# 4 Implementation/use in practice

## 4.1 General ergonomic criteria

The following criteria should be met when computer input devices are used:

- The input device should be suited to the job tasks. One aid in decision-making may be the brochure published by the Netherlands' occupational safety institute, TNO Arbeid [109].
- The input device should permit use with the body in a posture that is as neutral as possible. Neutral posture is influenced by the design and position of the input device and by individual work techniques.
- The aim should be to minimize the level of muscle activity by enabling a small amount of effort to suffice and by producing the least static and least poor posture. This is influenced by the design and position of the input device and by working technique.
- Individual differences in body posture, anthropometric measurements, working techniques and individual preferences must be taken into account.

The ergonomic use of computer input devices should receive initial attention before physical complaints are reported. Sensible preventive measures can protect against health problems and the corresponding losses in productivity. It is a key importance in this for the measures under consideration to be viewed with regard to their effects on the overall workplace. The BGI publication 650, "Bildschirm- und Büroarbeitsplätze – Leitfaden für die Gestaltung", contains all the data, information and examples of implementation to serve as a practical guide in making computer work as ergonomic as possible [14]. In following the guide's suggestions, it is safe to assume that all of the requirements and protective targets given by the German Labour Protection Law, the Ordinance on Display workstations and the Ordinanace on Industrial Safety and Health will be maintained and achieved, and that accidents and occupation-related health risks are avoided.

Should health problems nonetheless arise in association with a computer workplace and with the use of input devices, it is suggested that employers seek the advice of a specialist for occupational medicine early on.

## 4.2 Check lists

Computer work and the use of input devices may result in complaints of the musculoskeletal system of the hand, the arm, the shoulder and the neck. Especially in cases of developing acute or chronic diseases of the locomotion system, including rheumatic diseases, "tennis elbow" or "golfer's elbow", complaints may arise or symptoms may be worsened.

The following checklists (Tables 18 and 19, pages 73 and 81) should serve as an aid for occupational health experts in identifying occupation-related sources of complaints or their exacerbation on a case-by-case basis and in finding adapted solutions potentially in co-operation with specialists for workplace health and safety or others who work on designing ergonomic workplaces. The aim should be to make it possible to perform all of the data entry tasks described here in a neutral body posture, while not restricting body posture for other activities that may arise.

The following procedure is recommended for using these checklists: If and when the described complaints (see above) arise, it is a good idea to consult the company physician in order to determine whether or not the complaints can be traced back to the workplace. As this is done, the workplace itself needs to be inspected along with the normal procedure of taking the patient's medical history. The type of activity and the type of use of the input devices as well as the body posture and work method need to be reviewed.

The pattern of the complaints and the workplace analysis serve to identify the problem as it is listed in the first column of the checklist. The second column with the heading "Measure" lists the suggested solutions, and the section "Comments" in this column provides notes on the individual and workplace-related peculiarities that need to be taken into consideration. The effectiveness of the measures applied should be reviewed after a suitable period of adjustment and acclimatisation.

### 4.2.1 Keyboard

Table 18:
Keyboard checklist

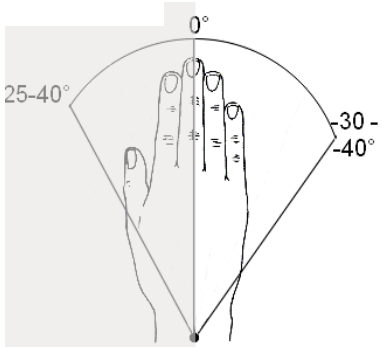
| **A Deviation from neutral posture** | | |
|---|---|---|
| | **Measure** | |
| **A I**<br><br>Wrist ulnar deviation<br><br>  <br><br><br>Radial deviation/<br>Ulnar deviation | • Turn the halves of the keyboards outward by up to 25º.<br>• Separate the halves of the keyboard to shoulder breadth.<br>*Comment:*<br>• The two measures only make sense for users who type using the ten-finger method without looking at the keyboard.<br>• Having the two halves of the keyboard at shoulder breadth cause some users problems with typing performance and the subjective perception of fatigue. |  |

Table 18: Continued

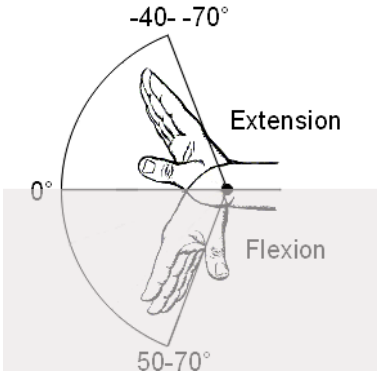
| **A Deviation from neutral posture** | | |
|---|---|---|
| | **Measure** | |
| **A II**<br><br>Wrist extension<br><br>  <br> | • Avoid a positive keyboard slope (collapse the keyboard's feet).<br>• Position the wrist at the height of the elbow.<br><br>*Comment:*<br><br>• Negative keyboard slope increases ulnar deviation. This can be compensated by applying measure A I.<br>• An elevated wrist position relative to the elbow does reduce extension, yet health problems may arise in the neck and shoulder regions.<br>• It is difficult respectively costly to implement negative keyboard slope as a universal workplace concept without restricting the rest of the working posture. |  <br><br>Keyboard laid flat (collapsed feet), wrist and elbow roughly at the same level |

Table 18: Continued

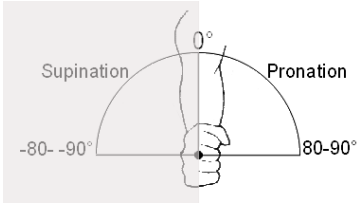
| **A Deviation from neutral posture** | | |
|---|---|---|
| | **Measure** | |
| **A III**<br><br>Forearm pronation<br><br>  <br> | • Keyboard halves sloped in a tent-like fashion.<br><br>*Comment:*<br><br>• Keyboard halves sloped in a tent-like fashion upwards to the middle only make sense for users who type using the ten-finger method without looking at the keyboard.<br>• Users vary widely in how they accept keyboards sloped in a tent-like fashion. The degree of slope should thus be adjustable by the individual user. |  |

Table 18: Continued

| **A Deviation from neutral posture** | | |
|---|---|---|
| | **Measure** | |
| **A IV**<br><br>For keyboards with numeric keypads*:<br>• The torso is turned to the left<br>• Increased ulnar deviation on right relative to the left<br><br>*See also Mouse checklist **A III** (page 83) | • Move the keyboard so that the alphabetic keys are in a centred position in front of the user.<br>• Use a keyboard without a numeric keypad or with a separate one that is only placed beside the keyboard when needed.<br><br>*Comment:*<br><br>• The measures described should be selected depending on the proportion of time spent in entering text and numbers relative to total work time.<br>• The numeric keypad is rarely used during text entry. It is thus recommended that the alphabetic portion of the keyboard be placed in the centre in front of the display screen. |  <br>  |

Table 18: Continued

| **B Force exerted** | | |
|---|---|---|
| | **Measure** | |
| **B I**<br><br>Disproportionate effort exerted and a lack of key feedback | • Choose keyboards requiring a force of between 0.5 and 0.8 N for keyswitching.<br>• Test key behaviour.<br>*Comment:*<br>• If the force necessary for activating the keys is too low, users cannot rest their fingers on the keys when not typing for fear of inadvertently depressing the keys (see B II).<br>• There are keyboards with different keyswitch behaviour. The manufacturer should be consulted for this information. Previous research indicates that kinaesthetic feedback is helpful (a point at which the fingers feel the key has been depressed). | |

Table 18: Continued

| **B Force exerted** | | |
|---|---|---|
| | **Measure** | |
| **B II**<br><br>Holding the fingers in a static posture | • Select a keyboard with a balanced key behaviour between the force necessary for activating the keys and the possibility of resting the fingers on the keys.<br><br>*Comment:*<br><br>• If the force needed to activate the keys is too low, users cannot rest their fingers on the keys when not typing for fear of inadvertently depressing the keys. This means that users have to hold their fingers above the keys constantly, which can result in severe local muscle fatigue and strain. | |

Table 18: Continued

| **B Force exerted** | | |
|---|---|---|
| | **Measure** | |
| **B III**<br><br>Holding the arms in a static posture | • Use hand-heel and forearm supports.<br><br>*Comment:*<br><br>• As a support for the hand-heels, space on the desk surface in front of the keyboard of 100 to 150 mm in depth normally suffices. A padded support (as flat as possible) may also make sense for individual sensitivities and anatomical peculiarities.<br><br>• The arm rests on an office chair serve as forearm supports. Fixed arm supports should be sloped forward to accommodate the different body dimensions of different users. The design of the arm supports should not inhibit the act of carrying out the user's job. Chair arm rests that are height- and width-adjustable allow for a better fit. |  <br>  |

Table 18: Continued

| **C Repetitive movements** | | |
|---|---|---|
| | **Measure** | |
| **C I**<br><br>Fatigue and strain from long-lasting and rapid repetitive movements | • Design the activity so that it is varied.<br>• Offer micro-breaks*.<br>*Comment:*<br>• The repetitive nature of an action can hardly be influenced by proportionate prevention – in other words, the choice of an ergonomic input device – but instead by measures of behavioural prevention.<br><br>*A micro-break is a short break of only a few seconds during which a static posture is interrupted and the muscles can relax. | |

### 4.2.2 Mouse

Table 19:
Mouse checklist

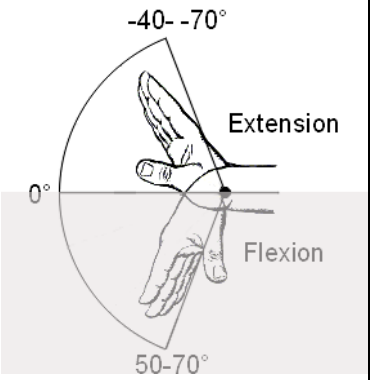
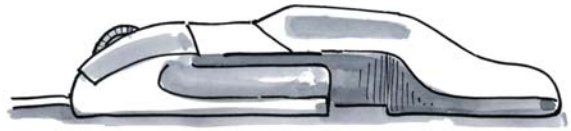
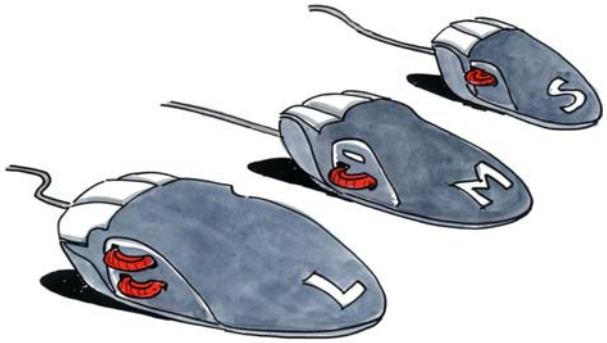
| **A Deviation from neutral posture** | | |
|---|---|---|
| | **Measure** | |
| **A I**<br><br>Wrist extension<br><br>  <br> | • Select a mouse with a low angle of rise in curvature (not too tall in height) and of suitable size.<br><br>*Comment:*<br><br>• Place the mouse at the correct working height and in a manner that the desk serves as a forearm support. |  <br>  |

Table 19: Continued

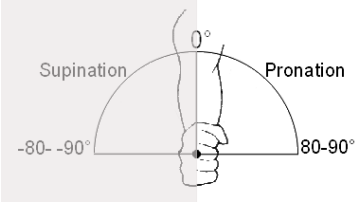
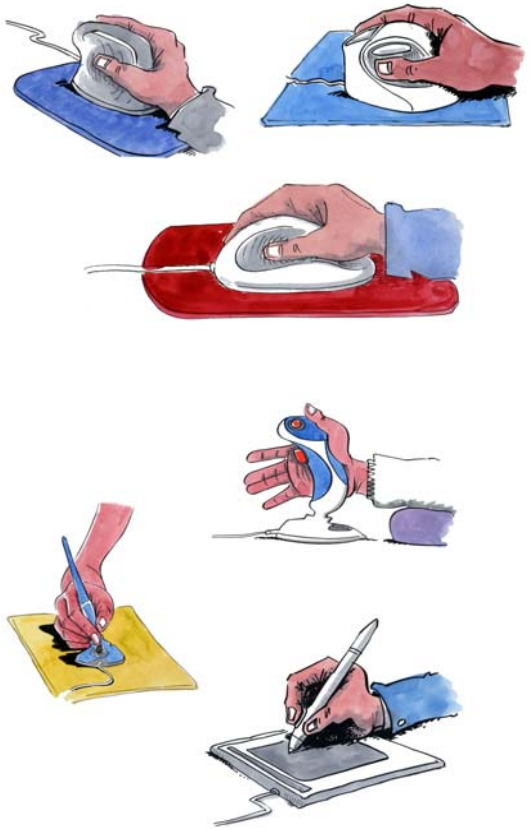
| **A Deviation from neutral posture** | | |
|---|---|---|
| | **Measure** | |
| **A II**<br><br>Forearm pronation<br><br>  <br> | • Choose a mouse with an optimized design or choose an alternative pointing device.<br><br>*Comment:*<br><br>• Pointing devices that reduce pronation include e.g. joystick mice, stylus-type mice, alternative mice with a shape that sinks to the outside (toward the elbow) or pen-tablet designs.<br><br>• Alternative pointing devices may require a period for the user to adjust. User preferences should be taken into consideration.<br><br>• Alternative pointing devices usually have to be chosen specifically for right- or left-hand use. |  |

Table 19: Continued

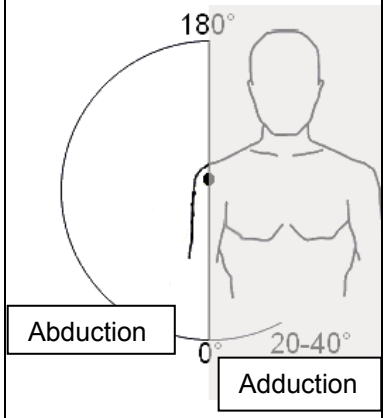
| A Deviation from neutral posture | | |
|---|---|---|
| | **Measure** | |
| **A III**<br><br>Arm abduction<br><br>  <br> | • Improve mouse position (shoulder breadth) by:<br>o Using a compact keyboard without a numeric keypad<br>o Using the mouse with the left hand (if a numeric keypad is on the keyboard).<br>• Use a mouse pad to define the workspace.<br>• Use a trackball as a fixed-location pointing device, see also Section 3.4.3, page 59.<br>*Comment:*<br>• Separate numeric keypads are available, if necessary.<br>• It takes practice to use the mouse with the left hand.<br>• While working with a mouse, the hand operating it often "wanders" unconsciously outside the ergonomically preferable working area. The use of a mouse pad helps to keep the mouse positioned consciously at a better location.<br>• If an activity requires only mouse work, the keyboard can be moved aside to allow the work to be performed at shoulder breadth. |  <br>  |

Table 19: Continued

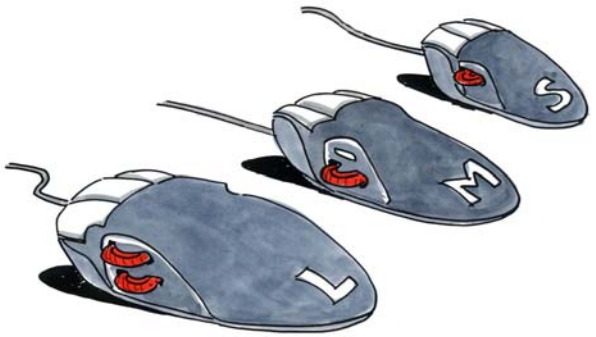
| **A Deviation from neutral posture** | | |
|---|---|---|
| | **Measure** | |
| **A IV**<br><br>Finger abduction | • Choose a mouse designed with a button arrangement suited to the individual or individual job.<br><br>*Comment:*<br><br>• In particular for mouse designs with additional buttons, attention needs to be paid that these can be depressed with a finger posture that is as neutral as possible. | |
| **A V**<br><br>Cramped finger posture | • Choose a mouse that matches the size of the hand.<br><br>*Comment:*<br><br>• If the mouse is too small, there is a risk that users will hold their fingers in a bent, cramped posture ("claws"). |  |

Table 19: Continued

| **B Force exerted** | | |
|---|---|---|
| | **Measure** | |
| **B I**<br><br>Disproportionate effort exerted | • Choose a mouse whose buttons are operated by a force of 0.5 to 0.8 N.<br>• Check button behaviour.<br>• Select a mouse that slides or moves easily.<br>• Avoid raising the mouse frequently to adjust its position.<br>*Comment:*<br>• The amount of force necessary to depress the buttons should not be too high, but nor should it be too low, because the latter situation would make it impossible for users to rest their fingers on the buttons for fear of inadvertently activating them (see B II). There are mouse buttons with different behaviours, and the manufacturer should be contacted for more information. Current research suggests that kinaesthetic feedback (a perceptible pressure point) is an advantage.<br>• Generally, an optical mouse is easier to move than a mouse with a rolling ball inside. Dirt on the underside of the mouse or on the working area (desk surface) can restrict mouse movability. | |

Table 19: Continued

| **B Force exerted** | | |
|---|---|---|
| | **Measure** | |
| | • Frequent adjustments in the mouse position are made necessary by unconscious "wandering" beyond the preferred work area (see A III) or by a work area that is too small. Correcting these problems helps to avoid the need for picking up and moving the mouse. | |
| **B II**<br><br>Static finger posture | • Choose a mouse that balances the properties of effort required to depress the buttons and buttons that serve as a place to rest the fingers.<br>• Choose a more suitable mouse design.<br>*Comment:*<br>• If the force necessary to depress the buttons is too low, users cannot rest their fingers on the buttons for fear of inadvertently depressing them. This means that users have to hold their fingers above the buttons the whole time, which may cause severe local muscle fatigue and strain.<br>• If the mouse is too small, for instance, users cannot rest their fingers on the mouse when the fingers are idle. | |

Table 19: Continued

| **B Force exerted** | | |
|---|---|---|
| | **Measure** | |
| **B III**<br><br>Static arm postures | • Use the mouse with the forearm supported.<br><br>*Comment:*<br><br>• Match the size of the mouse to the size of the hand so as to allow the heel of the hand to rest on the desk surface.<br>• The arm rests of the chair serve as forearm supports for this purpose. Fixed arm rests should be sloped forward for the different body dimensions of different users. The design of these supports should not hinder users in carrying out their job tasks. Height- and width-adjustable arm rests permit better fit.<br>• The area for moving the mouse (the mouse pad) should be at the same height as the keyboard. | |

Table 19: Continued

| C Repetitive movements | | |
|---|---|---|
| | **Measure** | |
| **C I**<br><br>Long periods of mouse use | • Design activities to be diverse and varied.<br>• Alternate mouse use between the right and left hands.<br>• Use different input devices, such as the keyboard (shortcut cursor keys), alternative pointing devices, including joystick mice, stylus-type mice, trackballs, pen-tablets, etc.<br>• Use suitable software.<br>*Comment:*<br>• It takes a certain amount of practice to learn to use the mouse with the non-dominant hand. Experience shows that gross motor movements, such as scrolling or clicking on large fields, can be performed practically from the beginning by using the non-dominant hand.<br>• There are keyboards available that have function keys that can in part replace mouse action. Suitable software is available that replaces mouse double-clicking with single clicks, or that supports the assignment of shortcut key combinations to the keyboard. | |