condition and present no foreseeable risk of harm; teaching staff are given suitable information, instruction and training; and there is adequate supervision and management. Furthermore, they also have a duty of care for the pupils and students. Secondly, teaching staff have a duty of care for the pupils and students. Thirdly, each pupil or student, to a limited extent, has a personal duty of care to him or herself because the prevention of injury is dependent on following sensible practices such as adjusting the workstation to fit the individual and adopting a suitable posture, and also depends on taking breaks and not working too often. With computers in about 75% of households, with some homework being done on computers, and with significant amounts of personal computing being done at home, the duty of care exercised by the school, and resulting control measures, should not be confined to what occurs within school premises, although responsibilities related to work at home may be greatly diminished.

Although the prime duty of care rests with the employers and school management, considerable duties have to be delegated to teachers. Specifically, because of the ergonomic nature of the risks, teachers have to be responsible for carrying out a risk

[1] Legally, a school cannot be regarded as a workplace where children are employed. Nonetheless, it would be looked on as the workplace of their teachers. Since the scope of this guidance is children's health and safety, workplace legal requirements do not apply.

assessment on each child at each workstation. One way for this to be practicable is through classroom teaching. We suggest that children are trained to adopt good posture and working practices. This will include how to adjust workstations to fit their frames (or body sizes), and set up, adjust and operate equipment. Children will also need to know to take frequent breaks, to limit the frequency of working and to take regular, and fairly vigorous, physical exercise. If these health and safety arrangements are to be effective, then they are dependent on teachers training and supervising children in a continual interplay so that, by influence, children assume responsibility for their own personal welfare.

It is presumed that most of the pupils for most of the time can be cared for by general guidance. Checklists for risk assessments for use by teachers can be found in Appendix 1, including one for issuing to pupils, the intention being to put the onus on the pupil – as discussed above. The responsibility for seeing that it works remains with the teacher, school management and employer.

Children or adolescents with special needs may need specific risks assessed and controlled. This may have to be on a one-off nature. This document does not offer guidance on working arrangements for the special illnesses or conditions that young persons might present. If a school finds that a child or adolescent has a special need, then it is up to the school management and employer to work out appropriate arrangements and, if necessary, provide specialist help to do so.

1.5 Supervision and training of pupils

The teacher's task and approach in this area will be akin to that of a teacher of any practical subject - namely that of watching out for poor practice and, when spotted, gently reminding pupils of the importance of correct posture and technique if they are to avoid injury. Such training for pupils is not only meeting the health and safety measures while in school, but will stand them in good stead working at home or indeed in their future careers.

There is an accompanying PowerPoint presentation for pupils aged 10-18 to show them both:

(i) the elements of good practice in terms of recommended postures and techniques, and also

(ii) some of the commonly found poor techniques.

SECTION 2: HEALTH RISKS

2.1 Health risk summary

The main health risks from working with display screen equipment are listed below (Table 2.1):

Health risk	Specific childhood hazards	Comments
Musculoskeletal disorders, particularly upper limb disorders and back pain	Bones, muscles and nervous system are still growing	Computer mouse or other NKID[2] is often the main hazard. Additional care is needed with laptops. Continual use of small keypads may be hazardous.
Eyestrain and headaches	First declaration of eye defects often occurs during childhood or adolescence. Between 5% and 8% of children are affected by squint.	
Tiredness, stress		

Table 2.1 Main health risks from working with display screen equipment.

2.2 Injuries

Injuries of the neck, shoulders, back, arm and wrist result from lengthy use of computers and are more liable to occur if incorrect posture and poor technique are used. Such injuries have been variously named as repetitive strain injury (RSI), or upper limb disorders (ULD) or work-related upper limb disorders (WRULD). Injuries of a specific site and type have been defined and medically named, for instance carpal tunnel syndrome (CTS) and tendinitis. A short summary of these can be found in Appendix 2.

Research on adults has shown that poor posture and technique used by DSE operators in the 1980s, a time when there was little or no training given, have resulted in serious and sometimes irreversible injuries. Signs have included backache, and tingling arms and wrists. Extreme consequences have been constant pain and physical disability where it becomes difficult or impossible for the victims to hold or grip even small items like a pen or a cup. Some victims have been unable to continue in the same employment.

Children differ from adults in an important respect in that their bones and muscles are still growing. This may make them more vulnerable to permanent injury. Research is presently being undertaken on the link between computer use and injuries in children. As yet there is no significant published research data giving clear evidence of such injuries to children. However there are many reports from doctors and anecdotal

[2] NKID: Non-keyboard input device (for example mouse, roller ball, touch pad, touch screen, graphics tablet and joystick).

evidence that children are also suffering severe computer-related injuries. Other research shows that children suffer discomfort after extensive use of computer stations; this is taken to be an early sign of possible injury. The current generation of pupils is the first to have used computers from early childhood. Hence it is more than just being prudent to take a precautionary approach.

"Limited evidence evaluating the risk of children developing musculoskeletal disorders from IT use is available. However the early epidemiological and laboratory studies support the view that children are at least as much at risk as adults.

This is highly significant as this generation of children will live in a world where computer interaction is an essential component of normal work and leisure life. The handicap created by an inability to use computers will be enormous for the individual and will impact significantly on the community at large."

Leon Straker, an Australian research ergonomist, commenting on computer-related injuries to children.

Children can be harmed by an overuse of computers and video games. This has been recognised in a case report by Dr D.M. Macgregor of Royal Aberdeen's A & E. The report, referring to an 11 year old boy, concluded with the statement: "Perhaps hand care instruction should be implemented in schools in the UK as possible prophylaxis." Those playing games greatly add to the repetitive use of the same muscles. The term 'Nintenditis' has been coined by doctors to describe the resulting injuries.

2.3 Eyes

DSE is not associated with permanent damage to eyes or eyesight; nor does it make existing defects worse. It can cause visual fatigue; symptoms felt include blurred vision, red or sore eyes and headaches. This can lead to the user adopting awkward posture. Because the first declaration of eyesight problems (long and short sightedness and squint) often occurs in childhood, the adoption of awkward posture may be a sign of a child who has difficulty in focusing. Persons with uncorrected short sight tend to move closer to their work to focus properly: this can be uncomfortable because the back and neck are bent forward and because of exacerbated head and neck movements turning from one object to another. Young persons with uncorrected long sight or astigmatism tend to experience visual discomfort looking at display screens. This is worsened if the task is prolonged and exacting.

Because display screen users tend not to blink as often as they ordinarily would doing other tasks, the eyes are not lubricated as much as normal. Therefore the eyes may become dry, causing discomfort. The risk is greatest for wearers of contact lenses. The effect is made worse by a dry atmosphere caused by the heating effects of electrical equipment, but this is likely to be mitigated by lots of children exhaling water vapour.

Another cause of possible discomfort is the strain of maintaining the eyes focused for a long stretch of time on near objects. Users should therefore be encouraged to focus on distant objects periodically, allowing eye muscles to relax.

There is a slight risk of harm to eyesight from the very bright light coming from a data projector. The risk comes from standing in the beam, facing the projector, and staring fixatedly either directly at the lamp, or at an object elsewhere. It is similar to staring at the sun, or staring fixatedly at some other object while directly facing the sun such as when driving into the sun while it is low in the sky. The risk is very slight because the eyes are protected by natural aversion responses such as blinking and turning the head away. The risk is easily reduced to a harmless level by engineering and procedural controls (Appendix 4).

2.4 Flicker and photosensitive epilepsy

A small section of the population, about 1 person on 10,000, is susceptible to epileptic fits induced by flickering optical sources including computer screens. Information on this rare condition and suggestions on control measures are provided in Appendix 3.

SECTION 3: TIME ON THE JOB

3.1 Time and frequency

Bad posture can arise from one or more factors such as an incorrectly set up workstation, not sitting correctly on the seat, or other poor practices. But even with the occurrence of bad posture, the likelihood that this will lead to injuries depends on two other factors also being present:

(i) too long a duration of many sessions at the keyboard and

(ii) too high a frequency or number of occasions a day this happens.

In other words, sitting incorrectly at a computer, if done occasionally, is unlikely to cause harm, but doing so repeatedly, for long periods of time, puts the user at a significant risk of injury.

You should ensure that no pupil is allowed to work continuously with DSE without a break of at least 10 minutes every hour. With young pupils, breaks in work should be more often and could be shorter. Breaks allow those muscles and tendons that were in constant use to relax.

During these breaks, children should be allowed to stand up, stretch, walk about and use a range of different muscles. Some organisations have recommended exercising during keyboard breaks. Information on such exercises can be found on their websites (see Appendix 7). Getting children into the habit of taking frequent breaks from computer usage should stand them in good stead against overuse at home, or, in later life, at work.

Break time should not be used for personal DSE use such as surfing the net, emailing or mobile phone texting.

The number of occasions children use computers and other forms of DSE such as games machines should be watched and may need to be limited. Some pupils use DSE in successive classes. Many spend more total time than this by working with DSE at home, possibly with most unsuitable furniture. In one study in three Australian schools where children had been issued with personal laptops which they took from class to class and from school to home, children were found to be using a laptop for an average of 17 hours a week with 60% reporting discomfort which was correlated with the time of use per session, rather than with the number of days of use. The same study found that the duration of one sitting varied from 11 minutes to 10 hours, with a mean of 102 minutes, and one pupil had been using his laptop for 80 hours a week.

SECTION 4: ERGONOMIC REQUIREMENTS

4.1 Ergonomic purpose

The computer workstation should be fitted to the user such that the computer can be used in comfort effectively and so that the risk of harm to the user is negligible.

4.2 Postural requirements

When seated at a computer workstation, the body posture should conform ideally with the following points (Fig. 4.2a):

- Set the seat height so that the elbows are at the same height as the keyboard, the upper arms hang vertically or slightly forward by 5° and the lower arms reach out with the fingers just above the keyboard when the lower arm and hand are horizontal.

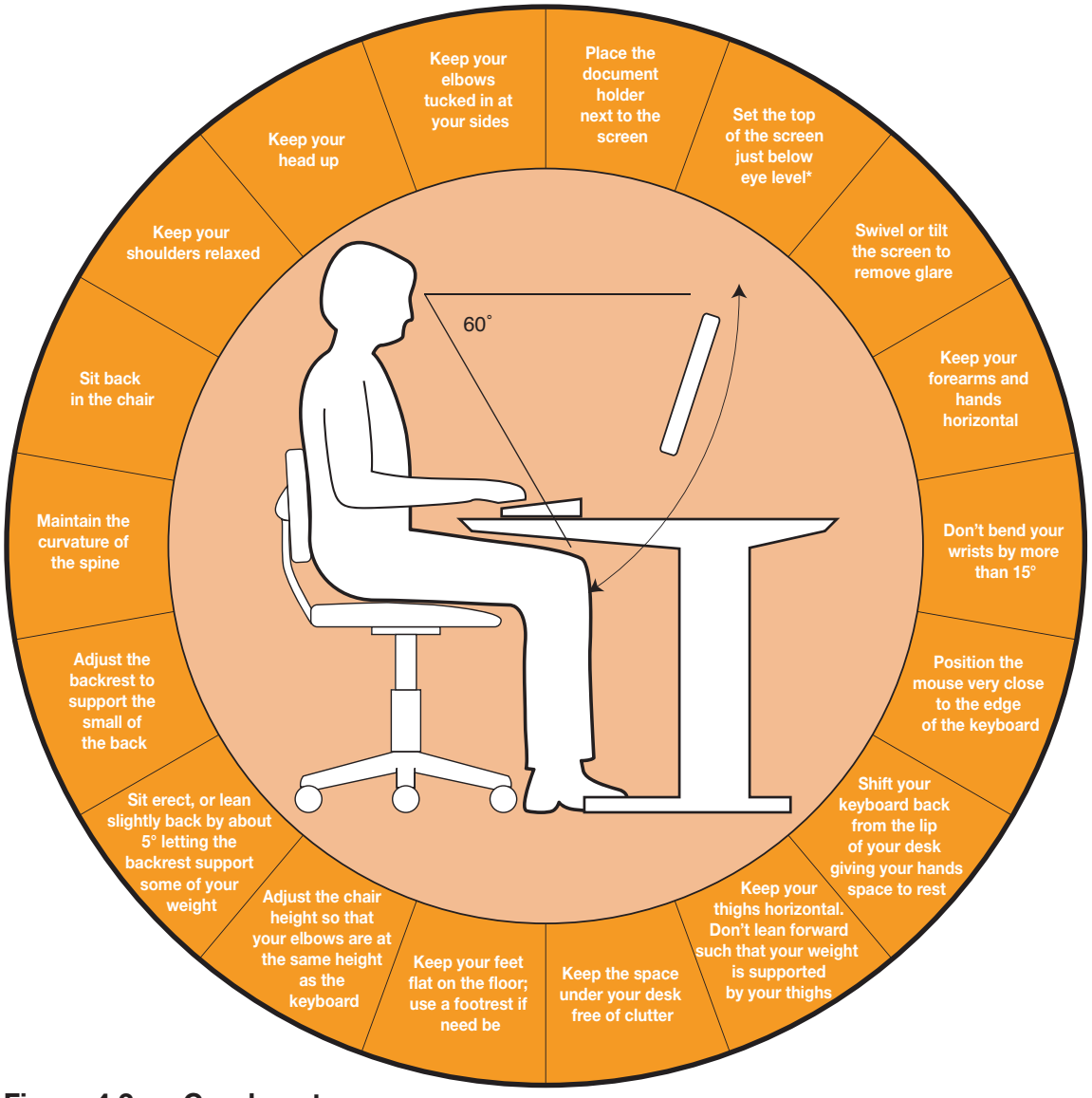


Figure 4.2a Good posture.

- The wrists should not be bent – neither up, down, nor sideways from the line of the forearm.
- With the thighs positioned horizontally and the lower legs vertically, the feet should sit comfortably flat on the floor. A footrest may be needed.
- The spine should be erect, or tilted back by no more than 5° allowing the small of the back to be supported by the backrest of the chair.
- Neither the upper torso nor neck should be twisted.
- The line-of-sight should lie between the horizontal and 60° below the horizontal (Fig. 4.2b).

No one should strive to maintain this body posture continuously. That would be uncomfortable. But since this is the optimum posture, the furniture should be selected and, when necessary, adapted for this purpose. The user should be able to shift from one posture to another to stay comfortable. In particular, the movement of legs should not be restricted by clutter under the table, nor by fixtures such as side panels, struts, spars, or cupboards.

It follows that if any of these rules were to be broken habitually, and often, and for long periods of time, the person would be at risk of harm from a musculoskeletal disorder. The following are examples of bad practice. Some are illustrated in the PowerPoint presentations:

- Extending an arm continually to use a mouse.
- Twisting the neck to view a screen which is not in front of the seat.
- Twisting the trunk to operate a keyboard which is not centrally in front of the seat.
- Twisting the neck and peering downwards to read off a paper document placed to the side of the keyboard.
- Looking up above eye-level to view the screen.
- Looking down at a laptop on the lap or on a low table.
- Leaning forward to view the screen.
- Slouching backwards.
- Flexing the wrists by more than 15° in any direction from the line of the forearm to use the keyboard or mouse.
- Using the top of a cupboard or chest of drawers as the workstation.

One instance where ideal posture may be untenable is when two pupils share a workstation. Provided that the frequency of sharing is occasional, and the periods of usage are less than an hour, the risk is likely to be negligible, particularly if the dual workstation has been well laid out (see Point 4.3.5 below).

Line-of-sight angle

This is the angle between a horizontal line and the visual axis of the eye. Ergonomists are divided on which line-of-sight angle to recommend. The mainstream opinion in the UK, endorsed by the HSE, recommends about 15° below horizontal, inferring that the top of the display screen should be at, or just below, eye-height and the sight line to mid-screen should be about 15° down from horizontal. The other opinion, supported by the ISO standard on display screen ergonomics (EN ISO 9241-5), recommends a line-of-sight of 35° below horizontal and a preferred viewing range of between 20° and 50°. Interestingly, the line-of-sight angle to a laptop display screen complies with the ISO recommendation. The overall range for satisfactory posture given by the ISO standard is 0° to 60° below horizontal, encompassing mainstream opinion also. Supporters of a line-of-sight angle of 35° point out that this is the preferred posture for reading. Detractors think this lower height puts unnecessary strain on neck muscles, which eventually may cause injury, and maintain that the head is most comfortable when kept in an upright, balanced position.

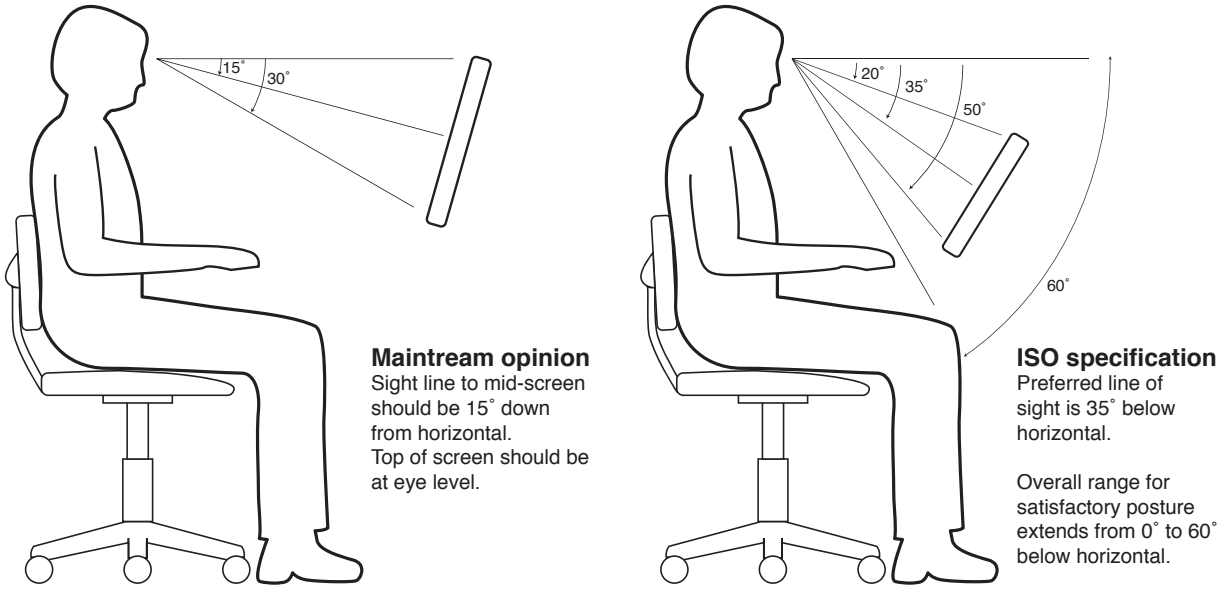


Figure 4.2b Line-of-sight angle. Mainstream opinion (left) and ISO specification (right).

4.3 Seat and table:

4.3.1 Relative heights

The workstation should be designed and possibly adapted to meet the size of the user. Being shared by many users, ideally the heights of both of the table and chair should be adjustable (Fig. 4.3.1 – Top). This allows for the needs of the whole population including wheelchair users and children with other disabilities.

Fixed-height furniture is far from ideal. If it has to be used, then table and chair heights should match each other and be suitable for the average size of pupil (Table 4.3.1a) (Fig. 4.3.1 – Middle).

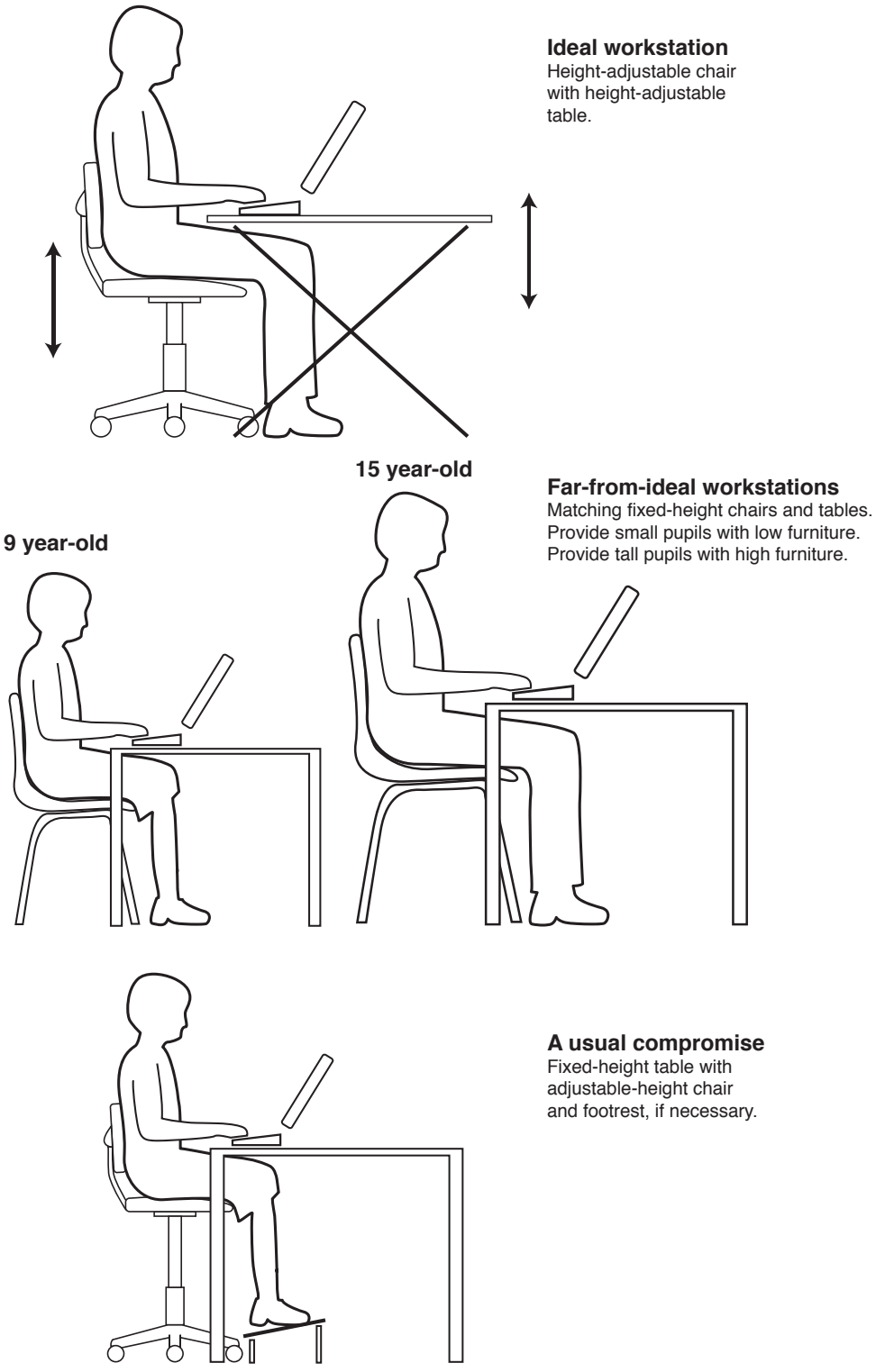


Figure 4.3.1 **Relative heights of seats and tables: ideal workstation (top); matching fixed-height tables and chairs (middle); and fixed-height table with height-adjustable seat (bottom).**

Fixed-height furniture size	Pupil group	Age range	Seat height (mm)	Table height (mm)
Mark 1	Nursery (Very small)		210	400
Mark 2	Nursery	3-4	260	470
Mark 3	Infant	5-7	310	540
Mark 4	Junior	8-11	360	610
Mark 5	Secondary	12-18	410	680
Mark 6	Secondary (Very tall)		450	750

Table 4.3.1a Recommended heights of matching fixed-height chairs and tables.

These recommended matching heights are taken from DD ENV 1729 1: 2001 (a draft European standard due to be approved shortly) and are based on anthropometric data gathered in England in the 1990s. A significant group of tall secondary school users will find Mark 5 furniture uncomfortably small. For this group, seat and table heights of 450 mm and 750 mm would be more appropriate. Small infant school pupils may fit Mark 2 furniture better than Mark 3. Similarly, small nursery children would fit Mark 1 furniture better than Mark 2.

The combination of thick-soled footwear and fixed-height seats is likely to cause poor posture. Fixed-height furniture is designed for children with shoes that raise their height by 20 mm. Many children, particularly girls, wear shoes that do not conform with the standard. Soles up to 80 mm thick are commonly worn. The habitual use by children of thick-soled footwear is likely to cause poor posture from using fixed-height seats.

Many schools provide workstations with fixed-height tables and adjustable chairs – this probably is the standard provision. It is not ideal as explained above, but is preferable to providing tables and chairs where both of these items are of fixed heights.

When designing a workstation to fit a range of users with an adjustable chair, but fixed-height table, the computer table should accommodate the legs of the tallest users in correct posture with elbows level with the keyboard keys (Table 4.3.1b). For other users, the chair height should be raised for correct posture, a footrest being provided as necessary (Fig. 4.3.1 – Bottom). The table height that accommodates 95% of the secondary population is 725 mm.

School type	Age range	Seat height (mm)	Table height (mm)
Junior	8-11	Adjustable	640 (fixed)
Secondary	12-18	Adjustable	725 (fixed)

Table 4.3.1b Fixed table heights for accommodating 95% of the population in junior and secondary schools. These are the recommended table heights for use with adjustable chairs.

In summary, the adjustment of the chair is probably the single most important part of setting up a workstation for correct posture. The chair's adjustability must be easy. Children must be trained in how to adjust a chair and set it up properly. Because of the inevitability of hot-desking[3] in schools, teachers and school management have to rely on the child to understand what should be done and how to do it; and to do it automatically at every workstation he or she uses.

4.3.2 Seating

Additional to the above information, chairs should be fitted with a backrest to support the lower back. Except where matching fixed-height furniture is provided, the backrest should be easily adjustable. Pupils should be trained to set the backrest so that it fits into the small of the back. They should be encouraged to sit upright or lean very slightly backwards letting the backrest take some of the weight off the base of the spine, a posture that helps to promote the curvature of the spine (Fig. 4.3.2). They should be discouraged from slouching forwards, or tucking their legs underneath onto the base of the chair.

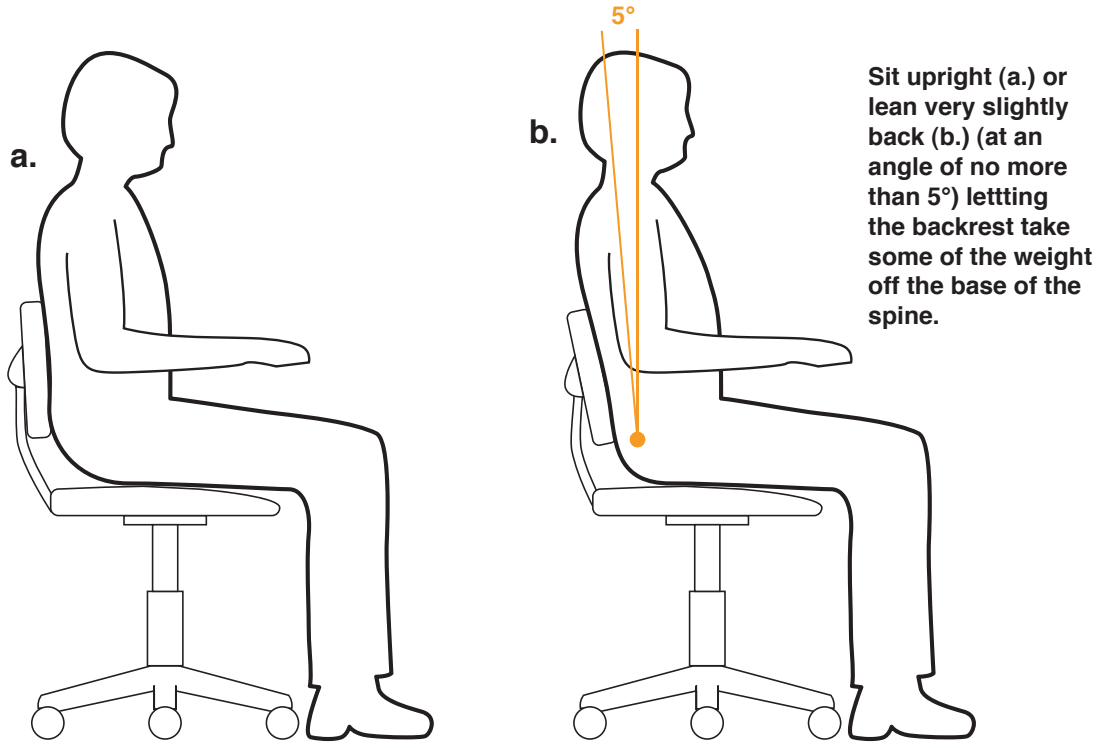


Figure 4.3.2 Seating posture.

Chairs should be on castors or glides and should swivel, letting users turn or shift from one task to another without having to twist the torso or neck. The castors should match the floor: hard castors on soft floors or soft castors on hard floors, stopping a chair moving away easily when unoccupied. The point of this is to prevent someone falling backwards accidentally onto the floor because the chair he or she was about to sit on has run away at the slightest touch.

[3] Hot-desking is the practice of many persons using a computer workstation. It implies that a workstation cannot be set up for one individual only, but should be readjusted every time a new user occupies it.

Chairs should not have armrests except, arguably, in primary schools, where armrests can prevent very small, young children falling off. Armrests get in the way. They encourage bad posture by pushing the arms up into the shoulders.

Children with a dwarfish stature are especially at risk of harm and may require special seating arrangements.

4.3.3 Tables

Additional to the above information, the workstation tables should be sufficiently large for pupils to lay out documents alongside the keyboard and mouse (Fig. 4.3.3). The minimum length that should be provided for a workstation is 1000 mm. A workstation shared by two pupils requires at least 1500 mm. The minimum depth required for a workstation with a CRT display is 750 mm if there is free space behind the workstation, or 800 mm if the workstation backs on to a wall. The leading edge of the work surface should be rounded so as not to cut into the wrist.

It is recognised that L-shaped, curved desks can provide beneficial support for the arm that operates the mouse. Nevertheless, on balance, we think that the leading edge should be straight, being parallel to the back edge. One reason is that the right-hand bias of L-shaped profiles would not suit the entire population. Another is that, with arm support, the arm is not in neutral posture. For this, and other reasons, for the general population, chairs should not be fitted with arm rests (4.3.2 above) and wrist support devices should be avoided (4.7).

4.3.4 Footrest

Footrests should be provided for those needing them (see 4.3.1). These should be height-adjustable and easy to adjust. Footrests should be stored out of the way when not needed.

4.3.5 Dual workstation

Where two or more pupils share a workstation, it is recommended that one pupil alone should operate the keyboard and mouse or other NKID while the other is assigned to another task. The layout should be optimised for the computer user and the screen swivelled so that the non-computer user can also view it comfortably. The minimum length of table for two to work at comfortably is 1500 mm and the length might typically range to 1800 mm.

4.4 Visual display screen

4.4.1 Specification

The user should be able to tilt and swivel the screen to remove or reduce glare, to swivel so as to be usable by a second person, and tilt so as to be seen by a teacher standing over it without needing to stoop.

Flat LCD screens, often based on thin film technology (TFT), are preferable to ones with cathode ray tubes. They give sharper, brighter and clearer images with better contrast and seem to be less affected by glare. Being much less deep, they free up a lot of tabletop and can be used on narrower tables.

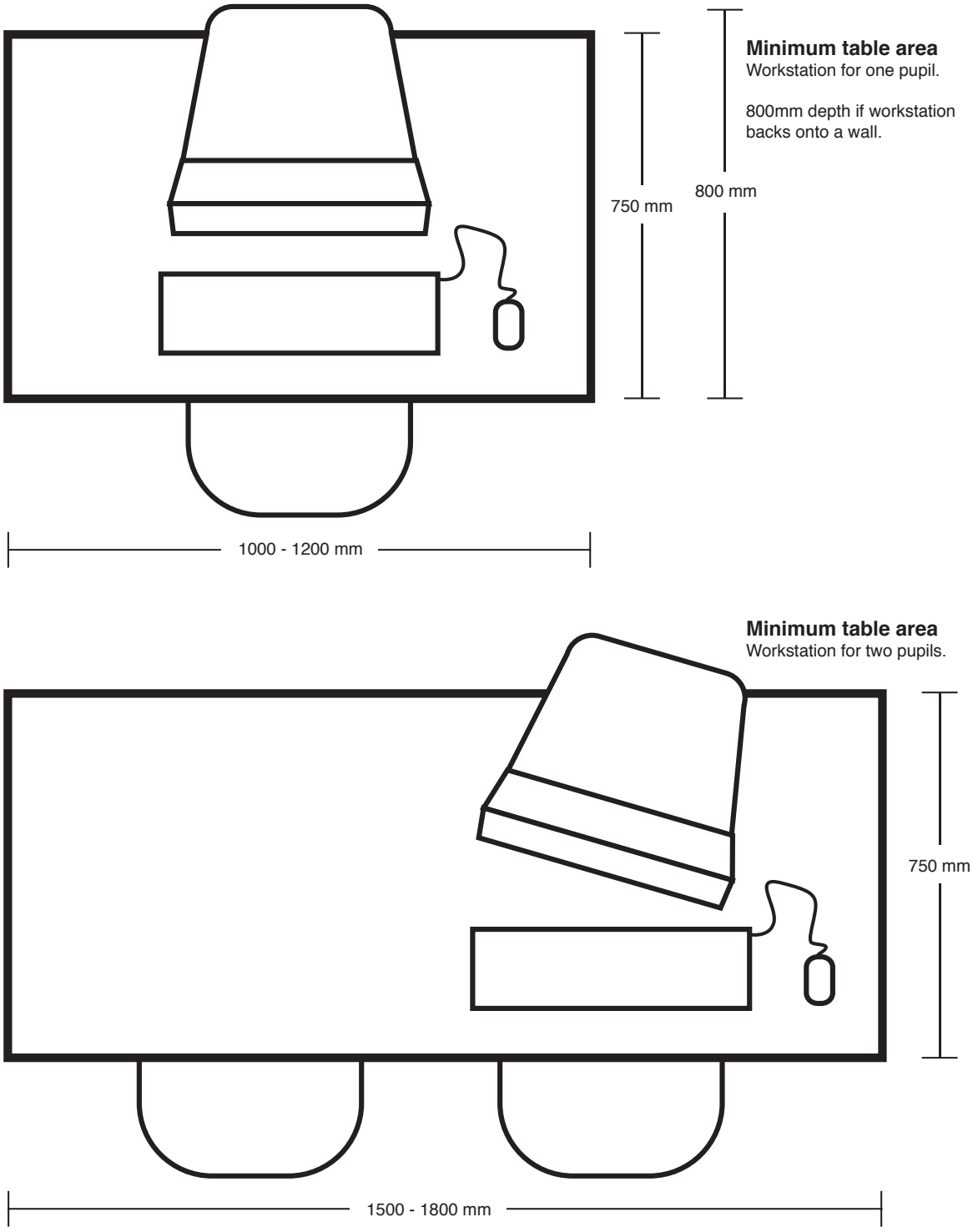
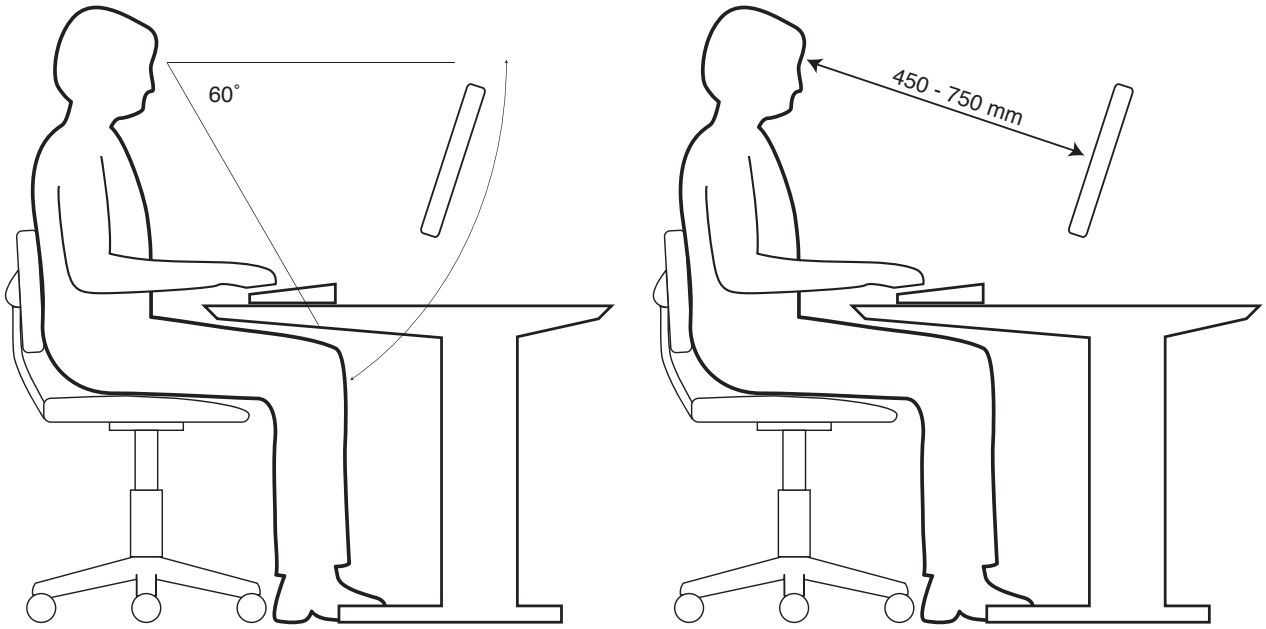


Figure 4.3.3 Table area specifications for workstations for one or two pupils.

4.4.2 Position

Please refer back to the comment on the line-of-sight angle in 4.2. The top of the display should not be above eye level (Fig. 4.4.2 – Left). In the relaxed seated position for touch-typists, the inclination of the head giving the most comfortable viewing has a line-of-sight that is a little below horizontal such that the top inch of the screen is at an angle of between 10° and 15° down from a horizontal line drawn from the user's eye height. In this position, neck and eye muscles tend to be under least strain.

For pupils who have to look for the keys, the screen should be slightly lower so that they do not have to bob their heads up and down continually. (See 4.5: Pupils should be taught to touch type as, once this skill has been acquired, the line of sight can be kept fairly high, reducing the amount of head and neck movement from screen to keyboard.)



Top of screen should not be above eye level. Bottom of screen should not be below a line-of-sight angle greater than 60˚.

Viewing distance should lie between 450 mm and 750 mm. 600 mm is optimum for typical person.

Figure 4.4.2 Line-of-sight angle and viewing distance.

The screen should be at least 400 mm from the eye. The best viewing distance is 600 mm, and ranges between 450 mm to 750 mm give comfortable viewing dependent on the eyesight of the user (Fig. 4.4.2 – Right).

Display screens should not generally be placed on shelves above the table. If so situated, the display is liable to be too high for users.

4.4.3 *Display image*

The brightness and contrast should be adjusted for best performance. For most people, there is little to choose between either image polarity (Table 4.4.3).

Character	Background	Relative advantages
Dark	Bright	Glare is less perceptible. Characters or lines appear sharper. Luminance balance is easier to obtain.
Bright	Dark	Flicker is less perceptible. Legibility is improved for persons with anomalous low acuity vision. Characters appear to be larger than they are.

Table 4.4.3 Relative advantages of different image polarities.

4.4.4 *Glare and other lighting problems*

The user must be able to see computer-generated screen images clearly and comfortably. When parts of the visual field are excessively bright relative to the general surroundings, vision can be impaired and discomfort felt. This effect is called glare. If the display screen is partially obscured by lighting problems, then the smooth interplay of looking at the screen and using the keyboard and, more significantly, the mouse is interrupted. Two consequences of lighting problems are:

- the adoption of bad posture; and
- the prolongation of actions with the mouse (see 4.7).

Some common, troublesome lighting problems are:

- on-screen reflections of the view out of the window, which can occur if the screen faces a window;
- reflections off the screen of a bright light source (ceiling light, sun, skylight); and
- distracting bright light source such as a window or ceiling light behind the screen.

These problems are overcome by a variety of measures such as:

- placing display screens such that they neither face nor back onto windows;
- fitting window blinds; vertical louvre drapes are recommended, but horizontal (venetian) or roller blinds have the advantage that they can be partially pulled down to shield the sky or sun;
- appropriate electric lighting with suitable colour finishes on surfaces (walls, etc.); and
- tilting or swivelling the display screen to remove annoying images (Fig. 4.4.4).

With these measures in place, the light level in the room should lie between 300 and 500 lux. Measures taken in the summer may not be suitable in the winter; similarly actions taken to avoid glare in the morning may cease to be effective in the afternoon.

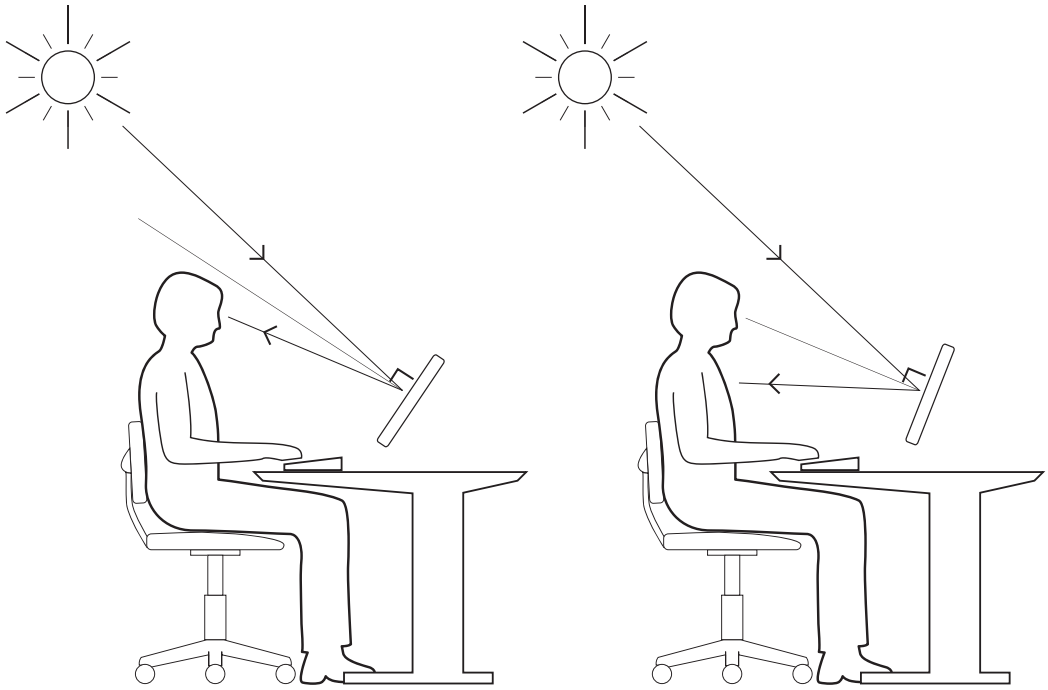


Figure 4.4.4 Glare can be removed by tilting or swivelling the screen.

4.5 Keyboard

The provision of mini-keyboards is recommended. This type does not have a numeric keypad at its right-hand side and is therefore shorter than the standard PC keyboard, but in other respects closely resembles it. In particular, its keys and their spacing are the same sizes as those on the standard keyboard. The ergonomic purpose is a reduction in strain on the arm used to operate the mouse. By bringing the mouse closer to the user, the mouse arm is less extended and twisted, and thereby closer to a position of neutral posture (see 4.7) (Fig. 4.5).

The keyboard may be flat or sloped at a small angle and should be slim and tiltable. The mid key-line height should be 30 mm. The front of the keyboard should be set back at least about 100 mm from the table edge allowing the user to rest his or her hands or wrists there when not keying in. It is recommended that there should be a palm-rest placed in front of the keyboard. This should have a depth of between 50 mm and 100 mm. It can either be a detachable accessory, or a fixed part of the keyboard.

Users should be trained to operate the keys with a gentle touch, keeping the hand-forearm axis approximately straight. It is also recommended that they be taught to touch-type. Once this skill has been acquired, the line-of-sight can be kept fairly high, greatly reducing the amount of head and neck movement from screen to keyboard.

With a standard keyboard, the right arm is bent outwards, putting the arm and shoulder muscles under tension.

With a mini-keyboard, the right arm is brought in close to a neutral posture, reducing the tension on arm and shoulder.

If the mouse is more remote, then the right arm has to stretch to reach it. The elbow is displaced from the user's side, no longer positioned under the shoulder.
The muscles of the shoulder and arm are under tension maintaining this static position.

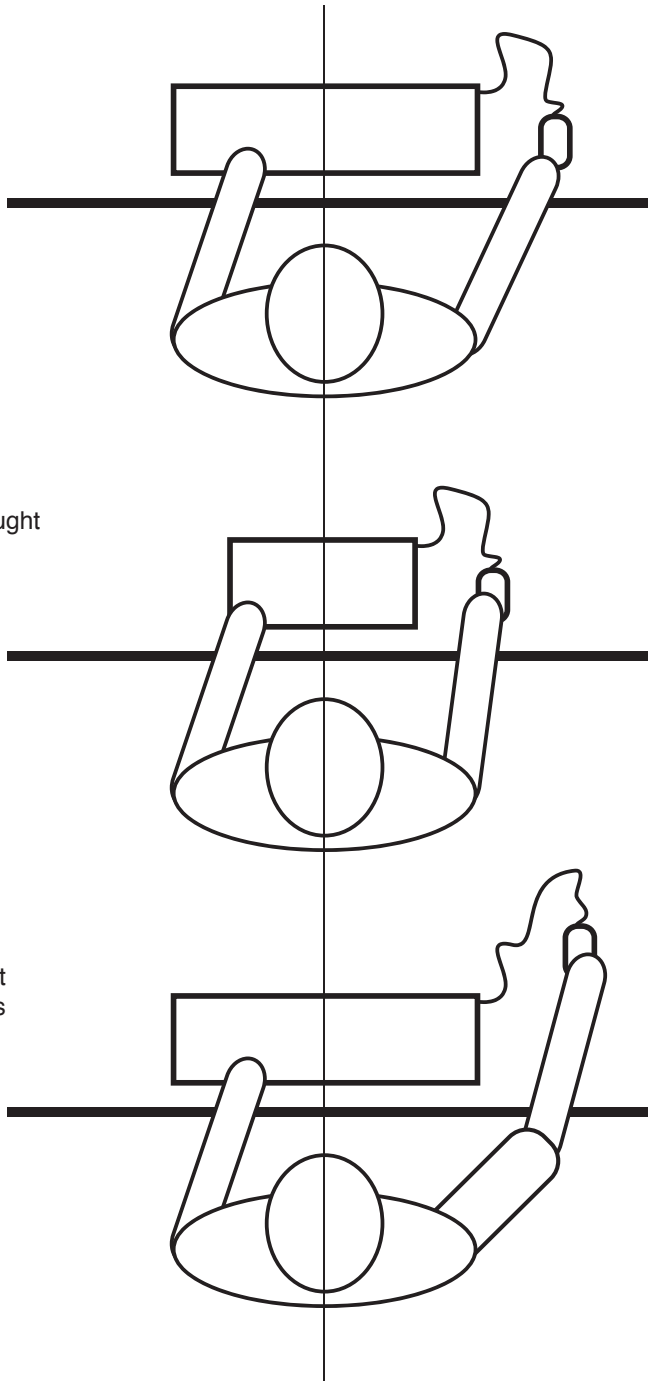


Figure 4.5 **Plans of three workstation layouts. The preferred scheme is the middle one shown because the user's arm is closest to neutral posture.**

4.6 Document holder

Document holders should be available to hold either sheets of A4 paper or bound books. The preferred positions to place text to be worked from are either:

- alongside the display, at the same height, or
- between the keyboard and display.

Both of these positions minimize the amount of head movement needed to shift the eyes from the document to the display (Fig. 4.6). In the second position, the three objects the user needs to look at – screen, document and keyboard – are all on the mid-line directly in front of the user. The user can shift his or her sight-line from one to another either by swivelling the eyeballs or nodding the head. One benefit is that there is no need to twist the neck; another is that it reduces the amount of eye and head movement for those who look at the keyboard rather than at the screen when typing.

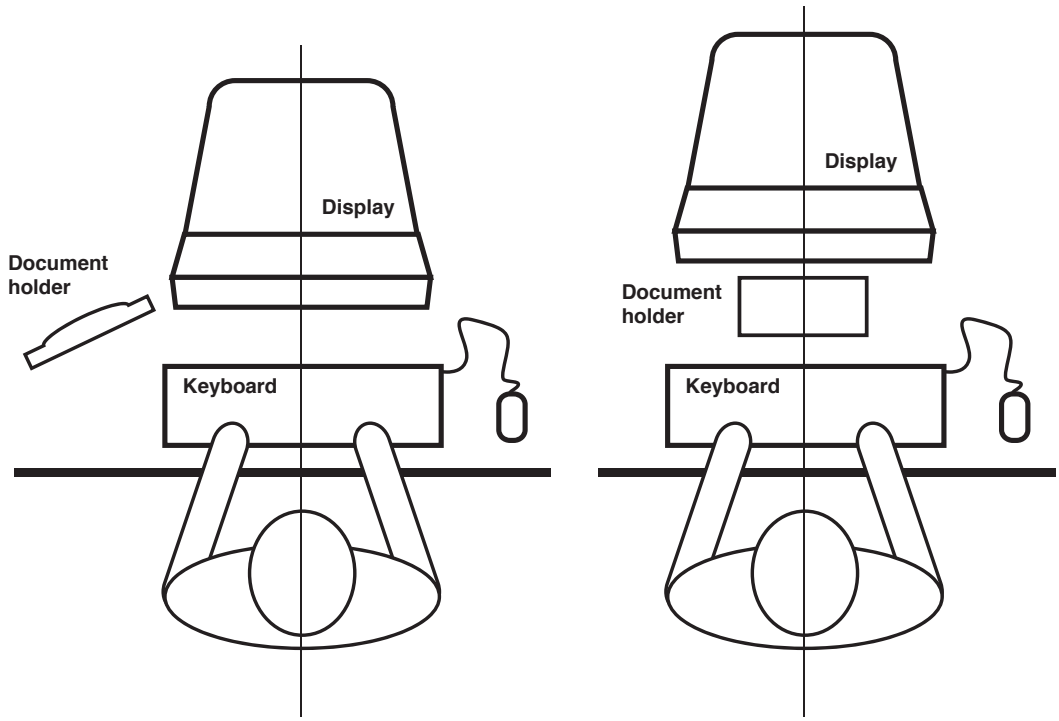


Figure 4.6 Preferred positions of the document holder.

4.7 Mouse

This section refers to types of non-keyboard input devices (NKID), of which the mouse is the most common. Other types include the trackball, touchpad, touchscreen, joystick, CAD tablet and computer pen. For brevity, we will restrict our comments to the mouse although they also can be applied to other NKIDs.

Recent research published by the HSE found that 42% of mouse users in a workplace assessment sample reported pain or discomfort associated with use of their device. Additionally, there was a prevalence of right wrist/hand self-reported symptoms

coinciding with 90% of survey participants using their device on this side. Widespread usage of the mouse is relatively recent, but already evidence is beginning to emerge indicating that the risk of harm from mousing is significant.

Some actions and procedures carried out by the mouse require precise movement of the hand, arm and wrist with simultaneous pressing of mouse buttons with the arm extended. If repeated many times, this can add more wear and tear on the wrist, hand and fingers. Postural concerns include:

- bending or twisting the neck when looking at the screen, keyboard and documents
- insufficient back support
- static postures
- deviated and extended wrist
- poor shoulder posture

The wrist posture or position that the user has to take is determined by both size and shape of mouse (as well as by the relative heights of table and chair). These in turn affect comfort and accuracy. Because of variation in hand size from person to person, a mouse that fits one can be uncomfortable for someone else. Some left-handers find it awkward using a mouse shaped to fit the right hand. The buttons on some types of mice take quite a lot of force to activate. For someone with small or weak hands, this can be tiring.

With many software packages and applications designed for mousing it is not easy to do without with the mouse. Graphics software can require the use of the mouse for more than two thirds of the time; word processing by over one third. Nevertheless, where possible, a reduction in its use should be encouraged. Use of keyboard shortcuts can replace some mouse functions[4]. Further information can be found in Appendix 5.

The mouse speed can be reset giving high precision with either small hand movements, or large ones. The former setting is less easy to apply and can cause excessive strain. The latter, while being easier in application, causes a lot of forearm movement, which becomes tiring.

If the mouse ball is dirty or sticky, tasks with the mouse take longer to accomplish and may have to be repeated because of mistakes, putting added strain on the forearm's muscles.

The following recommendations are made:

- Select the mouse or other NKID so as to provide appropriate precision, accuracy and ease of use.
- Provide undersize mice for children with small hands.
- If the type of mouse selected is awkward for left-handers, provide a left-handed version also.

[4] Keyboard shortcuts: Common examples are Ctrl+C to Copy and Ctrl+V to Paste.

- Specify a mini-keyboard (one which does not have a numeric keypad - a standard fitment on the standard keyboard). When a mouse is used with a mini-keyboard, the mouse is brought nearer to the front of the user's body, placing less strain on the shoulder and elbow (Fig. 4.5).
- The mouse should be sited close to the side of the keyboard. The arm should not have to deviate far from the neutral position to hold the mouse. Ideally the forearm should bend slightly inwards rather than outwards.
- Sit comfortably.
- The mouse should be placed just over 100 mm from the edge of the desk letting the surface offer support to the hand. (The leading edge of the work surface should be rounded so as not to cut into the wrist.)
- Wrist support devices should be avoided. They increase the pressure on the carpel tunnel and condone bad practice.
- Provide enough space so that the mouse can be used comfortably.
- Users should learn to operate the mouse with either hand.
- Users should learn to substitute keyboard commands in place of pointing at pull-down menu instructions (see Appendix 5).
- If a task has to be done almost entirely by mousing, shift the keyboard aside and place the mouse in front of the user.
- Take frequent breaks and vary the tasks.
- Avoid glare and screen reflections. Mouse interactions depend heavily on being able to see the screen clearly.
- Mice should be cleaned and maintained regularly so that they work efficiently.

4.8 Laptops

Laptop computers, sometimes called notebooks, present a significantly greater risk than desktops and therefore a desktop is to be preferred.

The same postural requirements should be met. Provided that they are used with suitable workstations where the table and chair fit the child, the additional risks, stemming from the fact that the keyboard and screen are not independently adjustable, are perhaps not so great. The main trouble with laptops is that because of their portability they can be used almost anywhere – in bed, on the floor, in the car, on the knees, on the sofa, on a coffee table – and if used excessively with bad posture harm is a likely consequence.

In the workplace, it is a legal requirement that the display screen shall be separable from the keyboard[5]. On account of this, and bearing in mind the risks from casual usage - casual in the sense of adopting a disinterested or slovenly attitude towards posture - laptops should not be used for long-term tasks.

[5] Annex to Council Directive 90/270/EEC(a) on the minimum safety and health requirements for work with display screen equipment.

To satisfy best ergonomic practice, the laptop should be sat on a table or desk as specified for a desktop computer. The user should be able to sit with his or her elbows level with the keyboard keys and with fingers on the keys without significant bending of the wrist or fingers. The forearms and hands should be horizontal, the upper arms hanging vertically from the shoulder. The seat height should be such that when the thighs are positioned horizontally, the lower legs are vertical with the feet flat on the floor or footrest.

Because the keyboard is set back about 100 mm, the front of the machine should be positioned at or very near to the front edge of the table. Not having a separate, numeric keypad, the keyboard is less wide than you normally find with desktops. Therefore, if used with a mouse, the mouse is significantly closer to the mid-line of the user's body, which is beneficial.

For applications requiring NKID, choose a laptop with a touchpad, trackball or external mouse rather than a nipple trackpoint or joystick device.

Apart from their inability to swivel about a vertical axis, laptop screens meet the ergonomic requirements for safe viewing in the ISO standard for DSE[6] (Fig. 4.8). If the user adopts optimum posture, we find that the eye to screen distance is slightly under 600 mm. Although this is the optimum viewing distance for the majority of the population, some users may find this distance to be uncomfortably close, or others too far. The line-of-sight angle is found to comply with ISO's recommended range for best viewing of between 20° and 50° below horizontal and is comfortably within the extreme range of 0° to 60° below horizontal.

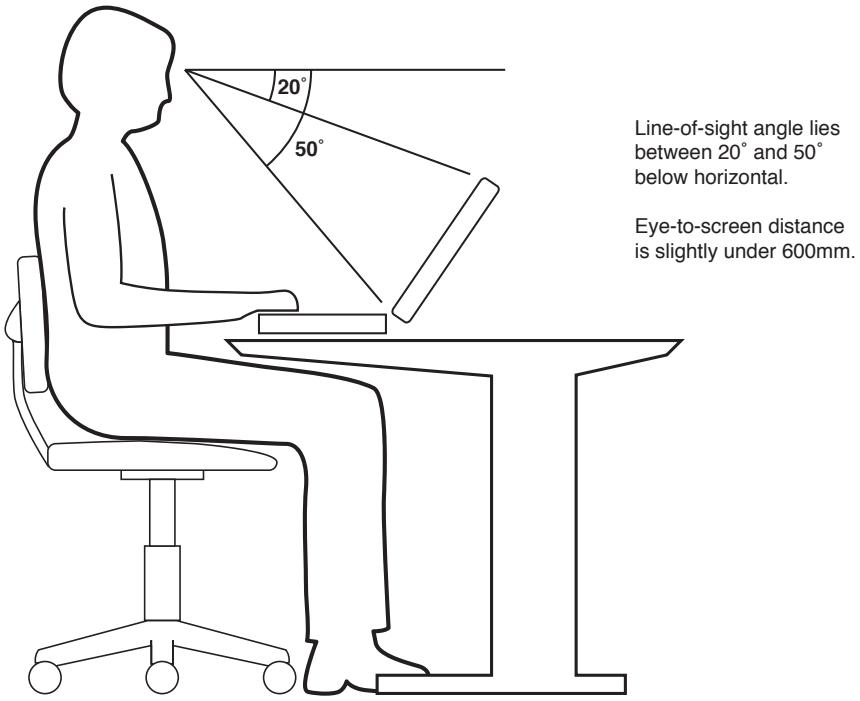


Figure 4.8 Workstation with laptop. (This setup complies with the ISO standard except that the screen cannot swivel about a vertical axis.)

[6] EN ISO 9241-5:1999 Ergonomic requirements for office work with visual display terminals (VDTs) – Part 5: Workstation layout and postural requirements.

On the warning about casual use, there is evidence from Australia that when laptops are issued to children for personal use at home, the set-up is often poor. Postures used by juvenile laptop users varied according to location, with sitting at a desk, mainly in school, accounting for 34% of the mean weekly use. The four other most common postures in order of frequency were:

- lying prone;
- sitting on the floor;
- sitting with the laptop on the lap; and
- sitting on a stool.

60% of students reported discomfort with laptop use and 61% with carrying their laptop. In another study with different samples of schoolchildren, 82% reported discomfort with laptop use against 36% with desktop use. Any school that issues portable DSE to children for personal use should take account of these findings and develop policies on home use to improve on these modes of behaviour (both posture and working times) shown by children working at home. There are also risks from theft and assault to contend with.

Recent UK research has indicated that children carrying heavy schoolbags are less likely to suffer back pain than those who do not routinely carry bags. This counter-intuitive evidence may indicate that the risk from carrying a laptop is slight provided it is in a backpack with straps over both shoulders.

Another hazard is the heat produced within a laptop. While the enclosure temperature is unlikely to be so hot that someone touching it would get burnt, the rate of heating can be enough to slow-cook human tissue in long-term contact with the base. This risk can become significant when the laptop is used on the lap for an extended period. Therefore it should not be used on a lap. Children issued with laptops for home use are especially at risk from this hazard.

4.9 Software

There are two points to be made. Firstly, if software is badly designed or inappropriate, then pupils will experience difficulty in performing the tasks set. The stress or frustration engendered by poor software may lead to postural problems through lack of motivation or efficiency. Teachers should vet software for usability, and refrain from using material that they think is poor, or which is badly received by pupils. Instructions on the display screen should be legible and tasks comprehensible for the age group and easy to learn. The system should tolerate errors and meet the needs of infrequent or intermittent use.

Secondly, software should be set up to make it easier to perform tasks. Generally the teacher should remove unwanted features that might be distractions, and optimise default settings. For instance templates and stationery files might be prepared with font, size, paragraph format, colours, polarity and header pre-chosen. A list of ideas can be found in Appendix 6. Information may be available from your employer.

SECTION 5: OTHER HAZARDS

5.1 Electrical safety

Your employer has a duty to ensure that electrical apparatus and installations are in safe condition. In carrying out these duties, he will arrange for systems to be routinely inspected and tested and he will provide schools with means for having equipment repaired. Any electrical work, including maintenance, should be carried out by suitably qualified and competent personnel only.

Notwithstanding your employer's duties, you, the teacher, should carry out simple, visual, external checks on electrical apparatus and cables routinely for signs of damage, abuse or misuse, reporting any dangerous condition. Information and training may have to be provided. Cables should be kept tidy. They should not be under tension or compression, nor bent through a tight angle. Faulty or damaged equipment should be withdrawn from service and sent for repair. Ventilation apertures should be kept clear. Paper or books should not be placed on computer enclosures, letting any heat generated within to escape freely.

Extension leads present a tripping hazard and are vulnerable to damage; their use should be discouraged. Powering several computers through a series of extension leads with multiple socket outlets daisy-chained together can be dangerous[7]. If a cable is taken across the floor then it should be covered with a protective walkway.

In complex wiring systems, plugs or cables should be clearly labelled so that users know which equipment is connected to which plug.

With battery-powered products, the manufacturer's instructions on the care and use of batteries should be consulted and followed – and kept for future reference. Be very careful not to short-circuit a battery. Contacting both terminals with a metal object can cause injury, fire or damage.

5.2 Radiation

5.2.1 CRT emissions

Display screens based on cathode ray technology (CRT) direct an electron beam onto the screen where electrical energy is converted into light. Other effects, namely x-rays, ultraviolet and infrared radiation, radiofrequency fields, very low frequency fields and static electric fields are also produced. There are no strong reasons for suggesting that these other effects are harmful.

5.2.2 WLAN emissions

Some computers are networked with wireless communication using a technology called a 'wireless local area network' (WLAN). Data is transmitted by high frequency radio signals between a base station and a group of computers. The technology is akin to how mobile phones work except that the radio links are more localized (generally under 100 m and often much less). Signal strengths are of typically the same orders

[7] For a technical explanation, apart from the accumulative power and other reasons, the total protective conductor currents (earth leakage currents) could result in someone touching a computer enclosure getting a painful shock.

of magnitude as you get from other radio sources in the environment (broadcast radio, TV and mobile phone base stations). Again there are no strong reasons for thinking that these radio signals are harmful.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has published public safety guidelines on radio emissions. In the absence of legal limits in the UK, these can be regarded as the best advice available.

Frequently asked questions:

Q. If there are 20 wireless computers sending out and receiving signals, won't the total radiation rise to a dangerously high level?

A. The base station communicates with one computer at a time. The other computers wait in a queue for their turn to transmit. In any case the total exposure is about a million times lower than the accepted public guidelines.

Q. If a base station were to be mounted on a classroom wall, are nearby pupils and teachers exposed to a higher level of radiation?

A. There is no simple answer because the strength of signal sent out by the base station varies according to needs. The system automatically adjusts the strength of signal to the lowest level needed for successful data transmission. When a base station is transmitting to a nearby computer, the signal strength will be quite low. However if it is transmitting to a distant computer in a remote location, then the strength of signal would be much greater. If you consider the reverse-way radiation flux from workstations to a base station, emissions from workstations that are near the base station are lower in signal strength than signals from distant ones. When a wireless network is set up in a school, the number and locations of base stations are chosen so as to keep the total radiation strength to the minimum needed for reliable operation. No one wants to waste energy. The cumulative radio power and energy levels in schools[8] are far below the ICNIRP public safety guidelines.

Q. The Stewart enquiry[9] on mobile phones and health took a precautionary approach recommending that children be discouraged from using mobile phones for non-essential calls. If wireless computers use similar technology, should its use in schools not be discouraged also?

A. The main risk from phones is from radio emissions from handsets, which cause radio frequency energy exposures many orders of magnitude stronger than you get from base stations. So although the technology is similar, the risks with wireless computers are much less.

5.3 Space requirements

The room size has to be sufficiently large to allow space for each workstation. Passageways between tables must be suitably wide to permit easy access. If the room is too small, then pupils are overcrowded, can become stressed and this can

[8] Measured values in some Scottish schools of power densities from WLAN base stations have been found to range from between 10,000 and 10,000,000 times lower than the ICNIRP public reference levels. The WLAN signal power densities were comparable to those from broadcast radio (for instance FM Radio), TV and mobile phone base stations.
[9] Enquiry by the Independent Expert Group on Mobile Phones (IEGMP): report published in 2000.

result in them being more prone to musculoskeletal injury. The right posture is harder to adopt and the teacher is less able to maintain adequate supervision. It may also cause behavioural problems, increase the noise level and raise the air temperature to an unacceptable level (see 5.4).

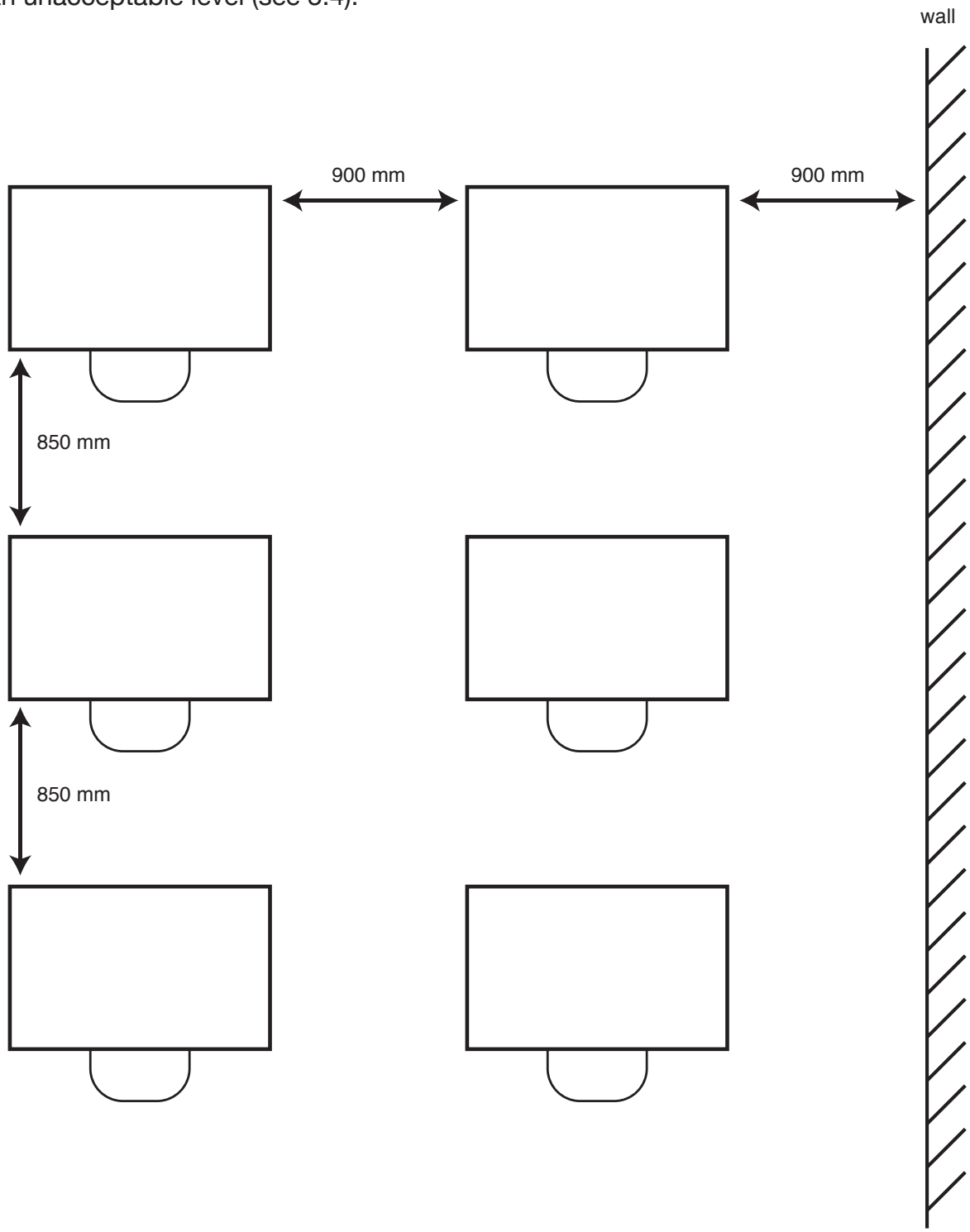


Figure 5.3 **Specifications for minimum distances between workstation furniture, and between furniture and walls.**

The minimum room area for 20 secondary pupils with individual workstations is about 52 m^2, but many would find this to be too greatly overcrowded. If the area were to be much larger, say up to 90 m^2 for 20 senior pupils, the working environment would be much better.

Passageways running across rows of workstations should be at least 900 mm wide (Fig. 5.3). The minimum distance between the front of one workstation and the back of another is 850 mm allowing safe access while a pupil is seated. When workstations are set up back to back, the passageway between them where pupils sit must be at least 1200 mm wide. If the room has long parallel rows of workstations, then the passageways should be considerably wider to allow for greater accessibility.

Bags and clothing present at least two significant hazards:

- Impediments to setting up workstations;
- Tripping.

Each classroom or work-area should have storage facilities for bags, clothing and footrests.

5.4 Other safety risks

There are some other safety risks to children, many of which can be addressed by good housekeeping. Please bear in mind that some of the risks tabulated (Table 5.4) are the commonest causes of injuries in schools.

The hygiene risk from either faecal or blood contamination on surfaces is not thought to be any greater than might be found in other classroom environments. Teachers should, as necessary, train and supervise children in personal hygiene. If necessary an appropriate risk assessment should be done to identify specific children that might be a source of harm, and on finding out what the risks are, appropriate responses can be prepared.

Risk	Specific risks	Comments
Emergency access and egress impaired	Blockage or restriction of access to emergency exits by large apparatus (DSE equipment, desks, trolleys, chairs, etc.). Access routes impeded with trailing cables.	DSE equipment on trolleys positioned temporarily in classrooms, corridors, or other locations, impeding access.
Crushing injuries from heavy falling or moving objects	Injuries caused by unstable, or insecure, apparatus toppling off tables, trolleys, or stands. Injuries caused by laden furniture collapsing. Crushing injuries from the movement of heavy trolleys, younger children being at greater risk.	Furniture should comply with standards. Display screens and projectors should be securely fixed to fixed or mobile stands or trolleys. Pupils should not shift mobile stands or trolleys unless adequately instructed and supervised.

Risk	Specific risks	Comments
Musculoskeletal injuries from lifting and carrying	Lifting and carrying heavy DSE equipment. Carrying laptops around school or between school and home.	Children should not be asked to carry apparatus that may be too heavy for them. Any portering duties require adequate instruction and supervision.
Trips, slips and falls	Tripping over trailing leads or cable runs. Tripping over bags or clothing. Falling injuries caused by the movement of chairs with too freely moving castors. Unsafe seating giving way. Bruising from colliding with the sharp corners or edges of furniture.	Cable walkways prevent tripping. There should be storage racks or shelves for bags; and pegs for hanging up outer articles of clothing. Provison should be made for storing footrests. Chairs with hard castors can move very freely on hard floors. One remedy is special mats placed under the seating areas.
Poor ventilation, Overheating	Electrical equipment produces heat (and also, sometimes, toxic vapours). It also tends to dry the air, causing eyes to become dry. Some users may experience discomfort or soreness with their eyes. There is a risk of injurious fumes. There is a risk of heat stress.	The risks can normally be controlled by the provision of adequate ventilation. The provision of forced ventilation may be needed to supplement the opening of windows.
Dirt, hygiene	Dust on a screen impairs the image, which can result in the user adopting poor posture. A dirty or sticky mouseball impedes movement and causes errors, adding strain to arm muscles. Dirt or crumbs on the keyboard getting under the keys may cause it not to function. Stickiness on the keyboard or other surfaces, apart from being unpleasant, can readily be spread if not quickly dealt with.	There should be a routine cleaning programme of screens, mice, keyboards and tabletops. Children should not be allowed to eat or drink at computer workstations. Any child with dirty hands, and especially if known to have been at the toilet, or eating sticky food, should be sent to wash. Cut or broken skin should be covered.
CD fracture	There is a low risk that if a disk fractures when spinning in the CD drive, fragments ejected at high velocity can cause injury. If a label is fastened asymmetrically on a disk, the resulting imbalance can cause the disk to fracture.	CDs should be checked for obvious signs of cracks before use. Cracked CDs should not be used; they should be disposed of. Disks should be marked with a felt-tip pen rather than a paper label.

Risk	Specific risks	Comments
Ozone	A small quantity of ozone can be released from printers. Ozone is very toxic by inhalation. Even a very low concentration can smell disagreeably and may cause headaches, irritate the eyes and the upper respiratory system, and result in dermatitis. These effects are reversible on removal from exposure.	Any room with a printer should be adequately ventilated.

Table 5.4 Some other risks with the use of DSE in schools.

5.5 DSE in practical subjects

In some specialist subjects such as art, music, science and technology computers are used in ways that are unconventional. For instance a computer may be used with other apparatus on a bench at which children work while standing, or sitting on high stools. If these installations are temporary – and in practical subjects, that would be the norm – then, because there is little risk of habitual usage over a long period of time, the risk of harm that can come from repeated upper limb strain, or bad posture, would seem to be trivial.

Nevertheless, teachers of practical subjects should pay heed to this guidance and comply with as much of its content as they reasonably can. Any permanent workstation in a practical area should comply as fully as possible with this guidance.

SECTION 6: INFORMATION

6.1 Home liaison

All work on computers, whether at home or school, can contribute to upper limb disorder or back pain. Since facilities and furniture at home may be poor ergonomically it is important that pupils and their parents are made aware of the potential dangers, and of ways of reducing them. In addition to pupils carrying home the right message, parents should also be made aware of the risks through the usual channels of communication such as the normal correspondence, parents' meetings, or leaflets. Other measures such as training specifically devised and run for parents, or briefings to the local press, might also be beneficial.

The self-check list in Appendix 1 has been devised for use by pupils aged 10 or over and should be used at home as well as in school. The accompanying leaflet 'Using Computers Safely' offers guidance on setting up workstations for children and on how to prevent computer-related injuries. It would be appropriate to issue this, too, to parents.

APPENDIX 1: Risk assessments

Two checklists are provided, one for use by teachers, the other for use by pupils or students.

A) Assessment by teacher

This is essentially in two parts:

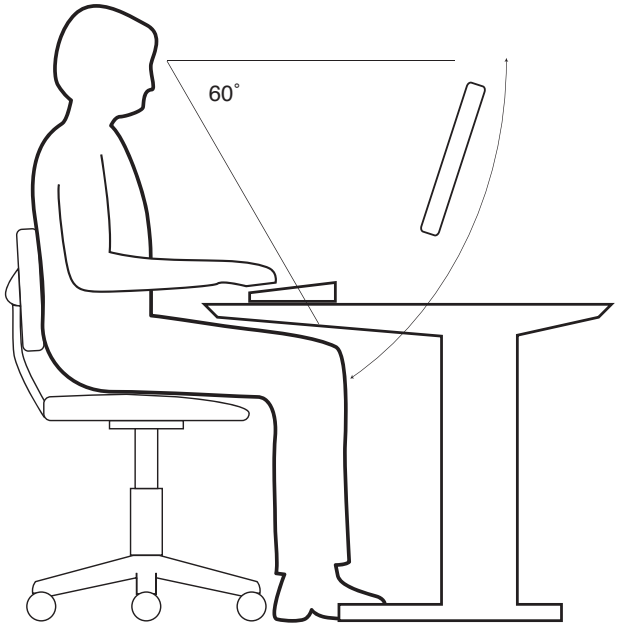
(i) *An initial assessment of the environment, furniture and computer equipment:*

Your education employer will have provided the buildings and furniture and these should meet several standards listed in the associated guidance for employers. He or she will have carried out a thorough assessment of the suitability of the furniture, equipment and of the way it is arranged. The school staff delegated to do so should quickly make their own initial short assessment of this same aspect. This does not need to be repeated again unless the fixed furniture or equipment is altered or suffers severe wear and tear or damage; for example if the adjustable feature of chairs fails, or if the mouse ball ceases to operate smoothly.

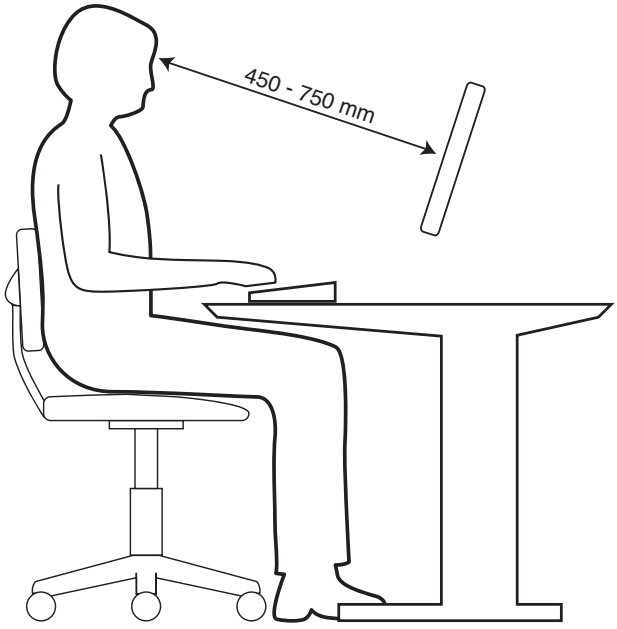
(ii) *A running watch on how pupils fit and use the equipment.*

Check them against the recommendations and the correct technique picture shown below.

This is best done as a continuing informal assessment by teachers. Once initial instruction has been given to pupils it is a case of just watching out for bad posture or technique and gently chiding pupils when necessary. The self-check by pupils is, we feel, a very important additional tool.



Top of screen should not be above eye level.
Bottom of screen should not be below a line-of-sight angle greater than 60˚.



Viewing distance should lie between 450 mm and 750 mm.
600 mm is optimum for typical person.

An extended, special risk assessment may be needed if a child presents one or more of these conditions:

- Medical condition
- Physical disability
- Mental disability
- Behavioural problems
- Learning difficulties
- Hygiene problem

Check list for use by department and by classroom teacher

Factors	Yes Y	No N	Possible remedial action
1 Environment			
Is the lighting too dim to read books and documents or too bright to see the screen?			Change lighting and use blinds if necessary.
Is room well ventilated to prevent overheating?			
Are surfaces (desk, walls, etc) free from glare and reflection?			Repaint or cover surfaces.
Are electric and other connecting cables tidied away so that they don't entangle feet or cause trips, etc?			
2 VDT			
Does the monitor swivel and tilt?			Modify if necessary.
Is the display screen pointing in such a way so that reflections and glare are avoided?			Screen may need to be at right angles to window. Blinds may be needed.
Is there a document holder next to the screen so positioned that uncomfortable head or eye movement is minimised?			
Is the keyboard separate from the screen?			This is a legal requirement for continuous work in a workplace.
Does the mouse make the pointer move smoothly across the screen?			May need cleaning or adjustment of speed settings.
Is there enough space for other books, etc?			
Is there enough space in front of the keyboard for the pupil to rest his or her hands?			

3 Chair			
Can the chair move freely on castors?			
Can the height of backrest be adjusted?			
Can the height of the seat be adjusted?			
Can the tallest pupil sit comfortably with eyes level with, or a little above, the top of the screen and with feet comfortably on the floor?			
Can the seat be raised to allow the smallest pupil to sit comfortably?			
Are footrests available?			

4 Individual user's technique and posture Can the pupil sit comfortably with:			
- elbows by sides and forearms horizontal?			Adjust chair height to get arms in the right position. Then adjust the height of the display screen and if necessary supply a footrest.
- wrists neutral, that is, in line with forearm (not more than 15° out of line up, down or sideways)?			
- thighs and lower legs close to a right angle and feet flat on floor or foot rest?			
- eyes level with the top of the screen or a little above?			
- the small of the back well supported by the chair's backrest?			Adjust backrest.
- hand comfortably on the mouse or other NKID?			Position mouse mat to side of keyboard to avoid need for overstretching.
Is amount of mouse use minimised?			Teach use of keystrokes. Encourage a relaxed arm. When not using mouse do not rest hand on mouse.
Is there plenty of leg space below the desk?			Remove any obstructions.

5 Breaks in work			
Do pupils spend at least 10 minutes in any hour away from the display screen either standing, stretching, or walking?			

B) Self-check for pupils

Pupils can do a self-check on their own computer station by answering the questions in the table below. It is based on general guidelines and questions produced by the International Ergonomics Association. Most things needing attention will be picked up by it, but this tool doesn't give any extra weight to the more serious faults. However it has the advantage over other more sophisticated methods of enquiring about tension in the user's muscles.

The appearance of a "No" means something needs to be changed. It may only require a simple adjustment of the chair height or screen, but might indicate that a more fundamental change in posture, or the way in which work is carried out, is needed.

School management or teachers can use the following form in whichever manner they wish. The best way may be that of handing over the form to the pupils and encouraging them to be responsible for their own health; that way they are more likely to carry the attitude and good techniques home with them. Another alternative is that of collecting the completed forms and using them as a diagnostic tool in conjunction with the assessment made above.

Self-check on computer work area

You can check your own computer station by answering the questions below. The appearance of a "No" means something needs to be changed. It may only need a simple adjustment of the chair height or screen to correct the problem. Also a "No" may tell that your posture is wrong, or the way you work needs changing.

Question	Yes Enter Y	No Enter N
Are your wrists fairly straight in line with your forearm (that is, not bent up or down nor to either side more than about 15 degrees)?		
Can you see the display screen without looking up or tilting your head backwards?		
Are you able to work at the computer without twisting your neck or your back?		
Are you able to view the letters on the screen without sticking your chin out or leaning forward?		
Are your upper arms relaxed at your sides (that is, are your elbows below your shoulders) when you are keying?		
Have you changed the way you are sitting in the last few minutes?		
Have you taken a break from the keyboard or mouse for at least 10 minutes in the last hour?		
When using the keyboard, do you use the keys lightly (just a little more than the minimum required to press the keys down)?		
When using the mouse do you rest your hands lightly on it without tensing your fingers?		
Do you relax your finger after clicking the button on the mouse?		
Do you minimise use of the mouse by using where possible: (i) keystroke short cuts?		
(ii) the right hand button to show the menu at that part of the screen and thus avoid longer distances of mouse movement to reach drop-down menus from the top bar?		
Can you work comfortably at the computer without any sharp edges (such as the edge of the desk) contacting your arms or body?		
Do you feel comfortable when sitting at the computer?		
Can you work at the computer without feeling tense?		
Do you take part in active sport or activities where there is vigorous movement of legs, arms, back and neck?		

APPENDIX 2: Injuries

Repetitive strain injuries (RSI) - also ULD and WRULD

Rapidly repeated movement of the same joints can damage tendons, ligaments, and muscles in addition to nerves and the circulation system, especially if these actions are carried out:

- in an awkward or fixed posture for lengthy periods without some rest-breaks to allow recovery; or
- with some force.

Unlike sprains and strains, which normally are caused by a single accident, repetitive strain injuries develop over a period of time (can be weeks or years) and are to a large extent cumulative. Wrists, hands, arms, elbows, shoulders, neck and back are commonly affected. For this reason these injuries are sometimes collectively named upper limb disorder (ULD) or work-related upper limb disorder (WRULD).

Generally RSI can be caused by any action that is continually repeated over a lengthy period. Such repetitive actions can be found in playing musical instruments, in using tools like screw drivers or pliers, in hairdressing, or in continuous work with a keyboard or mouse (for example, frequently repeated mouse clicks or keyboard presses with little or no rest time). If, in addition, the posture and technique are poor, for instance with the wrists very bent, the arm extended and a large force being used on the mouse button, then the injured state can occur sooner and can be more serious.

First signs

As the injury progresses one or more of the following symptoms may appear: swelling, tingling, aches, tenderness, loss of strength and of coordination in the affected area. There may be even a clumsiness in holding small objects. The symptoms do not necessarily occur immediately after the activity causing them. Pain and tingling may be felt much later and often in bed at night.

To prevent the injury from becoming worse it is important to recognise these symptoms and take remedial action. Do less keyboarding for a while; reassess the workstation and check your technique and posture.

Causes

Parts of the body move relative to each other when muscles contract and relax. Muscles are connected to the bones by tendons which slide to and fro inside tubes called synovial sheaths. Synovial fluid, which acts as a lubricant, is released inside the tube helping the tendons to slide more freely. Tendon disorders are common close to joints and are caused by tendons rubbing against ligaments and bones.

Most of the muscles operating the hand and fingers are in the forearm with nine long tendons, inside their synovial sheaths, running from these muscles through a narrow passage in the wrist to the finger bones in the hand - two for each finger and

one for the thumb. Try bending and straightening your fingers and you can feel the contracting muscles in the forearm.

This narrow passage on the palm side of the wrist is called the carpal tunnel (Fig. A.2). It is made of a U-shaped depression formed of the small bones of the wrist and capped by ligament. The median nerve, which serves the thumb, fingers 2 and 3 and part of finger 4, also passes through the carpal tunnel.

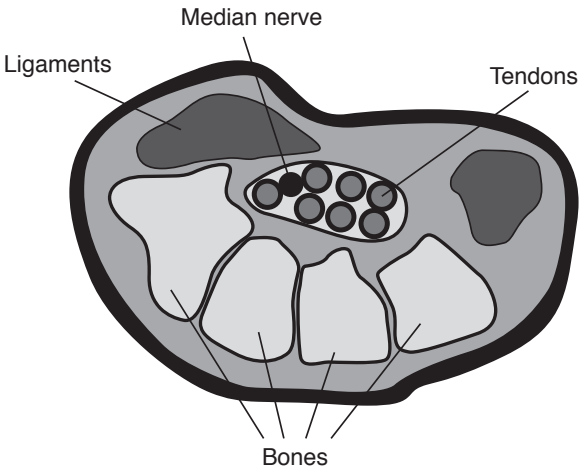


Figure A.2 Section of wrist with palm uppermost showing the carpal tunnel.

Back Disorders

Injuries to the back are the most common reason given for absence from work. Many back injuries frequently occur as pulled or strained muscles resulting from (i) single incidents or accidents or (ii) the cumulative effects over a longer period of time of poor body mechanics, such as excessive carrying, lifting, or pulling heavy loads, or stooping, twisting and over-reaching.

Sitting in the same position also stresses the lower back and can cause the spine to bow outwards.

Some conditions likely to affect computer users are summarized in Table A.2.

Condition	Causes	Symptoms
Carpal Tunnel Syndrome	Compression and entrapment of the median nerve in the carpal tunnel. This nerve runs from the shoulder down the arm to the hand and fingers. This can be caused by: • working with bent wrists; • swollen tendons squashing the nerve in the tunnel (this swelling can be caused by repetitive use without breaks for recovery); • using extra force in pressing keys or mouse buttons.	Tingling, numbness or pain in all fingers except the little finger and half of the ring finger. This is often felt at night. Clumsiness and weakness in hands and poor ability to grip small objects.
Tendonitis	Repeated flexing of tendon or muscle in an unaccustomed posture, resulting in some of the fibres of the tendon becoming frayed and lumpy. The injured area may calcify. The tendon will be weakened unless there is sufficient break time for recovery.	Pain and inflammation in joint in wrist, elbow, or elsewhere.
Tenosynovitis	Inflammation and swelling of the synovial sheath which surrounds the tendon. Excessive repetitive use of hands and wrists causes excessive secretion of the synovial fluid, resulting in the sheath becoming swollen and painful.	Pain and swelling of the affected area, together with stiffness of affected joint which is moved by that damaged tendon.
Lower back injury (Kyphosis)	Abnormal curvature of the spine caused by slouching (teenagers especially) or by sitting for long periods in a fixed position, particularly with poor posture and using a computer chair with poor lumbar support.	Pain in the lower back.

Table A.2 Some medical conditions which can affect computer users.

APPENDIX 3: Flicker and photosensitive epilepsy

Photosensitive epilepsy (PSE) is a rare medical condition triggered by flickering lights. It can result in an epileptic fit. About 1 person in 10,000 is affected. The medical condition is due to a susceptibility to flickering lights. Persons who do not possess this particular susceptibility will not get PSE by looking at flickering lights. The condition is more common in females. Puberty is a stimulating influence because most cases appear between the ages of 10 and 14 years. There is evidence of some genetic component because it appears more frequently in some families.

Very few people will react adversely to flicker with a frequency below 3 Hz and above 60 Hz. All frequencies between these values are more or less capable of triggering PSE in susceptible individuals. The peak triggering frequencies are between 15 Hz and 20 Hz. However PSE will only affect those potentially affected persons when they are looking directly at the flashing source. Gazing away from the flashing source, be it a lamp, or TV or computer screen, will not trigger an epileptic response in the brain. Flicker with a red rather than any other coloration is more likely to trigger a fit. Viewing with one eye covered would reduce but not eliminate the risk for those individuals who are susceptible.

Control measures

Schools should do all they can to identify children at risk. If a teacher has been forewarned that a child has PSE, then the following control measures should be put in place and the pupil with the condition warned not to look directly at the flickering light. Many would think it prudent taking precautions with all children since there is the possibility of having a child predisposed to PSE for whom the condition is yet to declare itself. If a child's first epileptic fit induced by flicker were to take place in school, it should be clear that the flickering source is the trigger of the condition declaring itself, not the cause of the condition. The purpose of control measures is to help those children known to have the condition from being exposed to types of flicker that might be capable of inducing seizures.

Whereas with stroboscopic lights a flicker sensitive person can avoid an attack by not gazing at the lights, this control does not apply for TVs, or computer displays. The mechanisms that might generate dangerous flicker are (1) electrical, mainly the screen refresh rate, and (2) programmed rapidly repeating images. The latter is not currently a problem in the UK with broadcast television because the producers' guidelines issued by television companies prohibit programme content with flashing or flickering images.

With computer CRT monitors, the number of times a second the electron beam scans the screen is known as the refresh rate. This usually lies between 40 Hz and 80 Hz, and is partly within the range of frequencies that can cause a PSE seizure. The optimum refresh rate is a compromise between keeping the value sufficiently high to avoid the risk of harm to persons with PSE, but not so high as to impair the resolution of the image. Modern CRT monitors tend mostly to have a refresh rate set at 60 Hz

or 72 Hz, putting them just outwith the range that can trigger an attack. Some older monitors had a lower refresh rate and were a cause of harm.

The control measure is obvious. Any child with PSE should be provided with a monitor or TFT screen whose refresh rate is set at above 60 Hz.

Regarding television, a whole TV picture is generated in 1/25th of a second. The picture is built up from two scans of the raster, each of which take 1/50th of a second, using a technique called interlacing. Thus although the whole picture is refreshed once every 25th of a second, the flicker frequency is effectively doubled to 50 Hz. This is inside the range of frequencies that can trigger an attack, but is far above the peak triggering frequencies. Persons with PSE are at risk of a seizure if they watch TV. The risk can be minimized by:

- keeping the room well lit, and
- ensuring that the person at risk sits sufficiently far from the screen that the individual line resolution cannot be seen.

Control measures for other sources of flicker found in schools can be found in SSERC's Bulletin 210 (Spring 2004 issue).

APPENDIX 4: Data projectors and whiteboards

Summary

There is a slight risk of harm to eyesight from the very bright light coming from a data projector. The risk comes from standing in the beam, facing the projector, and staring fixatedly either directly at the lamp, or at an object elsewhere. It is similar to staring at the sun, or staring fixatedly at some other object while directly facing the sun such as when driving into the sun while it is low in the sky. The risk is very slight because the eyes are protected by natural aversion responses such as blinking and turning the head away. The risk is easily reduced to a harmless level by engineering and procedural controls.

Control measures

Engineering controls:

- The brightness of a classroom projector should be no greater than 1500 lumens (ANSI units).
- If convenient, a classroom projector should be fixed to a ceiling mounting, or other inaccessible location, so that it is not easy to intrude into the beam and impossible to look at the lamp from close up.
- The screen height should be as low as possible for relatively unobstructed viewing. The top of the screen should not be too much above eye level, letting the viewer's head and neck be kept in a neutral posture – which avoids having to crick the neck for extended periods of time. (This measure is for ergonomic purposes and has nothing to do with eyesight risk reduction.)

Procedural controls:

- Keep out of the beam whenever you can.
- If you have to enter the beam:
  - never stare at the lamp;
  - try always to keep your back to the beam;
  - remember to step out of the beam to face the class;
  - do not face the class for more than a few seconds while in the beam;
  - do not try to counteract natural aversion responses.
- Children must be supervised at all times whenever a projector is in use.
- Children should be warned of the risk to eyesight from extremely bright lamps. They should be given the above rules of conduct and an explanation for their purpose. They should be told that if by mistake they were to find themselves in the beam they should turn away and step out of the light.

Report

Several stories were run by the press on or around 22nd January 2005 on the risk to eyesight from using data projectors and interactive whiteboards. The stories were based on measurements made in 2002 by the National Radiological Protection Board (NRPB) on DLP[1] projector radiation. These projectors differ from LCD ones, but their radiation is thought to be fairly similar. The work had been commissioned by the HSE.

The NRPB test on a single product found that, apart from possibly some radio-interfering EMF emissions, the radiation emitted is entirely optical; there is no ultraviolet or infrared of significance. Within the optical waveband, the risk comes from the blue-light photochemical hazard to the retina (which is caused by radiation in the visible spectrum between violet (400 nm) through blue, cyan and green to yellow-green (580 nm), with slight effects through to deep red (700 nm)). The risks to children in this case from blue-light induced photoretinitis are no different from the risks to adults with this hazard[2]. It is believed that there is no other hazard from the product tested.

If the retina were to be exposed to a very high energy irradiance or power density of blue-light, then it can be damaged. It is a threshold effect – a level which is different for every individual person. Below the threshold, the risk is negligible. Above, and harm occurs - the retina would be permanently damaged. The risk increases with repeated exposures over a short time period. Bobbing in and out of the projector light repeatedly, many times over, could bring someone up to his or her threshold.

Guidelines on limits of exposure to broadband incoherent optical radiation have been produced by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The ICNIRP exposure limits have been set conservatively to ensure that, below them, the risk is negligible for persons who do not have an abnormally low personal threshold.

NRPB found that if you were to stand in the direct beam from the projector under test and stare fixatedly at the light, a personal threshold could be reached within some tens of seconds. At a distance of 120 cm, the ICNIRP exposure limit for photochemical injury is reached after 20 seconds.

The main method of protection is instinctive. Were you to look directly at the beam, you would find that it is uncomfortably bright and your natural aversion responses would act to prevent harm - you would move out of the beam, or turn your head away, or shut your eyes, or shield your eyes with your hand.

It follows that when using a computer projector, the teacher or child should keep out of the beam, or, even better, the beam should be arranged so that no one can step into it if at all possible. That is the main control measure. To recast this advice in another way, whenever someone using a computer projector enters the beam, then that person should react instinctively to the light, doing the natural thing to prevent harm. The user must not try to counteract instinctive impulses.

[1] DLP stands for Digital Light Processor, a technology developed by Texas Instruments.

[2] Nevertheless the risk of blue-light induced photoretinitis happening is, in general, higher for children as their lens is more transparent with ultraviolet radiation.

Nevertheless, since anyone using an interactive whiteboard (of the type illuminated by a projector) has to enter the beam to write on the board, he or she should avoid turning to face the light and step out of the beam as soon as convenient. The second rule should be: never turn to face the class when in the beam.

To explain what lies behind this second rule, when looking at an object, light from that object is focused on a small area of the retina known as the macula. This is the most vital part for, once damaged, it becomes impossible to resolve fine detail with the eye and would prevent someone so injured from being able to read. Light falling on other parts of the retina forms fuzzy images. This is known as 'peripheral vision'. It is thought that peripheral vision could be damaged if the peripheral vision parts of the retina were to be bathed continuously in blue-light from a projector. In particular, if someone were to stare fixatedly at an object outside the beam while standing in the beam, that person's peripheral vision could be damaged. In this condition, the projector light could focus on one small part of the retina for long enough for the threshold to be exceeded. Such an event could happen if a teacher were to stand stock still in the direct beam for some tens of seconds staring at one particular child. But this would be improbable, for it is likely that movements of the head would cause the focused image of the projector beam to rove around over different parts of the retina, never lingering on any one spot for sufficient time for damage to occur. The control measure (or the preventive measure) is not to stand in the direct beam - neither to stare into the lamp, nor even to stare at some point to one side of the lamp.

There is a danger of allowing children to use projectors unsupervised. Whereas children usually behave instinctively, and this often prevents them from harm, they can behave perversely, trying to over-ride natural preventive measures. There is evidence, from playing with laser pointers, of children staring into a laser beam, fixatedly, trying to thwart the natural aversion responses. It can therefore be expected that, if left unsupervised in a room with a computer projector, some child or group of children may try to stare into the direct beam for as long as they dare, or a child may pretend to be an actor standing in the limelight, entertaining classmates. As explained above, both of these could result in either damage to, or the loss of, eyesight. The two preventive measures are:

1. to warn children of the danger; and
2. to supervise the use of computer projectors.

We understand that the Health Protection Agency (in 2005 the HPA took over the functions of NRPB, which now ceases to be) intend to make measurements on optical radiation from LCD projectors and interactive whiteboards.

Putting the risks into perspective, it is very rare for eyesight to be damaged by sunlight – from which the risk of harm is comparable to that from a data projector. This is largely because of the powerful influences of natural aversion responses. Whilst photochemical damage can be permanent, in practice these injuries tend to be reversible. A report by the Royal College of Opthalmologists on the effect of viewing the 1999 solar eclipse in the UK without eye protection concluded that, of the 70 people diagnosed as suffering from photoretinitis, none showed any long-term impairment.

APPENDIX 5: Short cut keystrokes for Windows in place of mousing

NOTE: The following information is for Microsoft Windows, but similar short cuts apply to other computers. For instance identical instructions apply for the Macintosh except that that the Windows Ctrl key should be replaced with the Apple Command key. However the short cuts do not apply generally; some systems use other instruction sets.

Mousing (or mouse use) can often be reduced by substituting keystrokes. For example, take the scene where your pointer happens to be located centrally on the screen page and you wish to print the page or, perhaps, the whole document. If mousing, this requires:

(i) moving one hand away from the keyboard to the mouse;
(ii) "travelling" up to and clicking on the **File** menu at the top left of the screen to generate the dropdown menu;
(iii) moving the pointer down to **Print** and
(iv) then clicking to select **Print** to bring up the dialogue box.

Instead the same dialogue box can be displayed by simply pressing **Ctrl + P**; this action is both a lot shorter and requires much less movement of the working hand, almost maintaining the arm in neutral posture rather than extending it to the mouse.

For fast scrolling use **Page Up** and **Page Down** as using these keystrokes requires much less tension on your hand and index finger than is needed for dragging the scrollbar.

Most people will already use some of the keystrokes, for example those for *Copy* (**Ctrl + C**) or *Cut* (**Ctrl + X**), and have their own little collection of favourites. The codes for many of the short cut keystrokes appear in the drop-down menus, but more are listed in Table A5.1 overleaf. A few are less likely to be used in the course of producing text and tables, for example *insert hyperlink*, but are included here for the sake of completeness.

Most of us find that once addicted to the mouse it is indeed difficult to break the habit. Try hard and with usage you can gradually pick up and adopt more of these keystroke short cuts. If, in your endeavours using this less familiar technique, a large chunk is accidentally deleted or otherwise drastically altered, don't worry. A simple **CTRL + Z** (equivalent to *Undo typing*) will restore everything! However not all actions can be carried out with the keyboard, but many can, reducing the amount of mousing and the likelihood of injuries.

Table A5.1 gives a short list of the keystrokes grouped by the type of action - *deleting, selecting, formatting*, and so on. Table A4.2 shows the spatial relationships of keystrokes for a smaller number of the common actions.

Combinations of keystrokes are also possible, for example **Shift + End** selects from the cursor to the end of the line. If now followed by the *delete* command **(Ctrl + X)** the marked selection is cut. Two different ways of doing this with the mouse are:

(i) move hand away from keyboard to mouse, select the required part of text, go up to *Edit* at the top; move down its drop down menu and select **Cut**; or

(ii) select the required part of the line, use the right button, which brings up a small menu box, and, with the pointer in the selected part, click on **Cut**.

If the mouse is used, the second alternative using the right hand button is preferable to the first.

Some of the **Ctrl +** commands use the first letter of the command word, for example **P** for **Print** and **S** for **Save**, making it easy to remember.

Commands	
Copy	**Ctrl + C**
Cut	**Ctrl + X**
Paste	**Ctrl + V**
Print	**Ctrl + P**
Find	**Ctrl + F**
Save	**Ctrl + S**
Undo last action	**Ctrl + Z**
Insert hyperlink	**Ctrl + K**
Opens Open dialogue box	**Ctrl + O**

Deleting	
Delete previous word	**Ctrl + Backspace**
Delete next word	**Ctrl + Delete**

Selecting	
Select all (ie whole document)	**Ctrl + A**
Select whole paragraph (from pointer to the end of paragraph)	**Ctrl + Shift + arrow down**
Select whole paragraph (from pointer to the top of paragraph)	**Ctrl + Shift + arrow up**
Select a word to right of pointer	**Ctrl + Shift + arrow right**
Select a word to left of pointer	**Ctrl + Shift + arrow left**
Select from pointer to start of line	**Shift + Home**
Select from pointer to end of line	**Shift + End**

Documents and windows	
Open new document on top of existing document	**Ctrl + N**
Close existing document and open new document	**Ctrl + W**
Close sub-window	**Ctrl + F4**
Change sub-window	**Ctrl + Tab**
Minimise	**Alt and release, then Space + N**
Maximise	**Alt and release, then Space + X**

Formatting	
Bold (as toggle)	**Ctrl + B**
Underline (as toggle)	**Ctrl + U**
Italicise (as toggle)	**Ctrl + I**
Superscript (as toggle)	**Ctrl + Shift + =**
Subscript (as toggle)	**Ctrl + =**
Right hand justified	**Ctrl + R**
Left hand justified	**Ctrl + L**
Page break	**Ctrl + Enter**
Change caps by selecting text and pressing	**Shift + F3**
Tab all lines in paragraph	**Ctrl + M**
Single space current para-graph or selection	**Ctrl + 1**
Double space it	**Ctrl + 2**
Tab all lines in paragraph except first line.	**Ctrl + T**

Navigating	
Instead of dragging scroll bar use	**Page Up or Page Down**
Go to end of document	**Ctrl + End**
Go to start of document	**Ctrl + Home**
Go to end of line	**End**
Go to start of line	**Home**
Move by one word	**Ctrl + left or right arrow**
Move by one paragraph	**Ctrl + up or down arrow**
Go to last edit made in document	**Shift + F5**

Tables and spreadsheets	
Move to	
- next cell	**Tab**
- previous cell	**Shift + Tab**
- first cell in row	**Alt + Home**
- last cell in row	**Alt + End**
- top cell in column	**Alt + Page Up**
- bottom cell in column	**Alt + Page Down**

Note that **CTRL + B** or + **U** or + **I** are on/off toggles. If applied during input of text all the characters thereafter will be in bold, underlined or italicised until it is switched off by repeating the same command again.

The **CTRL + B** or + **U** or + **I** commands can also be applied to a piece of selected text (selected by **CTRL + SHIFT + an arrow** or by using **SHIFT + Home/End**) as also can **CTRL** + **X** or **+ C**.

Table A5.1 Short cut keystrokes grouped by the type of action.

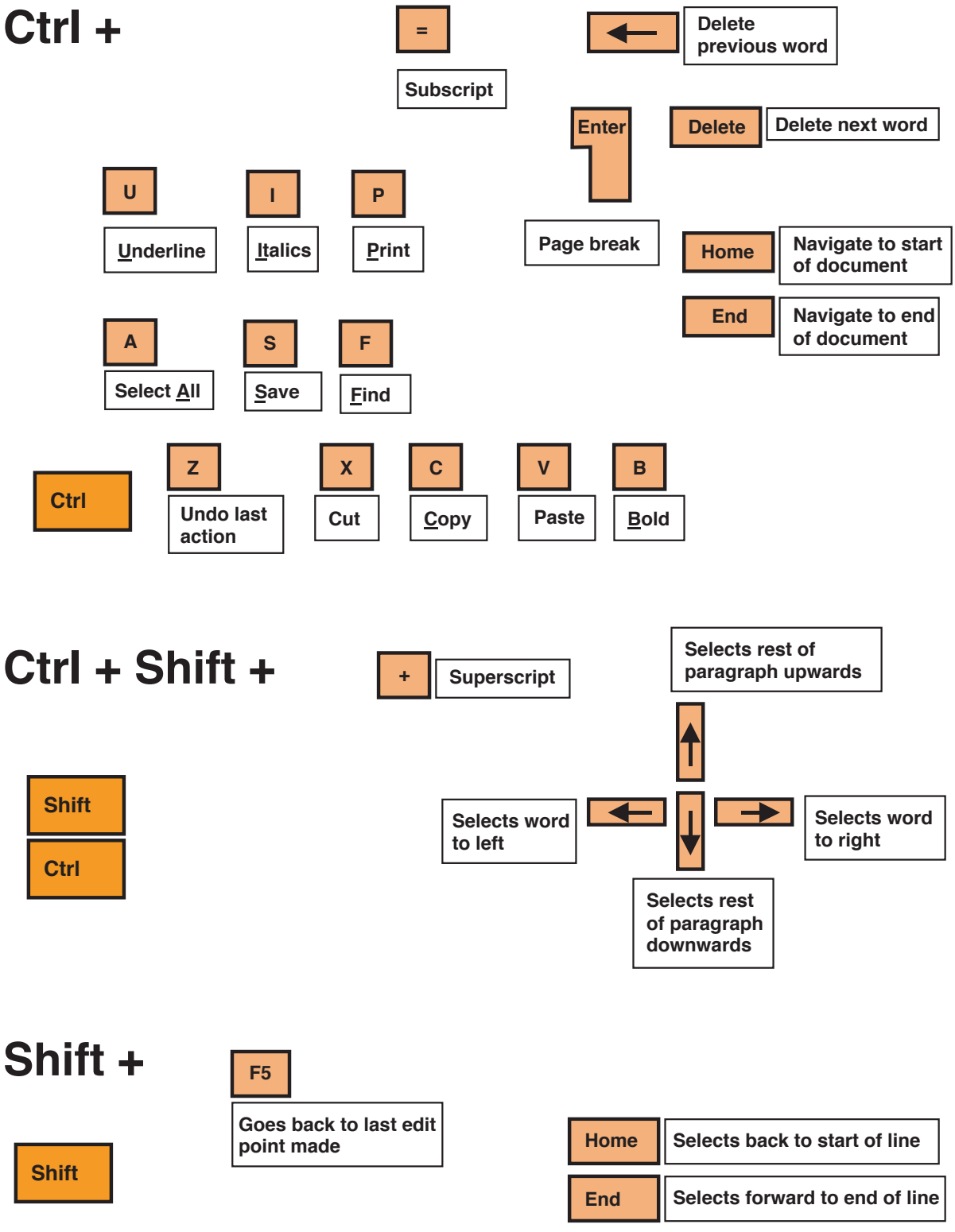


Table A5.2 Spatial arrangements of some keystrokes.

APPENDIX 6: Setting software to make tasks easier

The purpose of this appendix is to provide tips that simplify work with DSE equipment. This is another aspect of ergonomics. If the software is tailored to suit the user, then tasks can be accomplished more readily and at less risk of harm to the user. A few suggestions are given in Table A.6; the set is not intended to be exhaustive.

Action	Comment
Tidy desktop	Reduce the number of shortcuts to those that are essential and most frequently used and arrange in a neat array. These should be tailored for individual users.
Remove distractions from the desktop	Go for a plain background with high contrast – no Highland glens or Thai beaches.
Templates or stationery files	Set these up with pupils' preferred settings for font, size, paragraph format, colours, character polarity, header, etc.
Screen display	Young children, or those with visual impairment or learning difficulties, may get on better with a screen with fewer pixels: say 640 x 480 rather than 800 x 600 since this results in a larger size of text.
Screen appearance	Preset features to suit the user: • Character polarity. • Icon size. • Toolbar button size.
Toolbars	Customize the toolbar so that only those options that are actually used are displayed.
User profile	Customize to suit the user: • Mouse – left or right handed. • Mouse speed. • Keyboard settings (slowkeys, filterkeys, repeatkeys, stickykeys, key beeps, showsounds). • Display properties.
Desktop management	Prepare front end programs giving pupils a simplified desktop and password entry, and preventing them changing settings, installing software, or altering files.

Table A.6 Some software means for improving the usability of DSE.

APPENDIX 7: Sources of information and advice

HSE Publications

Working with VDUs INDG36 (rev1) HSE Books 1998 Available in priced packs ISBN 0 7176 1504 9. Single copies are free. Offers basic advice for people who use VDUs at work.

The law on VDUs: an easy guide HSG90 HSE Books 2003 ISBN 0 7176 2602 4. Gives illustrated practical guidance, with a checklist, on how to comply with the Regulations. Aimed primarily at employers whose staff use VDUs in offices.

Work with Display Screen Equipment: Guidance on Regulations L26 HSE Books 2003 ISBN 0 7176 2582 6. Gives detailed legal guidance and includes the text of the Regulations.

VDU workstation checklist HSE Books 2003 ISBN 0 7176 2617 2 (which is included in both HSG90 and L26 above).

Other Publications

The visual environment for display screen use Lighting Guide LG3 Chartered Institution of Building Services Engineers 1996 ISBN 0 900953 71 3.

Health effects related to the use of visual display units Documents of the NRPB Volume 5 No 2 NRPB 1994 ISBN 0 85951 376 9.

Furniture and equipment in schools: a purchasing guide Managing school facilities Guide 7 DfEE.

Design and technology accommodation in secondary schools: a design guide BB 81 Building Bulletins DfEE ISBN 0 11 270917 6.

Area guidelines for schools BB 82 Building Bulletin DfEE ISBN 0 11 270921 4.

Lighting design for schools BB 90 Building Bulletin DfEE ISBN 0 11 271041 7.

Access for disabled people to school buildings: Management and design guide BB 91 Building Bulletin DfEE ISBN 0 11 271062 X.

Designing for pupils with special educational needs: Special schools BB 77 Building Bulletin DfEE ISBN 0 11 270796 3.

Poster

Computer safety SEP/S357-1 RoSPA (suitable for ages 12-18 years)

Sources of Expertise

British Educational Communications and Technology Agency (BECTA):
Millburn Hill Road, Science Park, Coventry CV4 7JJ. Telephone: 024 7641 6994.
Web site: www.becta.org.uk

Chartered Institution of Building Services Engineers (CIBSE):
222 Balham High Road, London SW12 9BS. Telephone: 020 8675 5211.
Web site: www.cibse.org.uk

Employment Medical Advisory Service (EMAS):
Contact through HSE area offices.

Ergonomics Society:
Devonshire House, Devonshire Square, Loughborough LE11 3DW. Telephone: 01509 234 904
Web sites: www.ergonomics4schools.com and www.ergonomics.org.uk

Eyecare Trust:
PO Box 131, Market Rasen, Lincolnshire LN8 5TS.
Telephone: 01673 857 847.
Web site: www.eye-care.org.uk

National Radiological Protection Board (NRPB):
(from 1st April 2005 NRPB has become a part of the Health Protection Agency):
Health Protection Agency, Radiation Division, 155 Hardgate Road, Glasgow G51 4LS.
Telephone: 0141 440 2201.
Web site: www.hpa.org.uk

Repetitive Strain Injury Association:
380-384 Harrow Road, London W9 2HU.
Telephone Helpline: 0800 018 5012 Office: 020 7266 2000
Web site: www.rsi.org.uk

Royal Society for the Prevention of Accidents (RoSPA):
53 Lanark Road, Edinburgh EH14 1TL. Telephone: 0870 777 2228.
Web site: www.rospa.com

Scottish Schools Equipment Research Centre (SSERC):
St Mary's Land, 23 Holyrood Road, Edinburgh EH8 8AE. Telephone: 0131 558 8180.
Web site: www.sserc.org.uk

Useful websites

Additional to the websites of the above organisations, the following sites (Table A.7) offer useful guidance on DSE work, or related matters.

Organisation	Web address	Comment
IBM	www.pc.ibm.com/ww/healthycomputing	Technical information on all aspects of DSE health and safety
IBM	www.pc.ibm.com/ww/healthycomputing/stretching.html	Stretching exercises
Cornell University	www.ergo.human.cornell.edu/Pub/HFPresentations/NEEkidsweb.pdf	Ergonomics and children
Massachusetts Institute of Technology	http://web.mit.edu/atic/www/rsi/RSIMIT/exercise.html	Exercises for rest breaks
Massachusetts Institute of Technology	http://web.mit.edu/atic/www/rsi/mitrsi.htm	RSI

Table A.7 Some websites offering ergonomic and health and safety advice on DSE.

APPENDIX 8: Definitions of acronyms and terms

Definitions:

Anthropometry: Study and measurement of the physical dimensions of the human body.

Armrest: Support for the lower arms.

Backrest: Part of a work chair which provides support for the back.

Cursor: Visual indication of the focus for alphanumeric input.

Design reference posture: Posture specified for the workstation design to define relative positions and dimensions.

Design viewing distance: The distance or range of distances between the screen and the operator's eyes for satisfactory viewing of images.

Display screen equipment (DSE): Apparatus comprising of a display screen (either a conventional cathode-ray tube, or liquid crystal or plasma flat-panel tube) and other items such as a keyboard or keypad, computer, non-keyboard input device, document holder, etc.

Dynamic posture: Body position which changes, with relative movements of the limbs or other parts of the human body in relation to one another or with respect to a fixed object (such as a workstation).

Enclosure: Part providing the hazardous live conductors within electrical equipment against direct contact.

Flicker: Impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.

Glare: Condition of vision in which there is discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of luminance, or to extreme contrasts.

Hazard: Potential source of harm.

Home row: Row of the keyboard to which the fingers typically return between keystrokes.

Home row height: Height from the centre of the strike surface of an unactuated key in the home row to the support surface.

Joystick: Lever mounted on a base used to control the movement of objects displayed on a screen; a type of non-keyboard input device.

Kyphosis: Convex curvature of the thoracic spine.

Laptop: Portable DSE, sometimes called a notebook computer.

Line-of-sight: The line connecting the point of fixation and the centre of the pupil of the eye.

Line-of-sight angle: The angle between a horizontal line and the visual axis of the eye (line connecting the point of fixation and the centre of the pupil).

Local area network (LAN): A data communications network confined to a limited geographical area, which may be confined to a single school or building.

Lumbar: Region of the back between the thorax and the pelvis, sometimes referred to as the small of the back.

Mini-keyboard: A standard QWERTY keyboard in key size and arrangement without an extra numeric keypad section. It is therefore less broad than the standard keyboard.

Mouse: Computer input device having one or more buttons and capable of two-dimensional rolling motion which can drive a cursor or pointer on the display and performs a variety of selection options or commands. A type of non-keyboard input device.

Negative polarity: Relative condition of the display screen in which the foreground is bright and the background is dark.

Neutral posture: Position that the body (and parts of the body) assumes when completely relaxed, that is, without any intentional bending at the joints.

Non-keyboard input device (NKID): A type of input device, which includes mouse, joystick, light-pen, puck or stylus with tablet, and trackball.

Numeric keypad: The array of numeric keys to be found on the right hand side of the standard keyboard.

Palm-rest: Platform placed in front of keyboard or embedded in the keyboard on which the operator may place the palm of their hands.

Photosensitive epilepsy (PSE): A medical condition triggered by flickering lights; it can result in an epileptic fit.

Pointer: Symbol on a display which indicates the input or selection position whose movement is controlled by an input device.

Positive polarity: Relative condition of the display screen in which the foreground is dark and the background is bright.

Posture: Overall position of the body, or body parts in relation to each other, with respect to the workplace and its components.

Puck: Hand-held device similar to a mouse but with a reticle view port and that is typically used with a digitizing tablet; a type of non-keyboard input device.

Reticle: Orthogonal lines in the lens of a puck used to visually align the puck to an image.

Repetitive strain injury (RSI): A non-medical term used to describe a range of musculoskeletal disorders brought about by a mix of repetition, stress and poor static posture held over long periods of time.

Risk: The combination of the likelihood and severity of the consequence of a specified hazardous event occurring.

Risk assessment: The overall process of estimating the magnitude of risk and deciding whether or not the risk is tolerable or acceptable.

Selector (button): Actuator (often a push-switch) located on an input device (such as a mouse).

Static posture: Adoption of a body position which is fixed over time and where there is muscle contraction without motion.

Stylus: Pen-shaped pointing device which, when touched to a display or graphics tablet, can be used to draw images on a display or select displayed objects typically by depressing the stylus tip or actuating a button located along the side of the stylus; a type of non-keyboard input device.

Tablet: Special flat surface with an input device (such as a stylus or puck) for selection, drawing, or indicating position of images to be displayed.

Touchpad: Small flat rectangular surface across which a finger is dragged to control the movement of the display pointer: a type of non-keyboard input device.

Trackball: Ball in a fixed housing that can be rolled in any direction by the fingers to control pointer movement, and that often has adjacent buttons; a type of non-keyboard input device.

Trackpoint (nipple trackpoint): A miniature type of non-keyboard input device operated by very small finger movements causing the device to swivel about its base, which results in corresponding movements of the screen display pointer.

Upper limb disorder (ULD): A general label referring to a range of medical conditions which can be caused or made worse by work. The conditions affect the part of the body extending from the tips of the fingers to the shoulder and extending into the neck.

Usability: An expression of the effectiveness, efficiency and satisfaction of use.

Visual display terminal (VDT): Apparatus comprising of a display screen (either a conventional cathode-ray tube, or liquid crystal or plasma flat-panel tube) and other items such as a keyboard or keypad, computer, non-keyboard input device, document holder, etc.

Visual display unit (VDU): Same as visual display terminal.

Wireless local area network (WLAN): A data communications network where signals are transmitted by very high frequency radio at frequencies between 2 GHz and 10 GHz. Typically the range of WLAN varies from under 30 metres to about 200 metres.

Workplace: Any premises made available to a person as a place of work. In the legal sense in which workplace is used in this guidance, a school is the workplace of teachers; it is not the workplace of children. Children attending school do not do so as employees.

Work space: Volume of space allocated to one or more persons and the workstation.

Workstation: Assembly comprising display equipment with or without a computer, which may be provided with a keyboard, mouse or other non-keyboard inputting device, document holder, modem, printer and other peripherals, and includes a work table, work chair and immediate work environment.

Acronyms:

BS	British Standard
BS EN	European Norme or Standard adopted as a British Standard
CRT	Cathode ray technology
DSE	Display screen equipment
EMC	Electromagnetic compatibility
EN	European Norme or European Standard
HSE	Health and Safety Executive
HSWA	Health and Safety at Work etc. Act 1974
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
IEE	Institution of Electrical Engineers
ISO	International Standards Organisation
LCD	Liquid crystal display
NICEIC	National Inspection Council for Electrical Installation Contracting
NKID	Non-keyboard input device
NRPB	National Radiological Protection Board (now a part of the Health Protection Agency)
PC	Personal Computer
PSE	Photosensitive epilepsy
RSI	Repetitive strain injury
TFT	Thin-film technology
ULD	Upper limb disorder
VDT	Visual display terminal
VDU	Visual display unit
WLAN	Wireless local area network

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