SECOND EDITION

OFFICE ERGONOMICS AND HUMAN FACTORS

Practical Applications

Céline McKeown

CRC Press
Taylor & Francis Group

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CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Printed on acid-free paper

International Standard Book Number-13: 978-1-4987-9910-2 (Hardback)

This book is dedicated to June and Gerard McKeown, from whom I inherited drive and determination.

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Preface

Ergonomics, or Human Factors, has moved away from being viewed simply as an academic subject, into being recognised as a useful tool in generating safe, comfortable, and productive working environments. This process has been assisted by Ergonomics and Human Factors being presented in a more usable format by authors of Ergonomics and Human Factors texts, as well as Ergonomists/Human Factors Consultants working on the coal face. Because of this change in perception, the responsibility has landed in the laps of departmental managers, facility managers, safety managers, occupational health departments, etc. to pick up the threads of basic Ergonomics and Human Factors principles and apply them in their own working environments.

Computer users face a series of problems once they enter the 'workplace', whether that be an office, conference room, hotel bedroom, plane, or train station. These problems are likely to make them unhappy and uncomfortable, at the very least, and possibly injure them, if no form of control is exerted by those around them. The intention behind this book is to provide practical, usable advice that can be applied directly to any environment where a computer or mobile device user is required to work. The advice has grown from years of first-hand experience of many types of settings and dealing with their inherent problems. It is hoped that the application of the information contained in this publication will ensure that computer or mobile device users no longer have to use unsuitable workstation furniture or equipment; they will not have to perform tasks that are badly designed; and they do not remain ignorant of the very basic advice needed to ensure they can work comfortably and safely.

Author

Céline McKeown is a Consultant Ergonomist with Link Ergonomics, based in Nottingham, England. She works as a consultant to industry, as well as to commercial organisations. She specialises in identifying the causes of injury and ill health in the workplace and designing them out of the system. She also has a special interest in product design. She trains engineers, architects, health and safety professionals, and others who have responsibility for changing the working environment so that they know how to incorporate ergonomics and human factors during the planning stages. She acts as an expert witness for defendants and claimants in work-related personal injury claims. She is a Fellow of the Chartered Institute of Ergonomics and Human Factors in the United Kingdom, and she is a Fellow of the Irish Ergonomics Society.

1

Working Posture

1.1 Introduction

One of the key elements in ensuring that people can work comfortably and effectively is good posture. There is some controversy regarding what constitutes 'good posture'. The traditional view is that an upright posture is the most appropriate. Others suggest that people prefer to lean back in their seats, while some argue that the seat should be capable of sloping forward so that the angle of the hip is increased to reduce the pressure in the lumbar region of the back. Having so much published disagreement among knowledgeable sources does not help those who need to accommodate their workforce. What would be helpful is having an agreed starting point when it comes to posture and applying it with a little flexibility. This chapter aims to provide an understanding of what can assist in creating a comfortable working posture.

1.2 Sitting versus Standing

At one time it was generally recommended that where a task lent itself to individuals sitting down, a suitable chair should be provided that allowed them to do so. There are accepted benefits to sitting over standing: people can take the weight off their legs; greater stability is offered to the upper body; energy expenditure is reduced, as are demands on the circulatory system. It has been the view for some time, e.g. Bridger (2003), that a person who is required to stand for prolonged periods can experience physiological changes, including peripheral pooling of blood, a decrease in stroke volume, and increase in heart rate. However, it has to be understood that this outcome results from extended standing throughout a shift, where the individual performs an activity intended to be completed whilst standing, such as in a factory or an assembly-type environment.

This is not necessarily the case where the individual can alternate between seated and standing desk-based work. Despite the benefits to be enjoyed while sitting, however, there is general agreement that people are not designed to sit for extended periods without interruption. Barbieri et al. (2017) proposed the use of sit–stand desks as part of an initiative to decrease sedentary behaviour among office workers and to reduce the risks of negative effects on their cardiometabolic health. As part of their study, they promoted 10 minutes of standing after every 50 minutes of sitting. The workers reported that the use of the sit–stand desks contributed positively to their health and well-being, without interrupting their work.

Once individuals are sitting, many work in a manner that is likely to increase feelings of discomfort. For instance, some people tend to slump forward while working, which can have a negative impact on digestion and breathing. This is one of the main reasons why all people who work while seated should be given awareness training, which includes an understanding of how the back works, the mechanics by which it can be overloaded, and, more fundamentally, what type of posture they should be adopting and how they can actually adjust their chairs. No assumption should ever be made that a seated user knows how to operate their chair and how to make suitable adjustments so that they can work in a suitable, fully supported posture.

1.3 The Back

The back consists of many parts, and any one of these can be subject to general wear and tear, disease, the aging process, and abuse. Abuse of the back in the workplace is very common, but, generally goes unrecognised. There is too little appreciation of how easy it is to subject the back to unnecessary stresses inadvertently.

Apart from offering support to the trunk and being a main agent in its movement, the back also plays a part in steadying the upper limbs and head. This ensures that they can be moved and repositioned smoothly and that they can bear the stresses encountered as the person works.

Figure 1.1 is an illustration of the spine. The spine consists of 33 individual bones, referred to as vertebrae. It is normally divided into several distinct sections: the cervical vertebrae, comprising seven vertebrae in the neck; the thoracic vertebrae, comprising 12 vertebrae that incorporate the chest and rib area; the lumbar vertebrae, formed from five vertebrae in the lower back; the sacrum, which is formed by five fused vertebrae; and the coccyx, which is made up of the remaining three or four rather simple vertebrae. Because the weight borne by the lumbar vertebrae is greater than that borne by either the cervical or thoracic vertebrae, and because the lumbar region is subject

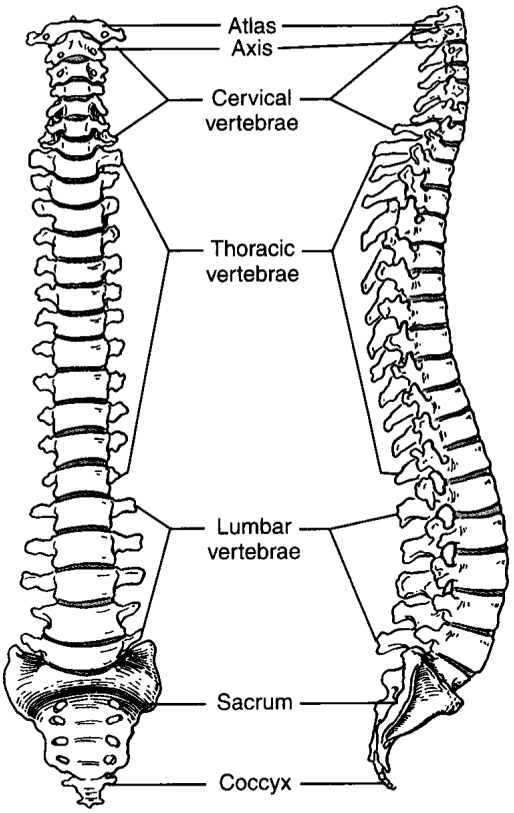

FIGURE 1.1
The spine. (From Watkins 2009.)

to a peak in leverage at this point (as a person leans forward, backwards, or sideways), it is subjected to higher levels of stress.

It has been suggested that 80% of people will experience back pain at least once in their lives. Back pain can occur with or without structural damage. Back pain that tends to be persistent is suspected to be due to structural damage or degeneration (Watkins 2009). Although it has been reported (Zhang et al. 2009) that the source of back pain is often difficult to diagnose, there is a view (Anderson and Tannoury 2005) that disc degeneration was one of the main reasons for chronic low back pain (LBP). Zhang et al. (2009) have a slightly different view and suggest that most data appears to indicate that chronic LBP is most closely related to the anatomical structure of the intervertebral disc, particularly in individuals with no obvious herniation of the disc, and is the disease process known as discogenic lower back pain (DLBP). DLBP is a loss of lower back function with pain.

The discs are like cushions that sit between the vertebrae and act as shock absorbers. They also give flexibility to the spine, allowing the individual

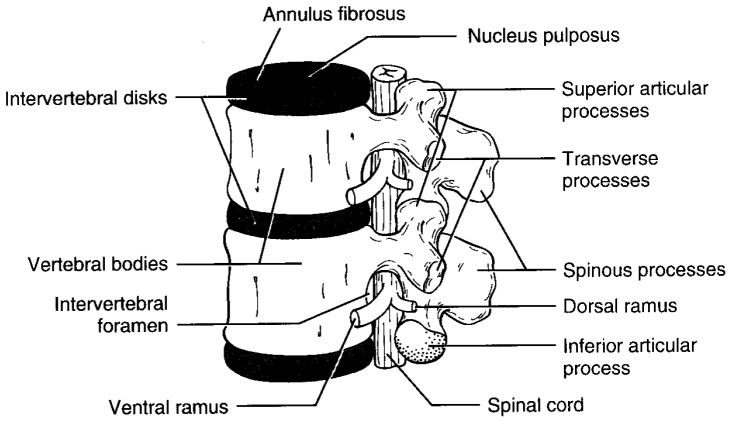

FIGURE 1.2
The discs. (From Watkins 2009.)

to bend sideways (lateral flexion) and lean forward (flexion) or backward (extension). Figure 1.2 is an illustration of the discs.

The discs in the cervical and lumbar regions tend to be thicker at the front than at the back, which contributes to the forward curving of the spine in these areas. The discs also get thicker as they progress from top to bottom along the vertebral column. It is estimated that they make up 20% of the total length of the vertebral column.

The discs are made up of two parts: the annulus fibrosus, a fibrous outer layer, and the nucleus pulposus, a gelatinous mass similar in consistency to toothpaste. Because of its consistency, it can change its shape easily. As a consequence, when a person bends in any direction, the nucleus pulposus becomes wedge-shaped, with the narrow end located toward the direction of the bend. At the same time, the annulus fibrosis bulges on the opposite side of the bend.

Degenerative changes in the discs first start to appear when an individual reaches their twenties (Zhang et al. 2009). When this starts to happen, the annulus fibrosis can bulge or rupture if it is subject to excessive stress, particularly stress imposed by bending. The bulges or ruptures (also known as prolapsed or slipped discs) tend to happen posteriorly because this is the point where the discs are thinner. They also tend to happen more frequently in the lumbar region and the lower cervical region.

A prolapse typically occurs suddenly as the result of an acute failure in the annulus fibrosis. Because the discs do not have their own nerve supply, they are not a direct source of pain. Pain is due to pressure being exerted on a nerve root or spinal nerve by the bulge or rupture and will be experienced in the areas served by the nerves in question. For instance, a protrusion in the lower cervical region may produce discomfort in the hand.

It is not uncommon for an individual who has complained of symptoms in the hands, which are suggestive of an upper limb disorder, to be diagnosed as suffering from a degenerative condition in the neck. Protrusions in the lumbar region can cause shooting pains in the legs, usually starting in the buttock and moving into the back of the thigh, sometimes travelling as far as the feet. This is commonly referred to as sciatica. There is often local muscle spasm following a rupture, which also causes pain.

The muscles of the back—the 'true' muscles—form several layers, which are actually covered by the muscles of the upper limbs. The 'true' muscles are the primary means by which the spine is kept erect and can be rotated. The main task for the muscles when the back is upright is to resist the pull of gravity. If the body is balanced when upright, the back muscles do little work to maintain its stability. If an individual leans forward, the muscles contract to prevent them from falling forward. The muscles also 'manage' the lean so that it is executed smoothly. The farther forward an individual leans, the more active the back muscles become. The same muscles assist in controlling the upward movement as the individual stands or sits upright again. In conjunction with the back muscles, the abdominal muscles are also called on to assist, which explains why people receiving physiotherapy for a back injury often get advice on strengthening the abdominal muscles.

Once an individual adopts a sitting position, they rely on static muscle work to keep them in that position. This requires prolonged and uninterrupted contraction on the part of the muscles. Dynamic muscle work, on the other hand, involves the contraction and relaxation of muscles, which achieves movement. Despite the fact that during static muscle work there may be no discernible movement, which might suggest no work is being done by the body, static muscle work is considered to be more demanding than dynamic muscle work. As a consequence, longer periods of rest are required to recover from this type of work than from dynamic muscle work. Tasks usually involve a combination of static and dynamic work. For instance, when an individual is sitting at a desk performing a computer-based operation, the muscles responsible for controlling the back, shoulders, and arms employ static muscle work while the hands employ dynamic muscle work as they use the keyboard and operate the mouse. Static muscle work can result in minor discomfort quite quickly. People who continue to work without changing position or taking a break can start to experience increasing pain.

The ligaments, in conjunction with the muscles, play a part in stabilising the individual when in an upright position. These can be likened to straps that stretch between bones, and they provide passive resistance and limit movement toward the extreme range of movement of the spine. It is thought that ligaments and muscles are susceptible to injury as a result of twisting and stretching, particularly if repeated over extended periods of time (McKeown 2011).

Given that the posture adopted by the individual has a significant impact on the health of the back, it would seem sensible to ensure that workers

are given appropriate information to allow them to work comfortably and reduce the likelihood of them developing injuries.

1.4 Posture

Some studies have purported to demonstrate that, when given the choice, seated individuals choose to sit in anything but an ideal position, preferring instead to lean forward or backward in their seats. However, none of these studies seems to make it clear whether these individuals have received instruction on how their chairs operate and what they should aim to achieve with their posture. As a consequence, they may simply be adopting postures dictated by their degree of knowledge, or lack of it.

Discussing posture is not just about what is right for the back; it also has to take into account of what is right for the upper limbs, the head and neck, and the lower limbs. When it comes to back position, the starting point should be to ensure that it is reasonably upright, which is completely different from suggesting that someone should sit erect. Sitting in a reasonably upright position actually means that the individual may have a slight—very slight—backward lean that positions them at about 110° relative to the base of the seat. This is considered to reduce disc pressure and to reduce the workload for the back muscles because the backrest of the chair offers greater support for the back; an assumption is made at this point that the chair in use will provide the required amount of adjustment to ensure that the individual is supported in the chosen posture rather than having to adjust his or her posture to a position that accommodates the limits of the chair.

Studies have demonstrated that if we did insist that people work in an erect posture, this would likely result in a forward slump. This is due to the fact that the static muscle work required to maintain the upright position is particularly fatiguing, so people relax the muscles responsible for holding them upright and slump forward. This causes deformation of the discs.

Should an individual decide to work in an inclined position that exceeds about 110°, this will require extending the arms farther forward to reach the keyboard or mouse. An important goal of good working posture is to reduce the workload on the arms. The workload can be minimised if the arm position can be kept close to normal or neutral during the course of the work. When the arm is completely relaxed, it falls naturally by the side of the body. The sitting position relative to a desk and its equipment, such as a keyboard and mouse, should ensure that the individual simply raises the forearm so that it forms a 90° angle with the upper arm, and the upper arm should remain in its natural position alongside the ribcage. If the individual sits at a distance from the desk or leans back in the seat, they have to overcome the increase in reaching distances by moving the upper arm forward. Holding it

in this position during tasks requires static muscle work, already described as particularly fatiguing. To facilitate the appropriate positioning of the arm, it is essential that the keyboard and mouse be located close to the leading edge of the desk, but not so close that there is no space to rest the hands when not operating the equipment. A 10 cm (4″) gap in front of the keyboard is considered sufficient to rest the forearms in between bouts of keying.

Leaning backward in the chair to an extreme degree will also have a negative impact on head and neck position. This is due to the fact that as the individual reclines, the head tilts back relative to the screen, keyboard, or documents being viewed. This will require a compensatory repositioning of the head. In other words, the head will have to be bent forward, and this is likely to result in neck pain over time.

Task chairs that incorporate a forward tilting seat have been advocated as a means to reduce the need for hip flexion. However, getting people to sit on a slope appears, in practice, to have two likely outcomes: they will brace themselves with their feet to combat the sensation of slipping forward; and women wearing skirts, particularly lined skirts, will find that they tend to slide out of their skirts.

Specifically designed stools with sloping seats have addressed the issue of users slipping forward on the inclined seat by incorporating knee pads that hold the user in place. Studies have shown that users of these types of seats can complain about discomfort in their knees. These chairs also lack any form of back support, and, as a consequence, the back muscles have no opportunity to achieve any type of support and have to maintain the upright posture throughout the time the individual sits on the seat. This requires long periods of static muscle work. This is compounded by the fact that the seat does not allow for easy variability of posture. When these points are combined with the fact that sloping seats are not particularly easy to get into and out of, it might be advisable to permit them to be used only under the instruction and guidance of a health professional such as a doctor or physiotherapist.

The starting point when setting up a seated posture is working height. Assuming a desk of fixed height is in use, the chair should be adjusted so that the individual's elbows are level with the home row (i.e. the middle row) of the keyboard (see Figure 1.3). By sitting at this height, users will not have to raise their shoulders when operating the keyboard or mouse nor move their upper arms away from their sides, as what would occur if they sat too low relative to their equipment. In addition, they will not have to work with their forearms above the horizontal. If the forearms are kept in a horizontal position, with a 90° angle at the elbow, they will be able to work with a straight line running through their wrists and into their hands. This makes them less likely to encounter symptoms of an upper limb disorder (ULD) in this area. (The issue of ULDs will be dealt with further in Chapter 11. ULDs are also known as Repetitive Strain Injury, i.e. RSI.) If a particularly tall individual finds that he or she has to lower the seat to get their elbows level with

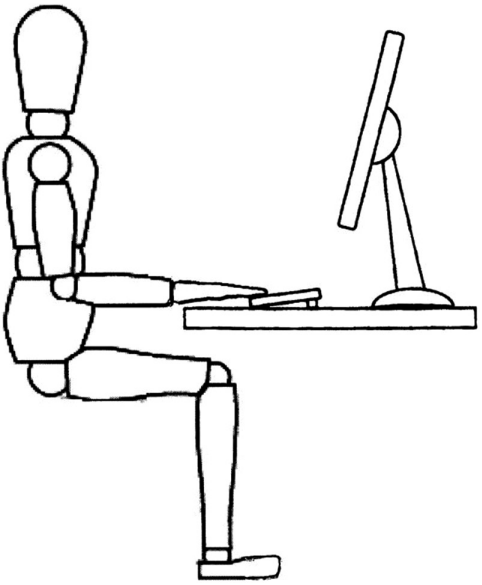

FIGURE 1.3
Ideal starting point for working posture.

the home row of the keyboard to such an extent that their hips are lower than their knees, that person needs a higher desk and probably a higher chair. If an adjustable-height desk is in use, the user would position the chair to get their feet on the floor, then position the desk to achieve the same arrangement as described above.

Once the chair height has been altered, attention should be turned to the feet. If an individual finds that, having moved the chair, their feet are no longer firmly on the floor, they should use a footrest. (The most suitable type of footrest will be discussed in Chapter 2.) The footrest should support the feet at a level where the user is able to work with an approximate 90° angle at the knee (see Figure 1.4). This angle can be increased slightly by sliding the feet (and footrest) forward, but should not be increased by having the chair too high, nor reduced by having the chair too low.

A footrest should not be used by anyone who finds that their feet easily reach the floor once the chair height has been altered. Doing so can have quite an adverse effect on comfort level. This results from two specific consequences. In the first instance, as the foot is raised off the floor and placed on the footrest, the knee is raised upward by a similar amount. As the individual does not change the seated height, the angle at the knee is reduced. This can result in a restriction of the blood flow into the lower legs, and the user will start to feel uncomfortable and fidget without realising why. Second, Figures 1.3 and 1.4 clearly illustrate that a significant proportion of

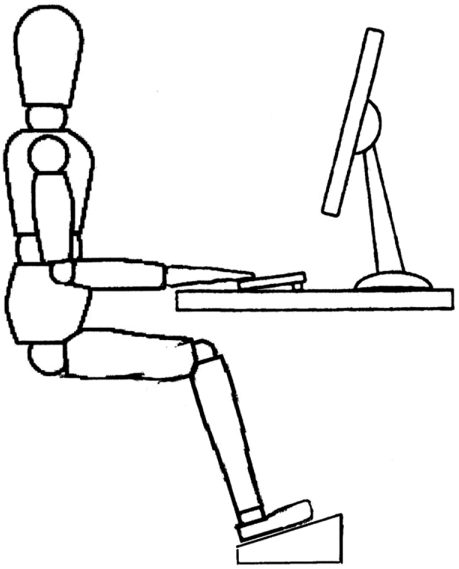

FIGURE 1.4
Using a footrest correctly.

the buttocks and backs of the thighs is likely to be in contact with the seat surface. This will ensure that a large surface area of the body supports the weight of the torso. If the knee is raised, owing to the unnecessary use of a footrest, part of the back of the thigh will also be raised, reducing the surface area supporting the upper body's weight. Focussing the upper body's weight on a smaller supporting surface will result in pressure points, again making the individual uncomfortable and likely to fidget.

If people choose to work without footrests and their feet do not touch the floor, they are likely to encounter other difficulties. The leading edge of the seat is likely to press into the backs of the thighs as the weight of the lower legs drags them down. The compressive effect will create discomfort, ultimately making people fidget.

Once the seated height is established and properly supported, the focus should turn to the back and to the degree of support offered by the backrest of the chair. Initially, individuals should adopt the position they would like to work in for a period of time, whether that be upright or leaning slightly back. The backrest of the chair should be capable of allowing them to adopt such a sitting position and should offer an adjustment mechanism, such as a lever under the seat that can be easily reached from the seated position.

Once the backrest has been adjusted to support the upper body posture of the individual, the lumbar support of the backrest should be positioned so that it falls in line with, and supports, the small of the back. Some chairs may not have this specific facility, and this is discussed further in Chapter 2. It is important that the angle of the backrest is altered prior to positioning the lumbar support,

because the lumbar support of a chair will appear to 'move' upward as the individual leans back in the seat, or will 'move' downward as the individual moves to a more upright position; this could leave the lumbar region unsupported.

As Figure 1.3 clearly illustrates, keyboard users should not rest their wrists on the desk or keyboard. Their hands should 'hover' over the keyboard. By doing so, the individual will be able to call upon the larger muscles of the arms to move the limbs and thus reposition the hands relative to a particular key. If people rested the wrists on the desk surface while keying, they would, in effect, be anchored in place and would have to extend their fingers to reach the keys. It is also likely that if people rest their wrists on the desk and raise their hands up toward the keys, they will work with bent wrists. Again, this is known to be associated with the development of upper limb disorders.

Individuals should sit as close to the leading edge of the desk as they wish and should have the keyboard and mouse within easy reach. They should not be prevented from sitting close to the desk by bulky armrests on the chair or by design features of the desk. The aim should be to allow them to work with an approximate 90° angle at the elbow. This will ensure that the upper arm can hang naturally by the side of the body and will demand a minimal amount of work from the muscles. The farther they sit away from the desk, or the farther they position their keyboard and mouse from the leading edge of the desk, the farther they will have to reach with their arms. Working in such a manner will increase the workload for the arms and the rate at which they become fatigued.

Head and neck posture will be determined by the visual requirements of the task. The aim should be to present equipment, such as the screen, at a height where the individual can adopt an upright, but not necessarily erect, head position. Figure 1.5 shows that when an individual sits or stands erect with the head completely upright and looks straight in front of the body,

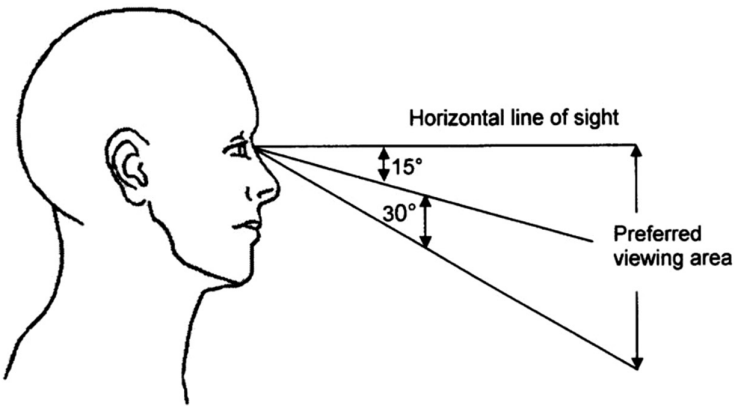

FIGURE 1.5
Illustration depicting the horizontal line of sight and preferred viewing area.

a stance similar to that adopted by a soldier standing to attention, the gaze will follow what is referred to as the horizontal line of sight. However, given the opportunity to relax, the head will drop down slightly because of its weight, and the eyes will ultimately adopt a downward gaze somewhere between 15° and 30° below the horizontal line of sight. This is considered to be the preferred viewing area. People can, of course, view information presented in an area that falls below this preferred viewing area, but this does require the head to be tilted downward to a greater extent. Pheasant and Haslegrave (2006) have pointed out that the neck muscles come under tension to support the weight of the head when it is tilted downwards in such a manner. This has implications in terms of viewing laptop screens and smaller sources of information such as tablets and smartphones. A computer screen should be set at a height where the top of the screen does not pass above the horizontal line of sight. Apart from ensuring that the screen can be read easily with the head in a more 'natural' relaxed position, screen users will never have to raise their eyes above the horizontal line of sight nor raise their heads so that they look upward, both of which increase the workload for the muscles concerned with managing and controlling this movement.

There is an exception to the rule with regard to computer screen height, and that relates to users who wear bifocal glasses. If they generally look through the bottom segment of their glasses when viewing the screen this will cause them to tilt their heads back if the screen is set at the levels suggested above. These individuals may need to have their screens lower than would be recommended for others so that they can keep their heads in a more natural position.

Having considered head position relative to a screen, thought also has to be given to any documents that might be used in conjunction with the screen. It is common practice to place documents on the desk surface to one side of the keyboard. This ensures that the worker has to tilt his head downward and to one side as they refer to the document (see Figure 1.6). To adopt a more appropriate head position, the individual should raise the documents off the desk surface. This could be achieved by placing the documents on a copy stand or document holder, assuming the documents are of a size that permits this. The document holder should be positioned alongside the screen and at about the same height. A better alternative is to use a document plinth which is similar in size and shape to a footrest. This is positioned in the space between the keyboard and screen and allows the documents to be presented directly in front of the individual in a tilted and raised position but without interfering with their view of the screen display.

Should an individual decide that they would like to work from a standing position, they should aim to establish the same relationship between keyboard height and elbow height by raising the desk to the correct level as discussed above. In addition, they should also ensure that the screen is presented at a height which enables them to work with their head in a comfortable position. See Figure 1.7.

FIGURE 1.6
A keyboard operator working with documents located on the desk surface.

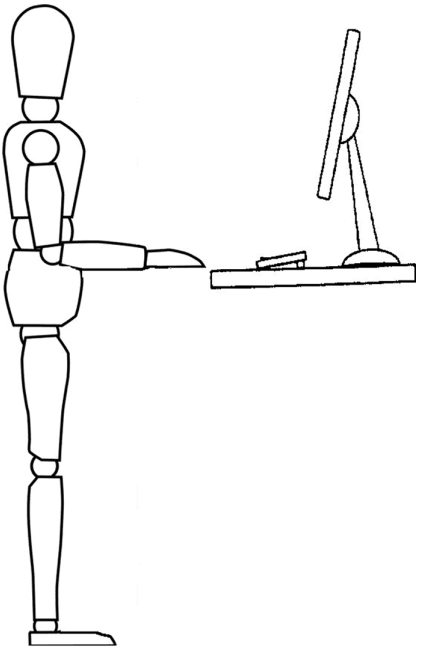

FIGURE 1.7
Posture when standing at a raised desk.

Some authors may suggest that the types of postures described in this chapter do not approximate actual working postures. They may suggest that they are too rigid, too 'idealised'. The fact is that the postures described above are based on what will impose the lowest loading on any part of the body active in the adoption and maintenance of working postures. What should be kept in mind is that the postures detailed in this chapter are a starting point. It is accepted that any posture, even one considered to be 'ideal', will become fatiguing if maintained for extended periods without interruption. Zemp et al. (2016) identified that subjects who reported back pain showed a clear trend towards a more static sitting behaviour when at work. Therefore, it could be concluded that office workers should move more during their working hours.

What is being advocated in this chapter is the provision of information to workers that will allow them to adopt postures known to be sound, and then allow them some flexibility around these postures. These postures are not expected to be adopted and maintained rigidly. Rather, the postures should have a fluidity about them so that individuals can alter their position within an acceptable range that still allows them to work comfortably.

1.5 Maintenance and Monitoring of Good Postures

Even if the workers appear to be fully committed to the concept of adopting suitable working postures and have made the effort to adjust their workstation equipment so that they can work comfortably, it is possible that over time the appropriate working practices will deteriorate. This could result from a number of factors, such as a new intake of untrained and/or inexperienced personnel, a change in the workstation furniture or equipment in use, a repositioning of equipment within the office or within a building, forgetfulness over time, trying to accommodate an illness or injury, or 'hot-desking' situations in which any number of individuals might use a given workstation.

An organisation should offer reminders at regular intervals about the need to adopt suitable working postures. Whether this is successful ought to be monitored carefully. Caution should be taken if any organisation is solely reliant on self-assessments, such as those that can be done on-line, as a means of gathering feedback. It cannot be assumed, even after thorough training, that all workers will employ the techniques reinforced during training or awareness sessions. It is not uncommon for individuals to complete self-assessment forms inaccurately because they do not appreciate that the postures they have adopted do not actually correlate with what has been suggested during training—which itself can sometimes take place using on-line facilities. Others may feel such time pressure from work demands that

they pay fleeting attention to the questions on the checklist and complete it so that everything appears satisfactory and, as a result, they will not be 'bothered' by any further investigations. Although there is a place for self-assessments, particularly in large organisations, they should be used in conjunction with other monitoring procedures such as follow-ups by health and safety personnel, managers, or team leaders.

1.6 Summary

- If the task lends itself to an individual sitting down, a suitable chair should be provided to allow them to do so.
- Sitting offers advantages over standing in that people can take the weight off their legs, have greater stability for the upper body, and reduce energy expenditure and demands on the circulatory system.
- Standing desks provide opportunities for the person to change their posture.
- Prolonged standing can result in physiological changes, including an increase in heart rate.
- There is general agreement that people are not designed to sit for extended periods without interruption. Many individuals work in a manner that is likely to increase feelings of discomfort. Much of this is due to lack of awareness and training.
- The back consists of many parts that can be subject to general wear and tear, disease, the aging process, and abuse.
- Because the weight borne by the lumbar vertebrae is greater than that borne by either the cervical or thoracic vertebrae, the lumbar region is subject to higher levels of stress.
- The intervertebral discs are like cushions that sit between the vertebrae and act as shock absorbers. They also give flexibility to the spine.
- When an individual bends in any direction, the disc can become wedge-shaped and a bulge can form on one side.
- Bulges or ruptures can occur in the disc as a result of excessive stress, particularly imposed by bending.
- Protrusions caused by a prolapse can result in sciatica.
- The back muscles do the least amount of work when the body is upright and balanced. Once an individual leans forward, the

muscles contract to prevent them falling forward. The muscles also have to manage the movement. The farther forward one leans, the more active the back muscles become.

- Static muscle work is required to keep an individual in an upright sitting position.
- Static muscle work involves prolonged and uninterrupted contraction of the muscles.
- Dynamic muscle work involves contraction and relaxation of muscles, which achieves movement.
- Longer periods of rest are required to recover from static muscle work than from dynamic muscle work. Most tasks involve a combination of static and dynamic work.
- Static muscle work can result in discomfort quite quickly. More significant pain can be experienced if the individual does not take a break.
- The ligaments play a part in stabilising the individual in an upright position.
- Ligaments and muscles are susceptible to injury as a result of twisting and stretching, particularly over extended periods of time.
- The starting point for adopting suitable working postures is to ensure that the upper body is reasonably upright. This is not the same as suggesting that the upper body needs to be completely erect.
- Sitting in an erect posture is more likely to result in forward slump.
- Postures that result in operators leaning farther back than a reasonably upright position will move them away from the desk and keyboard, resulting in them having to extend their arms. This is likely to be fatiguing.
- The mouse and keyboard should be located close to the leading edge of the desk. A 10 cm gap in front of the keyboard is sufficient to allow users to rest their wrists in between bouts of keying.
- Assuming a fixed-height desk is in use, a chair should be adjusted so the individual's elbows are level with the home row of the keyboard.
- If the person's feet are not firmly on the floor once the chair has been adjusted, the person should be provided with a footrest.
- A footrest should not be used by anyone whose feet naturally rest securely on the floor.
- Working without a footrest when the feet do not touch the floor when in a seated position will create problems, such as the leading edge of the chair compressing the backs of the thighs due to the weight of the legs. This will cause discomfort.

- If adjustable-height desks are in use, users should position the chair so that their feet are firmly on the floor, and then move the desk into a position where they are able to operate the keyboard when it is at the same height as their elbows.
- Once the user's sitting height has been established, the backrest needs to be altered. The lumbar support on the backrest should be positioned so that it is lined up with the small of their back.
- When operating the keyboard, the user should not rest the wrists on the desk. They should hover over the keyboard relying on the larger arm muscles to move the limbs into position rather than having to overextend the fingers to depress the keys.
- If armrests on chairs prevent users from sitting as close to the leading edge of the desk as they might wish, the armrests should be removed.
- Head and neck posture are determined by the visual requirements of the task.
- The computer screen should be positioned so that the top of the screen does not move above the user's horizontal line of sight.
- Users wearing bifocal glasses may prefer that the screen is presented at a lower level so that they do not have to tilt their heads upward and back in order to look through the bottom of their glasses when viewing the display.
- Documents should not be placed on the surface of the desk and referred to when the individual is operating the keyboard. People should be encouraged to use a document holder or copy stand to present the document at the same height and distance as the screen or on a document plinth in front of the screen.
- Once appropriate working practices are established, it is likely that they will deteriorate over time for a number of reasons. Organisations need to offer reminders at regular intervals about the need to adopt and maintain suitable working postures.
- Caution should be taken when using self-assessments because employees do not always complete these accurately, and they do not always correlate the information they have gathered online with their own particular workstation.

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