


Computer work



 This information is also available [in Swedish](#)

Laws, directives and standards

It is understandable that management and employees are fully occupied with thinking about their ordinary, day-to-day activities. The start-up and organization of many projects and businesses that make use of computer work sometimes occur too quickly, which is why work environment issues are not always given priority. However, taking into account work environment issues from the beginning is a good long-term investment.

It is important that employers be aware that they are always responsible for the work environment at the company workplace (Work Environment Act, Chap. 3). This also applies when an employee and the employer have agreed to locate part of the employee's computer work in the employee's home. Thus, on legal grounds, the advice given on these web pages on computer work also applies to home computer workstations.

Systematic work environment management

How the employer shall regularly follow up and document the organization's work environment policy, working conditions, health risks, employees' skills and knowledge and similar matters is described in "Systematic Work Environment Management" (AFS 2001:1).

Safety officer

A safety officer needs to be appointed if there are at least five employees, and a safety and health committee needs to be established if there are at least 50

employees (Work Environment Act, Chap. 6). The union organizations appoint employee representatives.

Skills and knowledge

The employer needs to ensure that employees are informed of the risks for ill health that the work entails and that they receive the training necessary to perform their work in a safe manner (Work Environment Act, Chap. 3, 3§; AFS 2001:1 7§). The employer needs to ensure that the employee has sufficient knowledge concerning: a) suitable work postures and working movements; b) the proper use of technical equipment and aids; c) the risks entailed by unsuitable work postures, working movements and unsuitable manual handling; d) early indications of the overloading of joints and muscles (Ergonomics for the Prevention of Musculoskeletal Disorders; AFS1998:1 6§).

The employee's duty to follow the ordinances

The employee needs to assist in work related to the work environment and follow the ordinances of the Swedish Work Environment Authority in order to avoid health risks (Work Environment Act, Chap.3, 4§).

Adaptation to the individual

Work and working conditions need to be adapted to suit each employee's specific conditions, e.g., body size (Work Environment Act, Chap. 3, 3§).

Occupational health services

The employer is responsible for the availability of the occupational health services which the working conditions require (Work Environment Act, Chap. 3, 2§). Such services provide help with questions on ergonomics, work organization, health and similar matters.

EU directive

The EU has issued Council Directive 90/270/EEC of 29 May 1990 on the minimum safety and health requirements for work with display screen equipment. The content of this directive is covered by Swedish work environment legislation. If you follow the Swedish Work Environment Act, you will also be following the EU directive.

Special ordinances for computer work

Rules for computer work are found primarily in "Work with Display Screen Equipment" (AFS 1998:5). In addition to the ordinances, there are also comments on the ordinances as well as advice and instructions on sound computer work.

Ergonomics for the prevention of musculoskeletal disorders

Musculoskeletal complaints can often arise as a result of computer work. How these may be avoided is indicated in the ordinance "Ergonomics for the Prevention of Musculoskeletal Disorders" (AFS 1998:1).

Standards

The International Organization for Standardization (ISO) has issued a number of standards for computer work equipment, applications, furniture, etc. The standard that is most relevant in this context is "Ergonomic requirements for office work with visual display terminals (VDTs)" (SS-ISO9241). There are currently 17 documents belonging to ISO9241. Most ISO standards have corresponding European standards (European Standard – EN). Some specific EU standards are: "Office furniture – Tables and desks" (SS-EN 527-1/AC 2002), "Office furniture – Chairs" (SS-EN 1335-1 and SS-EN 1335-2).

In Sweden, these standards are issued by the Swedish Standards Institute (SIS) and are called Swedish Standards (SS) [www.sis.se].

Adherence to these standards is voluntary. Company quality assurance systems usually include recommendations to follow current Swedish Standards.

TCO labelling

TCO Development has worked with testing and quality labelling of computer equipment and with labelling of computer furniture (TCO labelling).

There are few independent organizations that systematically test and label computer equipment and furniture in a similar manner. TCO is well known for its labelling of display screens.

Information on tested products is available on TCO's web pages [<http://www.tcodevelopment.com>].

Health and computer work

Like all other types of work, computer work may be associated with different kinds of complaints and illnesses that we, on variously well-founded bases, tend to attribute to computer use. It is uncommon for life-threatening or severely handicapping conditions to be related to computer work, however.

The widespread use of computers means that a large portion of the population is exposed to the risk of being affected by different complaints and illnesses. For this reason, such difficulties entail not only great suffering for the individual, but also a problem for the employer and for society as a whole.

The chapter "Help – Mouse arm!" suggests different measures to take if you are experiencing trouble with headaches, your neck/shoulders and upper extremities or with your eyes and vision.

Computer work under stress

If you always or too often work under inadequate organizational and psychosocial conditions – which are described in other chapters in the website – there is a risk that this might lead to feelings of stress and to various complaints or illnesses. Feelings of being pressed for time, of stress, exhaustion, anger, sadness or inadequacy may occur. These may develop into worry, anxiety or dejection, including an element of depression.

When you are under time pressure, you can easily experience problems with winding down, recuperating, resting and sleeping. Many find it difficult to relax because they cannot stop thinking about work or other things they are involved in or worried about.

A worn-out employee can't do a good job. They don't have time for, or stop prioritizing, activities that usually help them recuperate. They don't have the energy for things that require concentration or activity, and perhaps fall asleep in front of the TV instead.

Exercise and other physical activities are also easily ignored, which is very unfortunate. Computer work is often highly sedentary. For reasons of health, this should be compensated for with a great deal of leisure-time activity (if it can't be arranged during working hours). Regular physical activity may also be a way of reducing your sensitivity to stress and the negative effects of stress.

Time pressure, long working hours and work during the evening or at night may also lead to inappropriate mealtimes and a poor diet.

Effects of stress

Different physical reactions can arise when we are stressed, for example neck and shoulder tension, headache, stomach problems and heart palpitation. Such complaints are temporary if the stress is of short duration. If the stress is prolonged, there is an increased risk of more permanent and serious health problems, for example diabetes, high blood pressure and other cardiovascular diseases.

Insomnia is common during a state of stress. It may be difficult to relax and fall asleep at night. Thoughts about unsolved problems at work or in your private life may keep you awake. For some, sleep may be more superficial and marked by brief periods of wakefulness (which are not remembered in the morning). Others may wake up early without having had enough sleep. Sleep that is too short or of poor quality results in tiredness. If you are tired, you lack the energy to tackle the demands and strains of work and everyday life. It is easy to find yourself in a vicious circle in which stress causes poor sleep, which in turn causes more stress.

Similarly, physical discomfort, for example pain, may disturb sleep. Among computer users, one of the most common complications of physical discomfort is disturbed sleep. Around 20-30% of professional computer users report this type of disturbed sleep.

Sleeping difficulties and inadequate sleep are also common complications of unusual working hours, particularly night work.

During sleep, a large amount of growth hormone is secreted, stimulating the body's processes of recovery and reparation. During our daily toil, more or less imperceptible damage to various tissues probably occurs. We can assume that this occurs especially during states of stress, because stress hormones, to a certain extent, have "destructive" effects on bodily tissues. If the recurring injuries of everyday life don't have time to be repaired during each 24-hour period, we can assume, hypothetically, that the risk of being affected by various complaints and illnesses will increase.

Disturbed sleep may be a serious alarm signal indicating that you cannot overcome the problematic situation you are in. If your sleeping disturbance is of long duration, and if you cannot see a likely and immediate solution, you should seek expert help, for example your general practitioner or company health service.

A person suffering from stress complaints such as these can hardly be expected to be optimally productive in the long term. Stress, exhaustion, pain, depression or illness does not result in work of acceptable quantity or quality. What's more, many experience long periods of illness absence, which in turn may lead to early retirement.

Limited working hours

Working hours are regulated by the Working Hours Restriction Act. Regular working hours may not exceed 40 hours/week + possible overtime of max. 8 hours/week calculated over a 4-week period. Employees need to have at least 11 continuous hours of rest every 24-hour period and at least 39 continuous hours of rest a week. Employees may not work more than 5 hours without a break. In addition, employees need to take pauses when needed.

What is the difference between a break and a pause?

Break = non-paid time. The employee may leave the workplace and use the time as he/she wishes.

Pause = paid work time. The employee may not leave the workplace.

Working hours should be adapted to the individual employee's wishes and abilities. In sectors with irregular and inconvenient working hours, such as healthcare, co-workers filling in their own staffing schedules have been experienced as positive. The employer, however, should ensure that individual employees are not short-sightedly enticed to overwork, including long shifts and long combined working hours. This also encompasses work that employees take home. Computer work at home tends to have fewer time limits and often occurs under much poorer ergonomic conditions than those at the workplace.

One good rule of thumb is to avoid regularly sitting in front of a computer for more than a total of 4-5 hours a day, at work or at home. When work requires longer periods of computer work, be extra observant of working conditions, ensuring that they are good. Good working conditions include, in particular, physical and mental variation, good camaraderie, encouraging and rewarding support from management and a well-designed work environment, workstation and equipment. Also necessary are exercise, rest and recuperation after work.

Employers and supervisors have a responsibility to not overwork their staff (or themselves); this can be achieved by creating a reasonable balance between the amount of work and the number of staff. A too "lean" organization can easily lead to an overworked staff. It is the responsibility of the employee to establish reasonable limits and to say "no" when demands



are too high. Such responsibility is often difficult to live up to, because all parties tend to be "upwardly" loyal in relation to customers, company management and shareholders. However, the organization's goals cannot be reached with a "burned-out" staff – something likely acknowledged by owners as well as management.

As in the case of workstation design and good working techniques, supervisors should set a good example and establish the corporate culture by, for example, not regularly working long shifts, evenings or weekends.

It is important to understand that the longer/more often and the more restricted, monotonous or stressed your computer work is, the more important it is that you have a good workstation and work environment, as well as the opportunity to exert influence and get support.

There are, however, limits to what may be achieved with good furniture, lighting, education, salary and the like. Computer work that is too stressful, restricted for long periods and sedentary cannot be compensated for with other measures. If this is ignored, the result may be long-term complaints, illness, discontent and lowered performance levels. It is vital that the employer find a balance so that every employee feels "needed" but not "exploited."



The boss should set a good example.

Common problems with the neck/shoulders and upper extremities



Among people working with computers, it is generally common to experience problems with the neck/shoulders and upper extremities, which are part of the musculoskeletal system. As many as 50-70% of computer users may have musculoskeletal complaints during a period of one month.

What is the musculoskeletal system?

The musculoskeletal system refers to those body parts and structures that contribute to the body's ability to assume different postures and move around. Without this system, the body would lie like a rag doll on the floor.

Important components of the musculoskeletal system are the skeleton and its various joints. The various parts of the skeleton are held together by ligaments. Muscles are attached to the skeleton, sometimes by tendons. Also part of the musculoskeletal system are the nerves that extend from the spinal column and that control muscle activity.

Complaints may begin as a general feeling of discomfort – of being extra strained, tired, tense or stiff in, for example, your neck and shoulders. Later, episodes of temporary aches and pain may arise during movement. These aches and pain may then become more persistent and handicapping. Soreness is often felt when you press on your muscles and tendons. Problems are commonly found in the neck and shoulders, or farther down on the arm and hand you usually work with. Lower back complaints are also common. On the other hand, problems with legs and feet are generally less common. Swollen legs may become a problem if you sit or stand for long periods without moving, particularly if you have a predisposition towards varicose veins.



Problems with the upperneck or extremities among computer users are sometimes collectively referred to as "mouse arm."

What is "mouse arm"?



"Mouse arm" is a popular term for various types of musculoskeletal complaints associated with computer use, thus problems with the neck, shoulders, arms or hands. Mouse arm is neither a medical term nor a medical diagnosis.

What's more, the problems referred to with the term mouse arm are not new phenomena. The same types of complaints have long been known in other work contexts, for example inflammation of tendons in the shoulders or elbows (tennis elbow) among assembly workers, neck/shoulder pain among cashiers or pinched nerves in the wrists among food industry workers. What these workers have in common with people who work on computers is that their work is

highly controlled, static, monotonous, repetitive and often performed under time pressure.

Common locations for "mouse arm" problems.



Despite the extensive research conducted in this area, it is still often difficult to state with certainty what causes these complaints. The muscles and connective tissues of the neck and shoulders are probably often involved. In other cases, it may be a question of irritation of muscular attachments and tendons, for example in the shoulders, elbows or wrists. In certain cases, nerves extending from the neck vertebrae to the arm

may become pinched, for example in the wrist area. This may be felt as numbness or a tingling sensation in the fingers.

Youth is no protection against problems

Problems with the neck/shoulders and upper extremities are also found among youth who use computers frequently.

In a study of 17-year-old upper secondary school students who often use computers in school, students showed signs of ill health similar in degree and character to those of middle-aged gainfully employed persons, particularly women. It is of equal importance that children and youth be provided with a good computer work environment and that they learn how to work appropriately at a computer. The schools have a vital educational role to play in this context.

Read more about computer use at school in chapter Computer at school.

Explanation of musculoskeletal problems

The human musculoskeletal system – that is, the skeleton, joints, muscles and tendons in our back, arms and legs – is made primarily for "dynamic work" involving various types of movement and exertion. A body that is warmed up can tolerate a great deal, and muscles will be built up if loads are adapted to degree of fitness, if movements are varied in intensity, pace and pattern and if breaks



are taken for rest and recuperation. Examples of this are children's spontaneous play, games and sports, garden work, caretakers' duties and many types of service and repair work.

However, the musculoskeletal system – particularly the neck, shoulders, arms and hands – is not adapted to prolonged and monotonous strain in a single working posture or with monotonous repetitive movements. Even low-intensity but prolonged strain such as holding your arms up without support, called "static work," can be harmful. Examples of people with such work are hairdressers, cashiers and assembly workers.

In contemporary working life, one of the most common examples of static work is computer work, which often entails low-intensity but prolonged strain on primarily the neck and shoulder blade region, but also the shoulders, arms and/or wrists and hands. Prolonged sitting is also a strain on your back. This is because when you are sitting as opposed to standing, greater pressure is put on your discs and your back muscles need to work harder to hold your trunk upright, particularly if you don't have a good backrest.

During computer work, many different factors can lead to unfavourable strain on your neck/shoulders and upper extremities. The crucial factors are associated with prolonged, monotonous computer work and working long periods without pausing, for example during high work loads. Yet this may even be a question of having poor opportunities to control your own work or of lacking the support of supervisors and workmates. It is also common that the ergonomic design of the workstation is inadequate. The table, chair, display screen, keyboard and mouse may be poorly adapted to the user. But good equipment is not enough. You also need to be able to use it appropriately. Your table or chair may be adjusted incorrectly, forcing you to lift your shoulders and arms or to angle your wrists upward in order to work. It is common that screens are placed too high, so that users need to strain their necks, or that computer mice are placed too far from the body, causing unnecessary strain on the shoulder blade region and shoulder joints when the arm is extended far from the body.



Sometimes there is no appropriately placed armrest or sufficient room on the tabletop for the user to rest his/her forearms and/or wrists on when using a keyboard or mouse. Supporting the weight of the arms and hands is very important in all cases of prolonged computer work. The arms are attached to the shoulder blades, which are suspended from the rib cage by various muscles. When your arms and hands are working with, for example, the mouse, your neck muscles and the muscles surrounding your shoulder blades are constantly active. Some of this muscle strain is reduced if your elbows and forearms are supported by an armrest or the tabletop.

Where can you rest your arms and hands when things are in this state?

Corresponding phenomena are observed with regard to the forearm, in that the muscles of the forearm, particularly those that act to angle the wrist upward, are active when the hand and fingers are working, for example with the mouse. Consequently, supporting the hand and fingers on the tabletop, keyboard or mouse reduces the strain on the muscles of the forearm. Some people hold their index finger "on the alert" above the mouse button. This causes additional static work for the muscles of the forearm.



Mouse finger "on the alert."

During computer work, many people tense the muscles in their neck and shoulders or their forearms. Such tension tends to increase when the user is under stress, anxious, angry or working under high demands for precision, for instance when operating the mouse.

Other common causes of adverse strain on the neck are poor visual ergonomic conditions or that the computer user has vision problems or inappropriate eye-glasses.

Advice on what to do if you suspect you are suffering from "mouse arm" can be found under the heading "Help – mouse arm!".

Complaints are more common among women

Just as in various other types of occupational groups, musculoskeletal complaints are more common among female than among male computer users. The reason for this is unclear. One of the explanations often given is that women's work tasks, as compared with men's, tend to require computer use for longer periods during the working day. Women's work tasks at the computer also often entail more highly controlled and monotonous, repetitive work, which is known to be a risk factor for onset of, for example, neck and shoulder problems. In many cases, computer equipment/furniture is less well adapted to women's somewhat smaller bodies. For example, when using a standard keyboard, women – who often have narrower shoulders than men do – need to place the mouse farther outside their shoulder span, which can increase the risk of complaints, particularly shoulder complaints. What's more, women with families are often subject to greater responsibility and strain with regard to care for the home, family and children. In such cases, there is a great risk that women do not get the rest and recuperation that is so important. Life outside work brings additional stress and strain, which can increase the risk of musculoskeletal problems.

Consequences of musculoskeletal problems



Problems are of different intensity and severity in different individuals. Many take pain-killers to alleviate aches and pain. Around 50% of female professional computer users report having taken medications for musculoskeletal complaints during the past month. Most computer users who experience problems can continue working, though treatment and illness leave are sometimes required. Musculoskeletal problems

often affect people's abilities to perform household duties and engage in leisure activities. These difficulties, as well as sleeping disturbances – also quite common among computer users experiencing pain – would appear to be signals that life outside work is also being affected. Sleeping disturbances, in their turn, can lead to diminished ability to deal with stress and strain.

Eye strain and vision problems

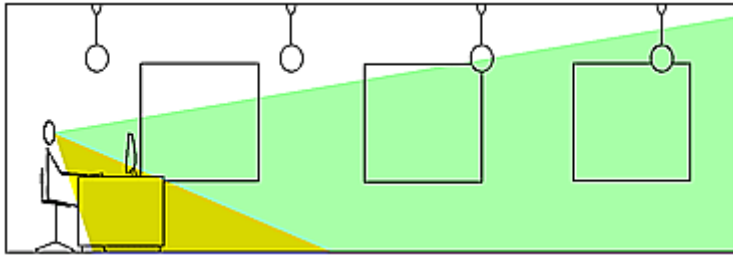
Work at a display screen places great demands on vision. The body and eyes are adjusted to help you see as well as possible. Strenuous visual conditions may arise for various reasons. This can lead to, among other things, various types of eye strain, for example eye irritation, pain, redness or tiredness. Eye strain is reported by one in four, and sometimes as many as one in two, computer users. The longer you work at a computer, the greater your risk of experiencing eye strain.

These problems pass, however, if visual conditions are improved. There have been occasional scientific reports of more permanent eye disorders (near-sightedness and glaucoma), but several studies have been unable to confirm these findings.

Vision problems and computer work

The computer screen is commonly placed relatively high up in the visual field compared with the position of a book while reading or a piece of paper lying on the table. This means that, to see the screen well, your head and eyes need to be angled upward.

When you gaze upward, light from lamps and windows is more likely to shine in your eyes, which can lead to glare.



When looking at a computer screen, different sources of light will be more easily within the visual field, compared to reading a book or piece of paper on the table. This can cause glare.

When you gaze upward, your eyes are slightly more open, which means the surface of your eyeballs can dry out more easily. Dry eyes sting and cause irritation. Dry and dusty air can make the situation worse.

What's more, the strain on your eyes increases when you gaze upward and are looking at something close up, for example your computer screen. This can increase your risk of experiencing eye muscles fatigue.

Looking at objects that are close up, that is, closer than about 2-3 metres, requires that certain eye muscles work particularly hard to adjust visual acuity at such a short distance. If this is prolonged, it is likely that your eye muscles will become fatigued

One cause of vision problems is a poor quality image on your screen. It is tiring to work with images that are out of focus (blurry) or that have a low contrast (an insufficient difference in brightness between light and dark parts of the image).

Flicker (variations in light intensity) from CRT screens (particularly old or large ones) and from fluorescent light fixtures can cause feelings of discomfort and headaches, even if this is not perceived on a conscious level. Research findings have shown that people who report being "hypersensitive to electricity" are more likely to be negatively affected by such flicker.

Read more about flicker in chapters Electric and magnetic fields in office environments and Screen image quality.

Difficulty in reading the display screen – for the reasons given above or due to, for example, too-small font size or blurred graphics – often causes computer users to project their heads forward in an attempt to see better. In this posture, often called "vulture neck", the upper part of the spinal column forms an elongated "S," which can lead to neck problems in the long run.

Another consequence of strenuous visual conditions is headaches.



Poor image quality or defects of vision will often lead to “vulture neck”.

Vision defects in people working with computers

Vision defects in computer users are often a cause of eye strain. Most common are the vision defects that emerge in the middle-aged and elderly, which cause difficulty in reading small print at close range. Appropriate eye (reading) glasses usually help. Progressive or bifocal glasses that are not suited to computer work can cause problems, because the part of the lens meant for near vision is at the bottom. The user wearing such glasses needs to angle his/her face upward to see a sharp image on the screen.



Non-optimal eye-glasses, bifocal or progressive, may cause awkward postures, e.g. backwards extension of the neck.

According to Swedish law, employers shall ensure that every employee who works regularly with a display screen complete a vision examination.

Illustration: Martin Toomingas

Eye strain and vision problems

In-depth – Disturbing glare and reflection

Your eyes can adjust to see in very dim or very intense light – the difference between the brightness in moonlight and sunshine is great (a factor of about 10,000). This adjustment takes a long time when you go from intense to dim light (from minutes to an hour), but is rapid when you go from dim to intense light (seconds).

If both dim and intense light are present in your visual field, your eyes will adjust to the most intense light. Intense light also spreads inside your eye, illuminating large portions of the retina. This makes it difficult to see things that are faint, for example text on your display screen. This is called disturbing glare. The risk of glare usually increases with increased age, because, among other things, the age-related cloudiness that occurs in the eye increases the spreading of intense light inside the eye.

Thus, the risk of disturbing glare is great for those who work with display screens, because the screen's brightness is relatively low compared with surrounding windows and lamps.

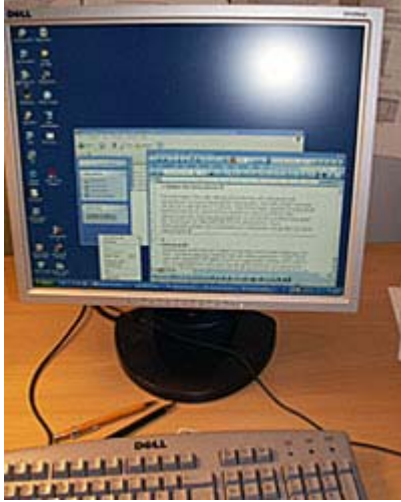
It becomes trying, and tiresome in the long run, to try to see characters on a weak display screen if the screen is surrounded by intense light sources.

Similarly, you can experience glare from light sources that are reflected on shiny surfaces, for example your computer screen or a smooth tabletop. This type of glare is called disturbing reflection.

Thus, vision disturbances, due to either direct glare or reflection, can arise if you have light sources near your screen. It is also common that display screens are too near a window. Having bright light fixtures in your visual field can also cause glare; this light may come from your own or your workmates' desk lamps, or even from insufficiently dimmed ceiling lights.



Computer screen in front of or close to a window is not recommended.



Light sources often cause reflexions from the screen.

Read, too, about vision problems in the chapter Computer work in open-plan offices.

Dry and irritated eyes

Many of the causes of eye strain during computer work may be attributed to dryness of the eyeballs. If the eyeballs become dry, irritation and pain can arise. The thin and superficial blood vessels that are always just under the surface of the eyeball are filled with extra blood and become enlarged. The eyes look as if they are red.



Irritation causes red eyes.

The surface of the eyeball (chiefly the cornea), therefore, needs to be protected from dehydration. Under the eyelids are small tear glands that are constantly secreting tear fluid. When you blink your eyelids, tear fluid is spread out to form a thin film of tears covering the entire eyeball. There are also small fat glands under the eyelids. Thus, in a similar manner, a thin film of fat is spread on top of the film of tear fluid. This keeps the film of tear fluid from evaporating too quickly. Using a special microscope, we can see how, after 20-30 seconds, the film of tear fluid increasingly disperses in patches, exposing the cornea to the air.

Excess tear fluid runs through a thin duct (the tear duct) down into the nasal cavity. (This is why you need to blow your nose when you cry.)

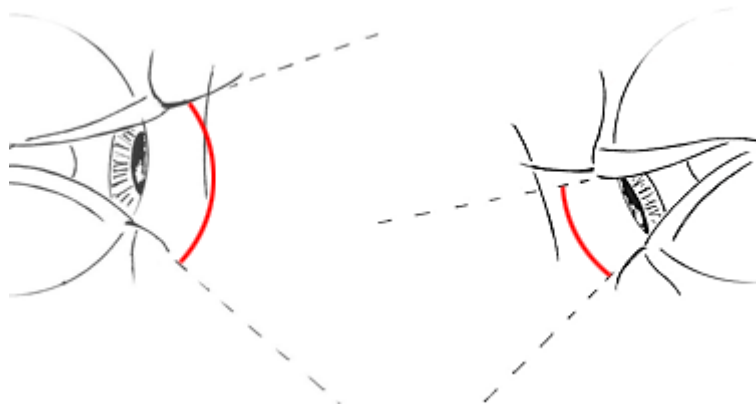
Blinking also removes any foreign substances that may have attached to the surface of the eyeball, for example dust from the air.

When our eyes feel irritated, we want to rub them with our hands. Foreign substances attached to our fingers are then easily transferred to our eyes, which may increase the feeling of irritation. Allergic reactions can also arise in people who have a predisposition towards eczema or eye allergies. Such reactions lead to even more irritation and red eyes.

Causes of dry eyes during computer work

A. Display screen placement.

When your screen is placed high up in your visual field (see above), you need to open your eyes more to see in that direction. The more open your eyes are, the greater the eyeball surface that is exposed to the ambient air. This can precipitate dehydration and increase the risk of foreign particles in the air attaching to your eyeballs.



When gazing in an upward direction, e.g. towards a computer screen, your eyeballs open more than when looking downward, e.g. at a piece of paper.

B. Lower blinking frequency.

It has been shown that, when people are looking at something, e.g. a display screen, blinking frequency decreases when they concentrate or are under stress. This means that more time passes between blinks and that there is an increased risk that the surface of the eyeballs will have time to dry out between blinks.

C. Dry or polluted air.

Dry and polluted air may increase the risk of the eyeball surface drying out and becoming irritated. The relative indoor humidity decreases if cold outdoor air is taken in and warmed, for example during the cold winter months. Heat-producing equipment, for example CRT screens, can increase the temperature further. Activities

that generate dust or other forms of pollution can also spread these unwanted air particles to computer workstations. Therefore, copying machines and printers that process large amounts of paper should not be placed in working spaces. Good cleaning routines may also help to reduce the dust content of the air.

Illustration: Martin Toomingas

Effects of prolonged sedentary work

Computer work usually entails prolonged periods of sitting still (sedentary work) and insufficient amounts of necessary physical activity. During an 8-hour working period, many sit for 6-7 hours, of which most are spent at the computer. In many computer-intensive occupations, employees have few other work tasks that can break up long periods of sitting.

In the long run, prolonged physical inactivity, such as that which characterizes a sedentary lifestyle, can lead to various problems with health and well-being. These problems can be divided into three main groups:

1. Effects on the musculoskeletal system

Weak muscles, fragile skeleton and poor mobility coordination and balance.

2. Effects on the metabolism and cardiovascular system

Overweight, diabetes, high blood pressure, elevated blood lipids, cardiovascular diseases.

3. Other effects

Constipation/diverticulosis, cancer, discontent, increased sensitivity to stress. Many of the effects of prolonged physical inactivity are categorized as "public health problems", that is, they are common in large portions of the population and include, for example, problems with the musculoskeletal system, overweight, diabetes, high blood pressure, cardiovascular diseases and cancer. Many of these are also serious medical problems. The portion of the population with these types of diseases has increased during recent years.

Many of the health problems associated with physical inactivity can be aggravated by simultaneous, prolonged stress. Stress increases the risk of, for example, cardiovascular diseases, diabetes, aches and pain. Signs of ill health may be expected to appear later in life after many years of sedentary work. Luckily, everyone is not affected. It is impossible to predict who will be affected and by what. Back, neck and shoulder problems, however, can appear much earlier – sometimes already after several weeks or months – if other unfavourable conditions prevail, for example inappropriate working postures resulting from poorly adjusted furniture.

Other conditions can also increase or reduce the risk of ill health. For instance, smoking increases the risk of skeletal decalcification and cardiovascular diseases. Poor dietary habits can further increase the risk of overweight, elevated blood lipids and diabetes. On the other hand, physical activity, for example organized exercise at work or during leisure time, can decrease the risk of most of these ill health phenomena and increase the individual's stress tolerance and well-being.

Computer use usually begins early in life. Many children and youth spend several hours a day sitting at school and at home in front of a computer or TV. One frequent question is whether prolonged inactivity of this kind during childhood and adolescence constitutes a particularly great risk for ill health later in life. As yet there are no reliable answers to this question. The question is, however, whether it is wise to wait for the answer or whether we need to take action now.

There are currently no studies that directly tie computer work per se to the ill health described in this chapter. Yet we should be able to apply our general knowledge of the association between physical inactivity, such as in prolonged sedentary work, and increased risks for ill health. Such risks, however, can be prevented through physical activity at work or during leisure time.

Effects of prolonged sedentary work

In-depth – Risks associated with prolonged inactivity

Human beings are built for activity



By two or three hundred thousand years ago, the human race, *Homo sapiens*, had adapted to life on the African savanna. In that environment, it was advantageous to have physical quickness, strength, flexibility and stamina. Today, we human beings are essentially the same creatures we were then. We are, by virtue of our basic design, adapted to a life of movement – to varied physical activity. This also includes making great

physical efforts and using our physical strength and flexibility.

Our bodies are highly adaptive. The cells of most tissues are constantly being replaced. The old and worn out are replaced by the new. The muscles, tendons and skeletal structures, etc., that are used often and subject to loads are strengthened and built up through this process of regeneration. The flexibility of a joint will become

more extensive if the entire movement range of the joint is used. Movements and activities that occur frequently become more finely adjusted and coordinated because the nervous system has become more "fine tuned."

One important function, which is adaptive, is the body's ability to supply muscles and other organs with oxygen and nutrients as well as to transport carbon dioxide and waste products away from the cells. Here, the blood circulating through the body serves as the transport medium. Your heart's ability to pump and the functioning of your blood vessels are, therefore, of vital importance. All these functions can increase and improve if your body regularly works so hard that your heart beats rapidly and you become short of breath. In everyday life, we call this functional capacity "fitness." We all know that we can increase our fitness through exercise, e.g., jogging, callisthenics and other physical activity.

The body's adaptiveness, however, also includes the regression, and thereby weakening, of structures that are not used regularly. This concerns, among other things, the skeleton, which becomes weaker (resulting in, e.g., osteoporosis) if it is not regularly subjected to strenuous loads. Muscles become weaker, have less endurance and decrease in coordination and elasticity. Joints decrease in their range of movement and "stiffen."

If we do not engage in regular, strenuous physical activity, we will reduce our level of fitness. This means that the heart's ability to pump blood will decrease and the ability of the blood vessels and muscles to utilize the oxygen and energy provided by the blood will diminish.

All the vital processes occurring in human beings require energy. We get this energy through the food we eat. Substances in our food are converted into blood sugar, blood lipids and proteins. Fat is the food that is highest in energy. Fat and other nutrients that cannot be used immediately as energy in various processes or as building blocks in the body will be stored. The body's largest fat or energy stores are the fatty tissues found in visible parts of the body, but also inside the body, for example in the abdomen. If you supply your body with more energy than you use, you will build fatty tissue – become "fat" and overweight.



Muscular action requires particularly great amounts of energy. Thus, the body's energy requirements are highly dependent on how strenuously and how long we work with our muscles. Heavy physical work requires a great deal of energy. Sitting still requires very little. The risk is great, therefore, that a person who has a physically inactive life, including considerable sedentary work, will supply his/her body with more energy (more calories) than will be utilized. The consequences of this are increased amounts of fatty tissue and weight gain.

Corresponding adaptive processes also occur in the brain. Mental stimulation accelerates brain development and can maintain its complex functions, e.g. memory.

Both muscular strength and endurance need to be used regularly in order to maintain flexibility and elasticity in joints, connective tissue and muscles, as well as the coordination and balance. The same is true of fitness. Fitness, strength, etc., are "perishables" that only exist for a short period of time and need to be constantly renewed and built up. After only a week or so of total inactivity, for example bed rest, the body's fitness and muscular strength begin to decrease. After prolonged inactivity, even the skeleton, tendons and connective tissues have begun to diminish in strength.

Society has developed towards less physical activity

During the past 100 years, many of the physically taxing and energy-demanding aspects of life have disappeared. This applies to our private lives, in which cars, washing machines, vacuum cleaners and power lawnmowers have taken over the work previously done using our own physical strength. In working life, the number of people working in physically strenuous occupations, for example farming, forestry and the manufacturing industry, has decreased greatly. In these strenuous occupations, we have aimed at decreasing elements of work that are physically taxing. Machines and other devices do the heavy work. There are still many occupations, however, that occasionally include strenuous physical work, for example in healthcare, the construction industry and cleaning.



On the other hand, the number of people employed in physically inactive and often sedentary occupations has increased dramatically. One example of this is computer work.

The combination of low requirements for physical activity in both private and working life implies that we risk getting too little training for our physical fitness, strength, coordination, flexibility, etc. We also risk

accumulating energy reserves (fat stores) that are too large and, thus, becoming overweight. The proportion of children and adults who are overweight or obese has increased substantially in large parts of the world. Such a development can entail a number of health risks.

Effects of prolonged sedentary work

In-depth –

Health risks and other problems resulting from prolonged inactivity

The body's ability to adapt to prolonged inactivity per se is a positive factor. The body economizes with its building blocks and energy, refraining from building up parts that are used less often. But there are, unfortunately, drawbacks to this.

One of the problems is that your body becomes weaker, has less endurance and flexibility, and functions less well. Consequently, everyday activities become more taxing and it is easier to become exhausted. You may become "clumsier" in your movements and lose your balance more easily, increasing your risk of making mistakes and having accidents. More demanding activities, for example lifting something heavy, skiing or playing tag with children, will not be manageable at all.

If your body is subject to a sudden load, weakened connective tissue can rupture, causing "microscopic" or larger injuries. A weakened skeleton, for example bones in the wrists, hips or spinal column is more easily broken or crushed. Tendons and ligaments can become stretched or completely or partially torn. The knee joint, for example, is highly dependent on having strong leg muscles and strong tendons and ligaments around the joint that can check forces that could twist or bend the knee and dislocate it. Thus, weakened muscles, tendons and ligaments increase the risk of knee joint injuries and problems.

It is a great strain to have an overweight body when the overweight consists of fatty tissue. Fat, as opposed to muscle, cannot do any work, but is instead only a burden to be carried. A person who should normally weigh 60 kg, but who weighs 90 kg, has to carry an extra 30 kg. Not many people have the strength to lift 30 kg from the floor or walk around with a backpack weighing 30 kg.

In addition to these problems, research carried out during the past decade has revealed an increasing number of risks for ill health and discontent as a consequence of prolonged physical inactivity. The list of diseases and complaints reported to be associated with physical inactivity is now long:

Health and other problems associated with physical inactivity

(A question mark means the relationship is less clear.)

- Overweight – obesity
- Diabetes (type II)
- Elevated blood lipids
- High blood pressure
- Coronary artery disease, heart failure

- Blood vessel constrictions in the legs
- Cancer (primarily breast and intestinal)
- Osteoporosis (brittleness of the skeleton)
- Musculoskeletal aches and pain
- Dizziness, balance disturbances
- Menopausal complaints ?
- Constipation, diverticulosis
- Depression ?
- Learning skills, memory ?
- Stress, sensitivity to stress ?
- Sleeping disturbances ?
- Low self-esteem, discontent

The relationships between prolonged inactivity and these diseases are complex. Figure 1 shows some of the patterns. Note that the outcome "ill health and aches and pain" often entails mobility difficulties for the individual, which may result in increased inactivity (indicated by the upward-pointing arrows). The same applies if you become less fit or if your musculoskeletal system is weakened. You may end up in a vicious circle in which inactivity breeds inactivity.

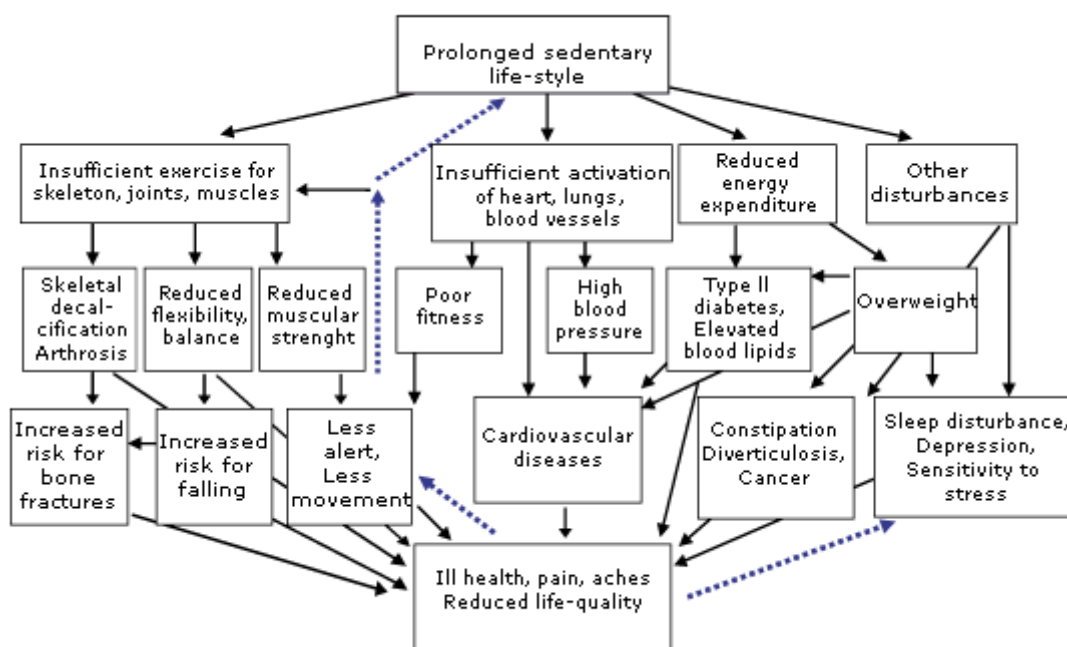


Figure 1. Relationships between prolonged physical inactivity (sedentary life-style) and various conditions of ill health. Upward-pointing arrows indicate ill health that can lead to inactivity.

Simultaneous, prolonged stress can further precipitate the onset of ill health (Figure 2). This primarily concerns the onset of "metabolic syndrome," which includes overweight (particularly around the stomach), elevated blood lipids, high blood pressure and poor blood sugar balance (possibly type II diabetes). Metabolic syndrome can constitute a risk for onset of cardiovascular diseases that primarily affect the heart, brain or kidneys.

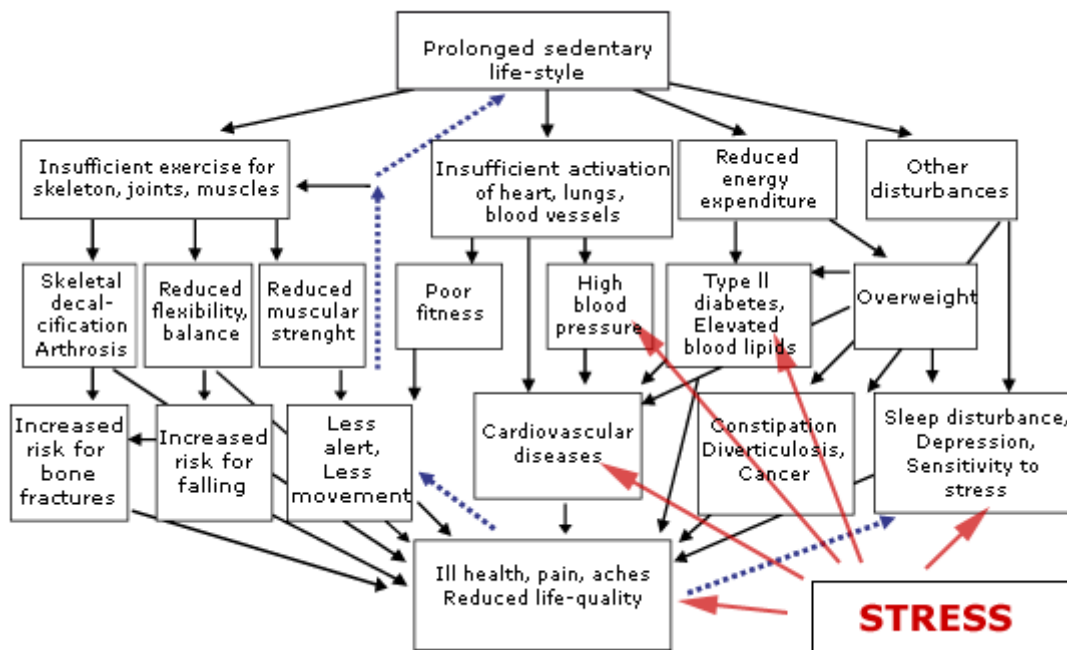


Figure 2. Relationships between prolonged physical inactivity (sedentary life-style) and stress and various conditions of ill health as well as effects of stress. Upward-pointing arrows indicate ill health that can lead to inactivity.

Read more

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Effects of prolonged sedentary work

In-depth – Energy requirements for various activities

A common measure of energy is the calorie (1 cal = the energy required to increase the temperature of 1 gram of water by 1 degree C). The calorie is a very small unit, so we usually use the kilocalorie (1 kcal = 1000 calories).

Different activities require different amounts of energy. The longer you are active and the larger you are (weight in kilos), the more energy you require for a given activity.

Scientists have developed the unit MET (Metabolic unit). 1 MET denotes the expenditure of 1 kcal per kilo body weight and hour.

Energy expenditure for various activities

Sleeping		0,9 MET
Sitting completely still		1-1,3 MET
Standing/walking slowly	2-3 MET	
Housework	2-5 MET	
Walking quickly or while carrying a load		4-5 MET
Running		8-10 MET
Office work	2 MET	
Light industrial work		4-5 MET
Heavy industrial work		6-8 MET

The MET values show that sedentary activities require somewhat more energy than sleeping and much less energy than work demanding more movement. The maximum MET for extreme exertion, e.g. ski-racing, is 15-17 MET. Normal exercise activities usually involve an energy expenditure of 6-10 MET.

Consider the following comparison: A sugar cube contains energy corresponding to approximately 15 kcal and a small individual portion of butter (10 gram) approximately 100 kcal. If you weigh 60 kg, the sugar cube will last 17 minutes and the butter 2 hours if you are sleeping. If you are doing light office work, the sugar cube will be used up after 5-7 minutes and the butter after slightly less than an hour. If you are exerting yourself maximally, you can burn the sugar cube in one minute and the butter in about 6 minutes.

Concerns about ill health

During the 30-year period in which computer work has become increasingly common, concerns about various types of problems and dreaded health hazards have been discussed and have attracted considerable attention. In addition to problems with the neck/shoulders and upper extremities, eye complaints and various stress-related problems described in other chapters on these web pages, discussions have primarily involved concerns about skin problems, "hypersensitivity to electricity," pregnancy complications or cancer.

Skin problems

Computer users have reported an association between computer use and facial skin problems, commonly involving redness, itching, burning pain and a feeling of having dry skin. In most of these cases, no specific diagnosis can be made. Such problems are usually temporary in nature.

Several studies have reported that skin problems are more common in warm, dry and dusty computer work environments. A few studies have shown associations between skin problems and electrical fields surrounding unearthed computers or static electricity in older CRT display screens. One common view is that reports of skin problems such as these have become less frequent during this century.

Hypersensitivity to electricity

A condition sometimes mentioned in this context is "hypersensitivity to electricity," including skin problems (as mentioned above), headaches, tiredness, dizziness, nausea and tingling sensations, etc. Such complaints are usually temporary. Those affected have associated these complaints with computer work. In several cases, complaints have become more lasting and general, triggered as well by other electric equipment or various light sources.

This type of complaint is thought to emerge in connection with stress and anxiety at work. Another supposed cause is warm and dry indoor air, like that found near older CRT display screens. Reports of "hypersensitivity to electricity" and skin problems are uncommon outside Scandinavia.

Studies have been carried out in which people who are "hypersensitive to electricity" were tested, e.g., while near a computer that was behind a screen and turned either on or off. Any complaints that arose had no relationship to whether or not the computer was actually on. On the other hand, some observations show an association between flickering light from fluorescent lighting and the complaints described by people who are "hypersensitive to electricity." Older computer display screens also show similar flicker.

The general impression is that the number of people affected in this way has decreased during this century. Perhaps this is because display screen technology

and fluorescent lighting have improved, resulting in less flicker. Moreover, flat screens, which are becoming increasingly common, produce less heat and no static electric fields.

Pregnancy complications

There has been some concern about pregnancy complications resulting from computer work. However, there is no evidence to indicate any definite associations between computer work per se and birth defects or other pregnancy complications. On the other hand, there is evidence showing that stress and anxiety can negatively affect the course of a pregnancy. It is extremely important, therefore, that pregnant women working at computers be offered extra help and support.

Cancer

There has been some concern about cancer resulting from computer work. Research has provided no evidence, however, that computer work per se increases the risk of cancer. However, a possible weak relationship has been reported between electromagnetic fields and certain less common forms of cancer. Such fields are not specific to computers, but are found everywhere electric current is connected. However, in office environments, even those containing many computers, electromagnetic fields are usually of a low level.

Summary

Despite extensive research efforts, there is no evidence of any definite increased risk of the problems described above in association with computer use. However, an individual's complaints and concerns always need to be taken seriously. An immediate and careful investigation of the individual's complaints and working conditions should be conducted. In most cases, problems can be overcome or alleviated by taking adequate measures.

Help - Mouse arm!

Advice and remedial steps in case of aches, pains and other problems during computer work

Here you can find advice and suggestions to help with discomfort that can arise or become worse as a result of computer work.

You should not wait too long before addressing discomforts. If you live with the problem, it can become harder to deal with later. Mild or moderate discomfort that has lasted several days or weeks or which tends to get worse should be dealt with within a week or a few weeks. Intensive or alarming discomfort should be dealt with immediately.

Discomfort can also be connected with factors that have nothing to do with your computer work. For example, it could be caused by an illness that requires medical diagnosis and treatment.

In cases of serious discomfort and where the discomfort is not obviously linked to computer work, you should seek medical advice, e.g. from your company healthcare unit or elsewhere. You can also get help by referring to the website run by the county councils together with Apoteken - InfoMedica. Information and advice are provided under the headings Symptoms and problems, Illnesses or on the Answer Bank. You can also consult your doctor.

Recommendations in case of aches, pains or discomfort

1. First read the information here in order to exclude the possibility of serious illnesses.
2. Review your computer workstation.
3. Reduce your stress, vary your work both physically and mentally.
4. Talk to your immediate superior/management.
5. Contact a doctor or physiotherapist at your company clinic/medical care centre.

Read more

Statute Book of the Swedish National Board of Occupational Safety and Health
1998:5 "Work With Display Screen Equipment "

Text and English translation: Jens Wahlström and Tohr Nilsson

If you are not seriously ill, you can follow the following advice and guidelines.

In the acute phase (first days) you should avoid activities, movements or situations that cause more pain or discomfort. It is also important to take regular breaks and to review the design of your workstation and working positions in order to deal with the problems as soon as possible.

Headache

If you are troubled by headaches, these could be caused by stress, unsuitable working positions, problems with your eyesight or problems with your jaw or other illnesses. It is important that you review your working positions, and determine if your computer screen is so high that you have to look upwards when you read the screen, so-called “vulture neck”. This can cause headaches.

A very heavy workload could be another cause. Discuss your work situation with your immediate superior/manager and try to find a way of addressing the problem.

It can be extra important for you to take regular breaks and relax, e.g. with deep breathing. If you suspect that your eyesight has changed, you should visit an optician and have it tested.

If you grind your teeth or clench your jaw while you sleep, this could be the cause of your headaches. In such cases you should visit your dentist as you could be helped by trying an acrylic splint.

Eyes/eyesight

If you experience problems in the form of “grit in your eyes”, burning, tiredness and/or irritation in your eyes, this could be caused by poor lighting, incorrect screen settings, insufficient shade from daylight (too bright).

It is important that you check the general lighting, spot lighting, and screen frequency settings and avoid reflections and being dazzled by sunlight. You can find more tips and advice on how to deal with this in the section on lighting and visual conditions.

If your eyesight has changed, it is important that you have it tested and possibly try out glasses that are adapted for screen work.

Aches, pains and discomfort

If you experience problems in the form of aches, pains or discomfort in your neck/shoulders, arms/hands or in your back, these could be caused by unsuitable working positions, lighting conditions or stress.

Can you take the load off your arms by using the desk or the arm supports on your chair? If you don't do this, it can cause pain in your neck or shoulders.

If you use bifocal/progressive glasses, it is important that these have been tested properly – eyesight and lighting conditions can give rise to aches and pains in the neck

If you have problems with aches, pains or discomfort in your forearms and hands, one of the reasons for this could be intensive clicking with your computer mouse. It

could be useful to learn the keyboard commands in order to avoid intensive periods of mouse-clicking.

When you experience discomfort in the form of aches and pains, it is particularly important to take regular breaks.

What does the law say?

The employer is responsible for arranging suitable work-adaptation and rehabilitation activities within the company (Work Environment Act).

Working conditions need to be physically and psychologically adapted to the varying needs of employees.

8 § If visual discomfort or other stress-related discomfort occurs despite remedial measures as in 2--7§§, work must if possible be arranged so that the employee can alternate with less strenuous tasks. If that cannot be arranged, the employee must be allowed sufficient pauses so that discomfort does not occur at work. (AFS 1998:5)

1 § The employer must organise and run his/her business with work-adaptation and rehabilitation for the employees. (AFS 1994:1)

12 § The employer must adapt the individual employees' work situation on the basis of their suitability for the task at hand. Special consideration must be paid to any reduced functional capacity or reduced working ability on the part of the employee. (AFS 1994:1)

Read more

The Swedish Work Environment Act

Statute Book of the Swedish National Board of Occupational Safety and Health
1998:5 "Work With Display Screen Equipment "

Scientific literature

Besides personal suffering, aches and pains also create considerable costs for employers in the form of reduced production. In a Swedish study (Hagberg et al., 2002) it was noted that almost 10% of all those with symptoms (pains in neck/arm but not off work) reported reduced productivity at work.

Persons who use progressive/bifocal glasses when working with computers report more often that they suffer from aches and pains (Bergqvist et al., 1995; Hales et al., 1994). It is important to check the glasses one uses during screen work in order to reduce the risk of developing aches and pains.

In the beginning of the 1980s, reports were received of persons who experienced skin problems in connection with screen work. Knowledge of the reasons for “electrosensitivity” is still very limited despite intensive research. The same applies to the mechanisms that give rise to the symptoms and how this type of problem should be treated and prevented (Arnetz, 2001).

In a Swedish study (Wahlström et al., 2004) the authors observed an increased risk of developing aches, pains and other discomfort in neck/shoulders in those individuals who experienced tension in their muscles at least twice per week. The same results have been noted in previous similar studies in both Sweden and Norway (Holte et al., 2002; Theorell et al., 1991; Vasseljen et al., 2001). Those who wish to look more deeply into this subject can download a dissertation published by the National Institute of Working Life’s scientific publication series Work and Health here.

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Work organization and psychosocial working conditions

In organizing work, the following decisions are made –

- who will do what
- where work will take place
- how work will be performed
- when work will be performed
- and at what pace.

Thus, how work is organized affects how the physical, psychological and social working conditions will take shape. This, in turn, is of importance for the demands that will be made on employees and for the opportunities employees will be given to manage and control their own work.

Computer work entails various mental (psychological) demands. These may involve, among other things, knowing how to use the computer and software, reading and understanding information on the display screen or performing the correct operations, e.g., opening the correct dialogue box on the screen.

The work should be varied, including an appropriate mixture of high and low mental demands on performance, competence, skill and pace. In other words, work needs to be a mixture of difficult and easy tasks, sometimes done quickly, sometimes more slowly.

The best situation is when work is organized such that it is adapted to each individual's abilities and needs and allows gradual development of each individual's skills.

What is appropriate varies across individuals and across different life periods for a given individual. The ideal situation is one in which each individual may regulate and control which requirements are to be met from one time to another. Being able to control and influence your own work and working conditions is perhaps one of the most important factors underlying well-being and health at work. Unfortunately, such ideal situations are unusual, not only among people working with computers, but in working life in general.

For many, the computer system itself (the computer) is a source of insecurity. A person who doesn't understand how a computer works can easily become stressed

by the mere thought of something going wrong. Few people know what to do to get the computer working again if a major problem arises. Even minor complications can completely prohibit continued work. It is sometimes difficult to navigate among all the various commands and features, even when everything is working as it should. In other words, many computer users have less-than-adequate control over their most important work tool. Consider this situation in comparison with the control people had over their work tools in the past, when typewriter, pen and paper prevailed.

Many types of computer work consist of rather simple, monotonous and repetitive work tasks. Employees are tied to their computer workstation for large parts of the working day. Such work is often also performed at a high pace. In such cases, there are few opportunities for the employee to control and influence how and when he/she will work. This implies few possibilities to develop, and limited experience with new work tasks. This type of work organization may be found in, e.g., customer service work or sales. Working life researchers have warned about such conditions, pointing to the great amount of established knowledge on the risks for health and well-being.

Solidarity in a well-functioning working group, in which everyone is working towards the same goal, is another important ingredient of sustainable computer work.

Every co-worker needs to feel that he/she is participating in the organization's activities, that his/her viewpoints are sought after and that, when needed and desired, he/she can have an impact.

There also needs to be scope for and understanding of personal needs and of the fact that people sometimes function less well. Examples of this are employee illness or personal circumstances, such as when children need to be picked up from day-care or are ill. The support and understanding of management are particularly important in such cases.

A positive and natural atmosphere at the workplace is an advantage. You should ask yourself, "How often do we laugh at our workplace?" Informal meetings, for example coffee breaks, should occur on a daily basis. If you find yourself regularly taking your coffee to your workstation instead of being social, this may be a warning signal that your work is too stressful, that you are not giving priority to group relations or that group members are not comfortable with one another.

Other factors of similar and great importance are, for example, the company's market and financial situation as well as its wage system. A wage system based on performance can easily result in a very high work pace and stress.

In-depth – Who, where, how, when and at what pace

Who does what job is controlled by management decisions concerning the distribution of work. Work tasks of varying character and complexity are found at different companies and governmental authorities. Many companies deal mainly with

only one or a few work tasks. If a company's only form of production is entering text or figures from forms into computers, then work tasks will probably be both physically and mentally monotonous. This is also true of companies whose only function is answering simple questions over the telephone using computer support, for example directory assistance or train/bus schedule information.

Where you work is sometimes highly controlled by the fact that almost all work needs to be performed at a computer. In such cases, most work tasks need to be carried out at the workstation and cannot be carried out anywhere else. About 20% of the female labour force in Sweden in 2003 reported that the bulk of their work was performed at a computer. It is often the case that three-fourths of the working day is spent sitting. This means that the work environment design and employees' knowledge and use of appropriate working techniques are of great importance for perceived comfort and for the risk of developing various types of complaints.

How you work is sometimes highly controlled by various routines and agreements. The design of computer programs also constitutes a form of control over how you can perform your work. Feelings of being steered, controlled and monitored recur in various contexts as negative aspects of computer work. Thus, being allowed to plan the details of your work – "to work in peace" – is an aspect of work that is often appreciated.

When you work is often controlled (scheduled) by the company. In some of the branches in which computer work is common, working hours and even short pauses are highly regulated. This is particularly true of the service sector, e.g., customer service, sales and healthcare. It has been shown that flexibility and the opportunity to influence working hours are positive work factors, both in theory and in practice.

At other workplaces, almost the opposite situation prevails: You can work at any time and for any amount of time. Computer work can often be done regardless of the time of day or whether you are at your workplace, at home or someplace else. Work with IT and computers has often been described as "boundless" with regard to time and space. It is difficult to set limits on working hours. Time spent in front of the computer can become long and extended. Pauses and lunch breaks may be omitted. Drinking coffee or eating a quick lunch at the computer is observed with increasing frequency at many workplaces. Many employees take work home and continue to work during the evening, at night and weekends. This sometimes implies work flexibility that is advantageous. Some people like irregular, odd and extended working hours. For many, however, such working hours instead mean difficulties with family life, seeing friends or participating in courses or other leisure activities. There is a risk that employees will become exhausted, regardless of how stimulating and enjoyable they feel the work is.

The pace of computer work is usually determined by the company's production demands and financial situation. Pace may even be affected by the wage model, for example a bonus system that encourages a higher work pace. In many cases, pace is controlled by how the computer is programmed or by the influx of customer contacts, for example in customer service, sales and healthcare.

In-depth – Mental demands

Computer work can be **mentally demanding**, meaning, among other things, that you need to work quickly and remain concentrated even in a disruptive environment, or that the work requires a high level of expertise and an ability to come up with your own solutions to various problems. The work may demand that you can manage difficult tasks for which information may be hard to find or understand and that place great requirements on memory, intelligence, creativity and the ability to make difficult decisions. Such work rarely involves routines, but instead every situation requires considerable mental effort. Computer work such as this is found, e.g., at many governmental authorities, in the healthcare sector and the educational system or at customer service facilities to which people turn for advice on computer problems or on financial or medical matters.

The computer software used is often not well adapted to the activity and therefore puts a strain on the user that is unnecessary and that reduces his/her performance.



Different factors makes computer work mentally demanding.

Computer work can also be mentally taxing if it places too few demands on your thinking processes, creativity and initiative or if it requires too much monotonous mental activity.

Examples of such situations are surveillance work via computer displays, work in sales (e.g., at checkout counters), routine administrative tasks or customer service work dealing with simple information, reservations, etc.

Even non-advanced work tasks may require, e.g., constant attention or that you are able to remember certain information. Such situations are tiring in the long run. Work that only involves monotonous tasks that don't utilize or develop your mental resources will become stressful and exhausting in the long run.

Special mental demands faced by computer personnel working with customer or client contacts, e.g. at customer service companies or within sales and healthcare, are emotional demands. Such demands may involve being constantly service minded, that is, constantly inquiring about and complying with customers' and clients'

needs and desires. Service personnel may even be subjected to unpleasant treatment from customers and clients. This may concern customer dissatisfaction with products or services or that the customer has had to wait a long time in the telephone queue or for attention. Customers and clients can become disagreeable, accusatory or downright threatening. In such cases, the employee is the recipient of their disappointment and anger. It is difficult for employees to defend themselves from personal accusations even if they know they are not responsible for the problems that have arisen. Naturally, this can be unpleasant and stressful.

Another aspect here is that employees need to refrain from showing their spontaneous feelings when they are angry, irritated or sad because a customer, client or patient has behaved in a threatening, insulting or unduly demanding manner. A professional attitude requires that customers still be treated in a controlled and strict manner. This constitutes yet another stress factor.



Emotional demands are common where computers are used in the service sector.

Work can also place great demands on you to work quickly, hard and efficiently. This often involves producing a great deal during a short period of time at a fast pace or being in a situation with tight deadlines for completion of work. Computer work such as this often entails mental demands that are too low, as discussed above. But it may also occur in work in the mass media or other branches that constantly face tight deadlines.

To facilitate (mental) work at the computer, it is important that the information shown on the display screen be adapted to the user. Yet all of us who have used different computer programs, search engines and websites know how they vary in user friendliness.

In-depth – Managing and controlling your own work

It is often important that the individual be able to control the following working conditions:

Working hours – when

It is favourable to be able to control your own working hours in terms of length, e.g. full-time, part-time or hourly, and in terms of scheduling, e.g. regular working hours, shift work, night work, weekend work or flextime. Different working hours may be better suited to different phases in life. During periods of study, extra hourly work is perhaps best. If you are a parent with small children, you might prefer permanent part-time employment. If the work takes place during inconvenient working hours, it is best if the individual can choose, e.g., when he/she will work a night shift. Computer work can often be done at any time and at any location. Thus, for many people, computer work tends to extend beyond ordinary working hours as well as into leisure time. Many view this ability to choose as beneficial, but it can lead to exhaustion if care is not taken.



Computer work can easily extend through day and night.

Working pace

It is important to be able to control your working pace so you can adjust it to the present situation and the different phases of your life. Sometimes you're out of step with things and need to take it easy; at other times you're feeling great and want to "give it all you've got." Thus, it is unfortunate if your working pace is controlled by a computer or other external factors (as though you're on a "mental assembly line"). Such situations are common in work controlled by the influx of customers, e.g., at checkout counters or customer service. Even the reward system used can affect working pace.

Working methods – how and where

Being able to organize one's own work and influence how it will be performed is an important part of adaptation to the individual's needs and abilities. Experience and competence play an important role here. A beginner needs more guidance and support, preferably provided by an experienced co-worker (mentor).

Work content – who does what?

Work content is often limited by the company's or governmental authority's business concept or mission. It is difficult for the individual to influence this, at least in the short run. But it is advantageous for people to be able to influence their work content within the given framework. In an ideal case, work tasks can be adapted to people's abilities and needs, and can change as they develop in their work roles.

Work is often distributed such that individuals become specialized in certain tasks. This makes them highly skilled at these tasks and highly productive. The drawback, however, is that if these tasks are monotonous and repetitive, there is a risk that employees will not experience sufficient physical or mental variation or stimulation, or possibilities to develop in their work.

In-depth –

Highly controlled/restricted and monotonous/repetitive work

"Dull," "monotonous" and "lacks stimulation" are words often used to describe the shortcomings of computer work. The importance of work content has been pointed out in research. The primary concern is about work that can become monotonous and lacks stimulation and possibilities for further development. The work may also require that employees work for long periods and be bound to the computer both at the workplace and perhaps even at home. Time for a pause, resting and recuperation is often neither given nor taken. Employees cannot leave the workstation for more varied physical activity.

Read more in chapter Effects of prolonged sedentary work.

Thus, the nature of computer work can sometimes be mentally taxing, monotonous, repetitive, highly controlled and restricted both physically and mentally and can entail little possibility for employees to control their own work. This is contradictory to what is stated in the Work Environment Act AFS1998:5, 7§: "Display screen work which is closely controlled or restricted in a physical or mental respect or is monotonously repetitive may not normally occur."

Such working conditions can constitute a risk for emergence of discontent and various types of problems and ill health, particularly if the work is performed during long periods without breaks, at poorly designed workstations or under stress.

Even seemingly low-complexity computer work, e.g. at customer service companies, can place high mental demands on employees owing to the need for constant attention, often in combination with high demands for work quantity and quality. Work situations such as this are often associated with physical and mental stress reactions. The risk of creating a situation in which women always lose is also great, as it is primarily women who end up performing routinized and non-stimulating work tasks.

Read more in chapter Computer work under stress.

What does the law say?

Work with display screen equipment The Swedish Work Environment Authority Ordinances, AFS 1998:5 7-8 §§

7 § Display screen work which is closely controlled or restricted in a physical or mental respect or is monotonously repetitive may not normally occur.

8 § In the event of eye strain or other strain-related disorders resulting from work with display screens in spite of the measures referred to in Sections 2-7, work shall if possible be arranged in such a way that the operator can switch to other, less strenuous tasks. If this cannot be arranged, the operator shall have sufficient breaks in the course of work for disorders to be avoided.

Comments

It is important that special attention be paid to monotonously repetitive work, to routine work and to work involving a great deal of control or restriction. Work of this kind includes, for example, continuous data entry, editing and proof-reading against a display screen. Display screen work involving intensive and monotonous inputting for a large part of the working day substantially augments the risk of musculoskeletal injuries to the hand and wrist. Work situations of this kind can be avoided, for example, by diversifying the job so as to include other tasks which will provide a professional development. The ability to see and understand how different tasks are interconnected and how one's own work forms part of and contributes to the overall scheme of things is highly important.

With the growth of opportunities for communicating with others through the computer, display screen work can mean isolation from social contacts. Therefore it is important that work should be planned and arranged so as to afford opportunities of personal contact. The working premises and general workplace environment should be designed accordingly.

Deeper and wider utilisation of information technology is making the computer a progressively more important working tool. Working sessions at the display screen can be extended, at the same time as the work itself may be found stimulating, developmental and independent. Work of this kind can also entail harmful stresses.

Physical variation of work is important, e.g. in the sense of being able to find comfortable and varied work postures and working movements.

Variation by means of breaks and alternation with other tasks aims at preventing the strain in the course of a working day from causing excessive fatigue or other discomforts which can be harmful in the long run. It is essential for the individual to be free to alternate tasks or take breaks according to his/her own needs. The length of time for which work with a display screen can be continued depends to a great extent on the nature of the work. There are some jobs where 1-2 hours' continuous work is feasible, while others may demand such close attention or such a degree of visual exertion as to necessitate shorter sessions. It is an advantage for work with a display screen to be organised from the very outset in such a way that it will naturally alternate with other tasks. The employer's responsibility for investigating working conditions, assessing risks and carrying out practical measures is defined in the Board's special Provisions on Internal Control of the Working Environment.

In-depth – Personal development and work task content

It is important that all employees feel job satisfaction and be pleased with and proud of their work and what they have accomplished. It is also important for people to develop in their work, at a pace adapted to their own abilities, and to learn to perform more and increasingly advanced work tasks.

One way to increase your competence is to learn more, albeit similar tasks, for example to deal with several different computer programs, client companies or services instead of just one. This requires, however, that the organization have access to such a variety of things. It is even more advantageous if there are work tasks of varying complexity and difficulty, for example software of different types and degrees of difficulty. In this way, beginners can start with simpler tasks, later learning more advanced ones, thereby increasing their competence.

Another way for employees to develop in their work is to supervise and instruct beginners or to plan, organize and lead an activity. Experienced co-workers can become mentors to the less experienced, who can then turn to their mentors for advice and support.

Companies should regularly hold personal career development discussions between individual employees and their supervisors in which the development plan every co-worker should have is drawn up and followed up. The development plan specifies, among other things, the co-worker's goals and needs as well as his/her desires for further education and training.



To be mentor makes your work more interesting.

In-depth – Participation and social support

Good camaraderie and a pleasant atmosphere are often reported to be among the most important characteristics of a good workplace. Workmates can help and support you when something has gone wrong or is hard to understand, e.g. some feature of a computer program.



Sometimes the nature of the computer work entails that you have relatively little contact with others. This may be because you are working from home or are isolated from your working group for other reasons. But it may also be because you are working under such great pressure that you don't have time for socializing. It is important that management ensure that all employees can have contact, regularly and on their own terms, with workmates or others.

It is also important to have the support of a supervisor or employer. This can involve an employer understanding that you can have a "bad day" for various reasons or listening to your ideas about your work. Moreover, it is important that employees be given encouragement and that any criticism be constructive and not degrading.

Thus, the support of workmates and management is very important to everyone. Being bullied, harassed or threatened, therefore, often constitutes a personal tragedy for the victim. The employee needs the help and support of his/her co-workers, but instead they constitute a threat.

Thus, bullying/harassment need to be dealt with actively and professionally, e.g. through occupational health care, as soon as it is observed. The same is true of threats and violence perpetrated by, e.g., clients or conflicts between co-workers or others.

In-depth – Management and monitoring

One important factor influencing work satisfaction and the effectiveness of the work is how work management functions. Management that emphasizes detailed control and monitoring of computer work will probably result in stressed co-workers who feel they are under surveillance. In contrast, management that emphasizes all employees' responsibility and control over their own work will likely help to create co-workers who are more involved in their work tasks.

It is relatively easy to register and map exactly when a computer has been used and what information has been processed. This can be done remotely if the computer is connected to a network. Such data can form the basis of performance measurements for, e.g., wage and bonus calculations. Registration such as this does not always follow work environment legislation or existing rules on personal data registers. Moreover, many have perceived registration as "surveillance" and "control" on the part of the employer. "You can't even go to the lavatory" without your employer knowing about it.

According to the Swedish Data Inspection Board's interpretation of the Personal Data Act, it is not permitted to openly post, e.g. on a company's notice board, data on work performance. It is also not permitted to track in real time employees' work performance, for example for management to follow employees' computer work via a network. Such monitoring is contrary to the basic requirements formulated in the Personal Data Act, 9§. It is not possible to bypass the legislation by obtaining employees' permission to process such personal data.

Read more in "What does the law say?" on the following page

In-depth – Reward systems

Naturally, any reward or punishment systems should be fair and perceived as such by all parties. We cannot describe here, for example, what a fair wage level might be. It is important to understand, however, that reward and punishment systems often have secondary effects on, e.g., health.

Incentive pay (e.g., bonuses) based on, for example, the number of forms processed, errands completed or customers dealt with often results in many employees pushing themselves to earn a bit more money. In the short run, this may seem expedient for

both employee and employer. But if the long-term price is, e.g., chronic headaches, stomach problems or strain injuries of the neck/shoulders, all parties are losers in the end. Thus, employers should pay particular attention to co-workers who perform at very high levels.

This is also true when elements of competition are used in which high performance is rewarded and low performance punished publicly within the company.

On the other hand, receiving rewards for a job well done is also very important. Naturally, a fair reward should primarily mean a fair wage. But other rewards are also important, foremost recognition from management and other important persons, for example one's mentor. Another form of "reward" is when the employer invests in a co-worker by providing, e.g., further education or increased work responsibility. Being proud of and satisfied with one's work and feeling needed are also rewards. Moreover, there may be various fringe benefits, such as free fruit at work, opportunities to exercise during working hours, healthcare and so on.

Any computerized performance monitoring should be undertaken with restrictiveness and care. The individual may perceive such monitoring as an unpleasant and obtrusive form of control. Such monitoring is not permitted to occur without the employee's knowledge (AFS 1998:5 10§). Results should not be made public, but should remain between the employer and the employee in question.

What does the law say?

The Work Environment Authority's Statute Book (AFS) 1998:5 10 §

Work With Display Screen Equipment

Software and systems

10 § No quantitative or qualitative control, through the data system, of the employee's work input may be undertaken without the employee's knowledge.

The use of display screens and computers at work can imply closer qualitative or quantitative surveillance of the employees. This in turn may be experienced as an encroachment on privacy and may augment the mental burden of work if it takes place without the employees' knowledge. It is also incompatible with the requirements of a mentally and socially good working environment for computer technology to be put to such use that particulars concerning an individual employee are used in a manner which entails the infringement of personal privacy.

The Personal Data Act

Fundamental requirements for processing of personal data

9 § The controller of personal data shall ensure that:

- a) personal data is processed only if it is lawful,
- b) personal data is always processed in a correct manner and in accordance with good practice,
- c) personal data is only collected for specific, explicitly stated and justified purposes,
- d) personal data is not processed for any purpose that is incompatible with that for which the information is collected,
- e) the personal data that is processed is adequate and relevant in relation to the purposes of the processing,
- f) no more personal data is processed than is necessary having regard to the purposes of the processing,
- g) the personal data that is processed is correct and, if it is necessary, up to date,
- h) all reasonable measures are taken to correct, block or erase such personal data as is incorrect or incomplete having regard to the purposes of the processing
- i) personal data is not kept for a longer period than that as is necessary having regard to the purpose of the processing.

When processing of personal data is permitted

10 § Personal data may be processed only if the registered person has given his/her consent to the processing or if the processing is necessary in order:

- a) to enable the performance of a contract with the registered person or to enable measures that the registered person has requested to be taken before a contract is entered into,
- b) that the controller of personal data should be able to comply with a legal obligation,
- c) that the vital interests of the registered person should be protected,
- d) that a work task of public interest should be performed,
- e) that the controller of personal data or a third party to whom the personal data is provided should be able to perform a work task in conjunction with the exercise of official authority, or
- f) that a purpose that concerns a legitimate interest of the controller of personal data or of such a third party to whom personal data is provided should be able to be satisfied, if this interest is of greater weight than the interest of the registered person in protection against violation of personal integrity.

Work premises, ventilation and indoor climate

Computer workstations are found not only in conventional offices, but these days also at most workplaces, e.g. healthcare facilities, banks, retail shops, workshops and in the schools. The same requirements should be placed on computer workstation environments, no matter where they are found.

At work premises intended for computer work, there should be sufficient space for workstations and all necessary peripheral equipment (AFS 2000:42 6§). Note that large display screens – the older CRT models require a deep work table, which can be difficult to fit into a small office and still retain general comfort. When planning to

build new or change existing computer workstations, it is appropriate to call in working environment experts, e.g. experts in ergonomics, lighting, ventilation or noise, from, e.g., the company health service.

The costs of correcting mistakes increase the farther one has come in the project. Making changes after the construction is finished is often quite expensive. Today there are advanced computer aids for visualizing a drawing in three dimensions. Such aids allow us to experiment with changes and see the results. It is wise to form working groups to which experienced employees can come with their knowledge and offer their opinions on project proposals.



Computer software can visualize an office plan.

Already during the planning phase, planners should consider how to facilitate cleaning and future maintenance and service (AFS 2000:42 116-117§§). Avoid wall-to-wall carpeting, which is unsuitable with respect to allergies because it collects dust, pollen and the like. Disruptive sounds should be attenuated using other methods and materials, for example partition walls of medium height or sound absorbing material in walls or the ceiling.

Planners should also plan electric wiring so as to minimize low frequency electromagnetic fields, in accordance with the precautionary principle recommended by the Swedish Work Environment Authority and other governmental authorities (ADI 477). Internal link: Electromagnetic fields. Cables should be gathered together and housed, e.g. using special shelves under the table, in order to facilitate cleaning.

Make plans for good light and lighting conditions. Windows need normally to exist to let in daylight and so that employees can see out (AFS 2000:42 11§).

To avoid glare and reflection, windows in work rooms containing computer workstations should be provided with blinds, curtains or a similar adjustable device that can soften bright sunlight (AFS 1998:5 3§).

In addition to causing feelings of being shut in, low ceilings in large rooms more easily give rise to glare from ceiling lights.

Indoor climate and ventilation

A good indoor climate is important for well-being and satisfactory performance. However, different people have different preferences for, e.g., indoor temperature. It is therefore difficult to adjust the appropriate temperature in an open-plan office in which many people work at the same time. Ventilation should be adapted to the number of people, computers and other equipment in the room (AFS 2000:42 18-28§§; 31-33§§). The room can otherwise easily become too warm and dusty and the air quality poor. The ventilation system needs to be checked regularly (AFS 2000:42 29-30§§). The organization's occupational health services can assist with measurements and advice.

Open-plan offices or separate rooms

Open-plan offices and separate rooms have their respective advantages and disadvantages.

Open-plan offices save space and can help to create contact between co-workers. People working on the same project or with the same customers can be grouped in a natural way. Workplaces that are grouped so that co-workers sit turned towards one another, e.g. in a circle or square, are popular and seem to function well. Least popular is sitting in rows.

The disadvantage of open-plan offices is that employees are often disturbed by, e.g., other people's conversations (on the telephone or in person) and visible movement. Moreover, it is more likely that employees will be affected by glare from various lighting fixtures in the visual field or by reflection on their display screens. Such a situation can be strenuous for vision and hearing as well as make work requiring considerable concentration more difficult.

As a rule, each co-worker has a special computer workstation he/she can consider "his/her own territory," whether in an open-plan office or in a room. These workstations can be formed on the basis of individual needs and desires. Sometimes, however, employers choose to have a number of ready workstations so that employees can take an empty station when they arrive at work. Such solutions place very high demands on workstation adjustability, i.e., that tables, chairs, lighting and display screens can be easily adjusted to suit the conditions of each individual co-worker.

A space for taking pauses is needed and should be separated from work premises so that employees are neither disturbed by nor disturb work activities (AFS 2000:42 108-109§§). "Quiet rooms" can provide needed rest for the ears and the brain, especially if work entails sitting, talking and listening for several hours at a time, e.g., at call centres or other customer service companies.

What does the law say?

The Work Environment Authority's Statute Book (AFS)

Design of the workplace AFS 2000:42.

6 § Workplaces, work premises and personnel rooms including ancillary spaces shall have sufficient area and headroom as well as be appropriately situated, designed and furnished with respect to the activity in question.

11 § At permanent workplaces and at work premises and in personnel rooms intended for more than temporary stays, there shall normally exist satisfactory daylight and opportunities for external views.

18 § Work premises and personnel rooms shall be arranged in a manner, and have a ventilation system for air exchange and filtration of air pollution, that generates an air quality that is satisfactory in the occupied zone at the premises. At premises where air pollution arises due primarily to the exhaled air of personnel, the carbon dioxide value may be used as an indicator of whether air quality is satisfactory. At such premises, attempts shall be made to attain a carbon dioxide value under 1000 PPM.

108 § Employees shall be able to spend work pauses in an appropriate space. If necessary, a special space for taking pauses shall be arranged.

109 § At the workplace, there shall exist or be easily arranged an appropriate space for temporary rest in the event of, e.g., nausea or headache. At larger workplaces, the rest space shall generally be found in a special room for resting.

What does the law say?

The Work Environment Authority's Statute Book (AFS)

Work with display screen equipment AFS 1998:5

3 § A display screen workstation shall be so designed that disturbing glare and reflections do not occur from the surrounding environment. This shall be achieved by co-ordinating workplace and workstation layout with the positioning and technical characteristics of the artificial light sources. Windows shall be fitted with a suitable system of adjustable covering to attenuate the daylight that falls on the workstation. The keyboard shall have a matt surface to avoid reflective glare. Desking surfaces shall have low-reflection surfaces where necessary for the avoidance of disturbing reflections. Visual and lighting conditions must not give rise to unsuitable work postures.

4 § The workstation shall be dimensioned, designed and equipped so that the operator can find comfortable work postures and vary work postures and working movements.

In-depth – Computer work in open-plan offices

Research on the advantages and disadvantages of open-plan offices has primarily concerned sound disturbance. Sound need not be high in volume to be disturbing. It is a well-known phenomenon that human face-to-face conversation or telephone conversation is particularly disturbing, even if voices are kept low [Kjellberg, Landström, 1994-I+II; Kjellberg, 1990]. This is probably because human speech is of great social value to humans. Thus, our attention is involuntarily drawn to other people's conversations. Disturbance is greatest during work that requires considerable concentration. Disturbances increase with increased personnel density in the premises [Oldham, 1988]. It has proven to be difficult to completely eliminate disturbing sounds using screens and similar devices.

The increased risk for glare from lighting fixtures in open-plan offices is due partly to the fact that there are significantly more lighting fixtures in a large room than in a small one. But it is also due to the fact that lighting fixtures in a separate office are usually placed directly above the computer user, thus outside his/her field of vision. In an open-plan office, lighting fixtures that are farther away in the room will be within the computer user's field of vision when his/her gaze is directed towards the display screen. Moreover, the large number of light sources in an open-plan office increases the risk that one or more of them will be reflected on the display screen.

Read more about glare in chapter Disturbing glare and reflection.

In an open-plan office, there are often many people coming and going from their workstations or other events involving movement. Our eyes are constructed so that our sharpest vision is straight forward in the direction of gaze. Outside the direction of gaze, e.g. to the sides, our visual acuity is poor. However, we clearly notice movement that occurs at the sides of our visual field (in the periphery). Our gaze is drawn purely instinctively to sudden movement in the periphery of our field of vision, for example a person entering through a door farther away in the room. Such an instinct was of great importance to our forefathers when they lived in areas where wild animals lurked in the bushes. Those who failed to react quickly to movement in the periphery often fell prey to predatory animals. Today, such reflexes are good to have while driving. But in an open-plan office, employees' concentration is often broken by movement in the premises.

In a common work room, it is more difficult to identify a lighting level and indoor climate that suits everyone. In separate offices, the sound, lighting and indoor climate can be better adjusted to the person working in a given space. Moreover, people have different needs with regard to privacy and having their "own territory" where they can form their own, individual workstation [O'Neill, Carayon, 1993]. Forcing

people with such needs to share an office space with others can result in stress and reduced well-being.

Increased levels of stress hormones have been found among people who work in open-plan offices [Evans, Johnson, 2000]. It has also been shown that disturbing sound reduces people's tendency to change their working posture. Employees sit for longer periods in fixed postures, which can constitute a risk for emergence of musculoskeletal complaints.

People probably differ in the degree to which they appreciate or are disturbed and stressed by working in an open-plan office.

In-depth – Ventilation and indoor climate

Work in office environments is often quite sedentary, which means that the room temperature needs to be somewhat higher than in the case of physically active work. A temperature of 20-22 °C is commonly specified as suitable for most office work.

To avoid the emergence of disturbing air draughts, air velocity should be kept under 0.15 m/s. Large cold or warm surfaces, e.g. large or poorly insulated glass facades/windows, can easily give rise to the feeling that it is too cold in the winter months (downdraught) and too warm in the summer months, even if the room temperature is maintained at 20-22 °C.

Another problem is air humidity, which is usually measured as percent relative humidity (% RH). Zero % RH, i.e. completely dry air, never occurs, and at 100% RH things are dripping with moisture. During the winter months in the Nordic countries indoor air is usually rather dry (15-25% RH), because the cold, dry outdoor air is taken in and warmed. Common levels in home environments and offices are 20-40% RH. Lower levels can be perceived as "dry and dusty" air and much higher levels as "sticky" air. Dusty and poorly cleaned premises can more easily give rise to a feeling that the air is too dry.

If the air is perceived as unpleasantly dry, an air humidifier should not be installed as a first measure, because such equipment can easily spread bacteria and other microorganisms. Instead, to the extent possible, efforts should be made to keep the office free from dust (good cleaning routines) and the temperature as low as possible (e.g., 20 °C), draught-free and without downdraughts. Wearing appropriate clothing suitable to each individual (e.g., an extra sweater) allows reduction of indoor temperature.

Various measurements can be made of the indoor climate. In addition to measuring air temperature, we can even measure "radiation temperature," which reveals whether there are large cold or warm surfaces that may be experienced as

unpleasant. Air velocity (draught) and humidity (% RH) can also be measured. Using these data, we can calculate the proportion of people (wearing normal clothing) who will be dissatisfied with the indoor climate (PPD value = predicted percent dissatisfied). There is no indoor climate that everyone sees as "just right" and comfortable. What some feel is just fine, others will feel is too cold and vice versa. Some people seem to be more sensitive than others to draughts or air humidity. We should try to attain a PPD value that is maximally 10%, that is, a situation in which at most 10% are dissatisfied with the indoor climate (AFS 2000:42 page 59).

The effectiveness of ventilation equipment can be measured directly as the airflow in and out of the premises. Another method is to measure the carbon dioxide value. In outdoor air, the carbon dioxide value is normally about 300-400 PPM (PPM=parts per million). The carbon dioxide value in office spaces is higher due to the exhaled air of the people working there. Values less than 1000 PPM should be aimed for (AFS 2000:42 18§). To achieve maximum contentment, values less than 700-800 PPM should be aimed for [Seppänen et al., 1999; Bourbeau et al., 1997].

Research has shown that under-dimensioned or poorly maintained ventilation equipment and poor cleaning routines can lead to various problems with the mucous membranes of the eyes and respiratory tract as well as other kinds of discomfort [Wargocki et al., 2002; Skulberg et al., 2004]. There are also reports showing that working in draughts can cause musculoskeletal problems [Hildebrandt et al., 2002].

The property owner is responsible for the maintenance and quality of ventilation equipment. Employers can even ask for help from their company health service if they suspect problems with the ventilation or indoor climate.

Office environment acoustics

Sound levels that could damage hearing are seldom found in offices or at computer workstations. The sound level in normal office spaces is often around 40-60 dBA (see end of In-depth about dBA). However, such sound levels can be stressful and may interfere with your ability to concentrate. Sound levels in offices can even disrupt spoken communication, e.g. telephone conversations with customers.

Sources of noise (undesired sound) in modern computerized offices commonly include ventilation systems, computer fans, various signals from computers and talk, e.g. on the telephone.

In certain contexts, for example open-plan offices containing, e.g., customer service centres (call centres) in which many people are talking (on the telephone), the human voice may be the main sound source. Sound levels in such contexts can reach 50-70 dBA. Acoustics and conditions for communication need to be good, especially if you are communicating with, e.g., customers over the telephone. If computer users are sitting in cubicles, the cubicles should be screened off from one another to avoid disturbance.

If your work entails a great amount of telephone contact, a headset is necessary to free your hands from the telephone receiver. Holding the receiver in your hand or pressed against your shoulder often leads to neck, upper back and shoulder problems. The telephone system needs to be of such quality that the user's hearing is not endangered by sudden loud sounds. Headsets are usually not designed to block out disturbing environmental sounds.

According to the Swedish Work Environment Authority's ordinance on noise, work needs to be planned, carried out and followed up to ensure that noise is reduced by eliminating the noise source or by attenuating it to the lowest possible level. Your occupational health services can assist with measurements and advice.

In-depth

– Disturbing sound levels

The problem with sound levels in offices is that, even if they are relatively low, they may be disturbing and can reduce performance if your work requires high levels of concentration [Kjellberg, 1990; Kjellberg, 1994 I; II]. Concentration difficulties arise at sound levels above 45 dBA, depending on the type of work being done. At sound levels exceeding 55 dBA, problems understanding other people's speech also arise. People with a hearing impairment have particular problems understanding speech in noisy environments. Reduced hearing acuity is quite common, and is found among 5-20% of the working population, depending on age. Where there is noise, immigrants and others have extra difficulties to understand when listening to a non-native language. Ten percent of all inhabitants in Sweden have parents who are born in another country than Sweden.

It has been shown that long-term exposure to high noise levels (>75 dBA) can lead to increased blood pressure and increased levels of stress hormones. Recent research has stressed the health consequences associated with long-term exposure to low-intensity (<75 dBA) noise. This research describes an increased risk for development of high blood pressure and, with that, cardiovascular diseases. The cases studied have dealt mostly with traffic noise, aircraft noise and the like.

More uncertain, however, is whether similar health problems can also arise as a consequence of, e.g., long-term exposure to office noise. Low frequency noise, of the type commonly coming from ventilation systems, can interfere with concentration and has been shown to result in reduced performance and secretion of stress hormones, even when noise levels are not very high (40-50 dBA) [Bengtsson, 2003].

There are even individual reports stating that low-intensity noise can lead to aches and pain, e.g. headache or neck/shoulder pain, likely as a consequence of muscle

tension. Other problems that may conceivably arise in noisy office environments concern employees becoming more stressed and exhausted.

Research has also shown that stress reactions, increased blood pressure and other signs of ill health associated with noise exposure are more severe in cases of complicated work tasks or simultaneous psychosocial stress [Melamed et al., 2002; Yitzhak et al., 2002; Leather et al., 2002].

Sound level

Sound levels (e.g., noise levels) are usually measured using the decibel unit, abbreviated dB. The decibel indicates how much the sound level exceeds the level of the quietest sound that can be heard by a normal ear in an absolutely quiet environment (0 dB).

The dB scale is logarithmic. If we add together two equally intense noise sources, the combined level increases by 3 dB, e.g. from 40+40 to 43 dB, which is a barely audible increase. An increase needs to be about 5 dB to be clearly audible. A given sound needs to be increased by about 10 dB in order to sound twice as loud. These dB changes apply across the entire scale, whether we begin with a sound at 30 dB or one at 70 dB.

The human ear does not hear all frequencies equally well. We are best at hearing frequencies that fall within the range of human speech (1000-5000 Hertz=cycles per second). We have more difficulty hearing low and very high frequency sounds. For this reason, instruments for measuring noise level have been designed to mirror the frequency sensitivity of the human ear. This is referred to as "weighting" the measurement. One weighted measurement that is often used is called the "A scale." Use of this scale is indicated by dBA.

We normally perceive as "silence," e.g. in the bedroom, a sound level around 20-30 dBA. Human speech at a distance of one metre is about 60 dBA. Sound levels in larger office spaces are usually around 50-70 dBA and in workshops or factories around 80-90 dBA. Extremely high sound intensities (exceeding 120 dBA) are heard at, e.g., rock concerts. Sound levels at 140 dBA cause pain. Prolonged exposure to sound levels at 80-85 dBA or more entail a risk of development of hearing impairment.

What does the law say?

The Swedish Work Environment Authority Ordinances on noise – Buller AFS 2005:16 – are only available in Swedish. However, these are harmonized with the European directive 2003/10/EG.

Lighting and visual conditions

Visual conditions and lighting are important because computer work places great demands on our vision. Almost all information is presented on the display screen. The small cursor on the screen needs to be moved with great precision using the keyboard or control device (mouse), which places great demands on hand-eye coordination.

Work premises that are used regularly need to have windows to let in daylight and to allow employees to see out (AFS 2000:42 11§). In the case of work with a display screen, windows need to be provided with blinds or curtains that can screen out intense daylight (AFS 1998:5 3§).



The display screen provides relatively dim light. Therefore, you should avoid having other intense light sources in your field of vision. Do not place your display screen in front of or beside a window. Appropriate placement of your display screen is at a right angle to or angled obliquely away from the window wall (see Figure).

Appropriate placement of the computer screen in relation to windows as well as good main and local lighting. Note the ceiling fixture, that emits both direct and indirect light, situated just above the person at the screen.

Main lighting (usually ceiling fixtures) may not dazzle or result in reflections on the display screen. Appropriate placement is just above, in front of or to the side of the person working at the display screen. Thus, if the work table is moved, ceiling fixtures should also be moved. Having adjustable track lighting on the ceiling makes it easier to move light sources.

There are ceiling fixtures available that illuminate both upward towards the ceiling (so called indirect lighting) and downward towards the workstation. Such lighting provides more even illumination throughout the room without creating sharp shadows or contrasts, and thus its placement is not as crucial.

Main lighting can be supplemented with a work lamp (local lighting) that can be directed towards documents or books when you need extra light for reading. Thus, a work lamp should be adjustable and may not dazzle (AFS 1998:5 3§).

Make sure as well that there are no reflections from the window or lighting (your own or other people's) on your display screen.

Lighting may not produce disturbing flicker (AFS 2000:42 16§). Flicker can be eliminated in fluorescent lamps by the use of high-frequency electronic ballasts.

Read more about flicker in chapter Electric and magnetic fields in office environments.

Eyesight tests

Everyone who works regularly at a display screen for at least one hour a day should have an eyesight test at regular intervals and in the event of problems possibly associated with visual conditions (AFS 1998:5 6§). In addition to eye discomfort and vision problems, you should also have your eyesight tested if you have headaches or neck/shoulder complaints. The law does not specify how often eyesight tests should be conducted if the employee has no complaints. It has become the practice, however, to conduct such tests every 2-5 years. The longer intervals should be applied to those below 40-45 years of age, the shorter intervals to those over 45.

The employer needs to cover the costs of such eyesight tests. If special glasses are needed for work, these costs also need to be covered by the employer.

What does the law say?

The Work Environment Authority's Statute Book
(AFS) 1998:5

Lighting and visual conditions

3 § Room lighting shall ensure satisfactory lighting conditions in the room and an appropriate contrast between the screen and the background environment, taking into account the operator's capacity, the vision requirements of the display screen work and the type of work. Room lighting must not impede the reading of the display screen. Task lighting shall be provided if needed. It shall be adjustable and must not dazzle.

A display screen workstation shall be so designed that disturbing glare and reflections do not occur from the surrounding environment. This shall be achieved by co-ordinating workplace and workstation layout with the positioning and technical characteristics of the artificial light sources. Windows shall be fitted with a suitable system of adjustable covering to attenuate the daylight that falls on the workstation. The keyboard shall have a matt surface to avoid reflective glare.

Visual and lighting conditions must not give rise to unsuitable work postures.

Eyesight test and special glasses for display screen work

6 § The employer shall see to it that an employee normally having to work with a display screen for more than one hour during the working day undergoes an eye and eyesight test. This test shall be carried out by a person with the necessary capabilities.

If an eye and eyesight test of this kind has recently been carried out through arrangement by another employer, a new test shall be carried out only if the present display screen work entails new or different vision requirements or if the employee's vision status has changed since the last test.

An eye and eyesight test shall subsequently be provided at regular intervals and whenever the employee reports discomforts which may be connected with the visual demands of the work.

If the results of an eye and eyesight test shows supplementary examination by an ophthalmologist to be necessary in view of the visual requirements of the display screen work, examination of this kind shall be arranged by the employer. If an eye and eyesight test shows that it is necessary and normal corrective appliances cannot be used, the employer shall provide the employee with special corrective appliances tested for the display screen work concerned.

Measures needing to be taken by virtue of this Section must not involve employees in additional financial cost.

Read more

Adjusting furniture and computer equipment to achieve sound working postures

Workplace Design

AFS 2000:42

The Work Environment Authority's Statute Book (AFS)

Work With Display Screen Equipment 1998:5

The Work Environment Authority's Statute Book (AFS)

In-depth – Lighting conditions and computer work

There has been a relatively limited amount of research on lighting conditions for computer work. Much of the current knowledge comes from earlier studies of office environments in which typewriters were used, or of other work tasks that place great demands on vision. In these circumstances, relatively intense lighting was needed to illuminate text on paper or the object being manipulated with the hands. Normal illumination levels on the surface of the workbench were 500-1000 lux. The goal was that illumination be most intense on the workbench and gradually decrease towards the periphery.

There is no broad consensus as to the appropriate illumination level for display screen work. The illumination level should be somewhat lower for display screen work than for paperwork, particularly if you are working with a dim screen. The levels often mentioned are 300-500 lux [North, 1993; Hodgson, Yarham, 1996]. Because the amount of illumination needed varies between individuals, calculations have shown that there is no level that suits more than about half of employees at a time, if the group is rather large and comprises people of different ages [Newsham, Veitch, 2001]. Thus, older people often need much higher illumination levels to see well than do younger people. On the other hand, older people are also more easily dazzled by intense light sources.

Light intensity

Light intensity is usually measured using the lux unit. As a reference, consider that 1 lux is approximately the illumination level found in moonlight and 100,000 lux is the level found in full sunlight. Simple instruments for measuring light intensity are available. Your occupational health services should be able to assist with such measurements.

Read more

North R. Work and the eye. 2 nd ed. Oxford: Butterworth & Heineman; 1993.

Hodgson S, Yarham R. The visual environment for display screen use. London: CIBSE; 1996.

Newsham G, Veitch J. Lighting quality recommendations for VDT offices: a new method of derivation. Lighting Res Technol 2001;33(2):97-116.

Electric and magnetic fields in office environments

With the increased use of electric and electronic equipment in our offices our daily exposure to electromagnetic fields has become more and more complex. Today, focus has shifted from monitors as the dominating source of electromagnetic fields to other electronic equipment or nearby sub-stations and power lines. Strong electric and magnetic fields are known to have immediate negative effects on people. We also have EU directives with recommended limit values to avoid acute effects. However, the risk of being exposed at such levels in an office environment is largely non-existent. On the other hand, we know very little about the effect of long-term exposure to weak fields. This uncertainty has led to the application of a precautionary principle to magnetic field exposure by the Swedish and some international authorities. This principle needs to be kept in mind when constructing new office facilities in order to create good electrical environments.



During the last decade the VDT workplaces have considerably improved. Flat screens are more often used resulting in better ergonomics as well as low emission properties.

Electromagnetic fields in the radiofrequency range are now being used for wireless communication both between people and between devices. To a certain degree, they all add to the complicated issue of the extensive fields frequency found in the office.

How can we create a good electric environment with the knowledge we have today? The following sections explain what electromagnetic fields are, how they originate and what regulations and recommendations currently exist. We also give advice on how to reduce the fields and show how monitors can be affected by magnetic fields and indirectly become workplace problems.

Text and English translation: Monica Sandström

How are low frequency fields generated?

We are surrounded by electric and magnetic fields created by nature as well as fields created by ourselves. An example of a natural field is the geomagnetic field of the earth.

Alternating electric and magnetic fields occur due to our use of electric current and different communication systems. The fields have different qualities depending on how fast they change direction, namely, the frequency of the field. The current in our main has a frequency of 50 Hertz (50 cycles/second), which then becomes the dominant frequency for the electric and magnetic fields found in our offices. This frequency range is called the power frequency range. Magnetic fields are measured in Teslas (T) or commonly in the subunit microtesla (μT), which is one millionth of a Tesla. Electric field strength is measured in Volt/metre (V/m).

When you push a plug into an outlet, an electric field is created around the device. The higher the voltage is, the stronger the field that is created. Since the voltage can be present also when no current is flowing, the device doesn't need to be switched on for an electric field to exist.

Magnetic fields occur only when there is current flowing through the conductor. The higher the current strength, the stronger the magnetic field.

Electric and magnetic fields of slightly higher frequencies (kilohertz range) occur in some lighting and around monitors.

Magnetic fields

Outdoor sources

Strong external sources can contribute to increased magnetic field levels inside buildings. Power lines close to an office building as well as nearby railroads when the power supply is on, namely, when a train passes, can contribute to heightened magnetic field levels in the office.



Buildings that are too close to power lines can have increased magnetic field levels.

Fixed installations

Factors that most often lead to increased magnetic field levels in offices are proximity to in-house substations and distribution boxes, cabling, and most of all stray current. The latter is current that flows through metal structures in buildings instead of the cables that it should be flowing through. Examples of such structures are metal water pipes, district heating systems, and metal sheathing. These

currents can cause considerable magnetic field levels in offices and homes.

Low voltage transformers emit a locally strong magnetic field, but since it decreases rapidly with distance it does not contribute much to the general magnetic field level in the room.

Point sources

Electric and electronic equipment in an office also generates magnetic fields of varying degrees. The largest local sources are the transformers that have become increasingly common in equipment such as desk lamps. These give off a locally strong magnetic field, but since the field strength is greatly reduced with distance, their contribution to the general magnetic field levels in the room is low.



Monitors are considered to be point sources for magnetic fields where the size of the field depends on which monitor technology is used to create the image. read more in chapter Monitors.

What magnetic field levels are found in offices?

Magnetic field levels in office environments vary greatly depending on the localisation of the office. In general, the average value in an office varies between 0.01 and 0.2 μT if the office is not located near a power line or another external source. Values up to several μT can be observed in facilities where stray current is present. If the office is located right above an in-door substation, magnetic field levels up to 30 μT can occur.

How can we reduce magnetic fields?

Computer users

- Turn off equipment you don't use.
- Make sure that transformers and chargers are not in your immediate vicinity. These can be surrounded by a magnetic field even when the equipment is turned off, depending on the localisation of the switch. If the current is interrupted between the plug and the transformer, the field disappears when the equipment is turned off, but if the switch is located after the transformer, the field remains.

- Make sure the power to motorized adjustable desks is switched off when the motor is not in use.

Buyers of office equipment

- Computer equipment and monitors should comply with TCO requirements, read more about TCO-labelling on TCO Development's website.
- When purchasing motorized adjustable desks, make sure that the power can be switched off when the motor is not in use.

Building owners

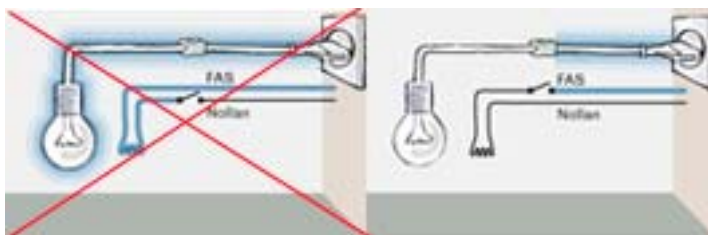
Elevated magnetic fields due to stray current in the building can be dealt with by changing the electricity distribution system in the building from a 4-wire to a 5-wire system. This is a costly measure that is justified only in certain cases. A simpler measure, that is increasingly being used, is the installation of several booster transformers on incoming power lines. But for new constructions, it is more suitable to install a 5-wire system.

Offices that are placed on the roof of an internal sub-station have elevated magnetic fields; permanent workrooms should not be placed there. If the area above a sub-station has to be used as office space, technology for encasing the sub-station is available.

Electric fields

Outdoor sources

Office buildings shield electric fields from nearby power lines and railroads effectively, so these sources very rarely increase the electric fields inside the office.



The electric field around an ungrounded lamp depends on if the switcher is located on the phase or neutral connector. If the switcher is located on the neutral the electric field can be even higher if the lamp is switch off.

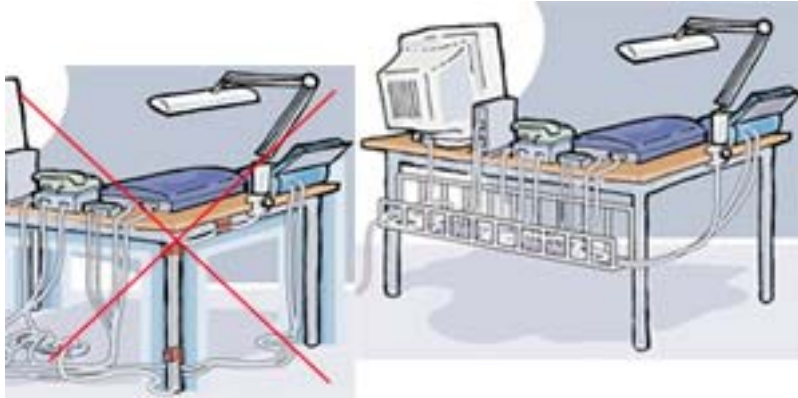
Fixed installations

Cabling in the building contributes to the electric field in the office. Elevated levels can also be registered near electrical outlets and switches.

Point sources

The main source of electric fields in offices is equipment that is not grounded. An example of this is desk lamps with "European" plugs. These are symmetrical plugs

with no ground connection. The way it is plugged into the wall outlet can result in the electric field being even greater when the light is switched off.



When an ungrounded cable lies close to the metal legs of a desk, the electric field will be spread through the metal structure and generate electric field around the desk.

Electric fields may also spread in a building by capacitive coupling. One example of this is when an ungrounded cable lies close to the metal legs of a desk. The electric field will then spread through the metal structure and generate a strong field around the desk.

A monitor that is not grounded can also result in a powerful electric field. Read more in chapter Monitors.

How can we reduce electric fields?

Computer users

- Make sure all equipment is grounded.
- Make sure that unshielded cables do not lie close to the metal legs of the desk.

Buyers of office equipment

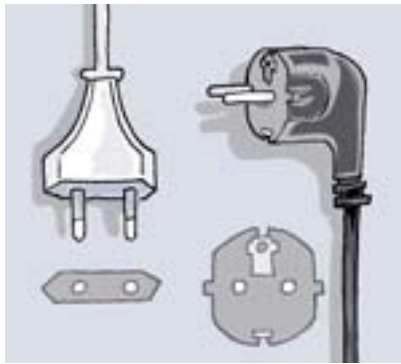
- Computer equipment and monitors should comply with TCO requirements.
- Only purchase equipment with ground connections.

- Purchase shielded ducts for cable runs.

Building owners

If there is a need for very low background electric field in an office the following steps might be of interest:

- Use shielded cable for electrical wiring in the building.
- Shield electrical boxes and switches.



To reduce the electric field all equipment should be grounded. To the right there is a plug with a ground connection and to the left an ungrounded so called "European plug" is shown.

What regulations are in place?

Limit values

There are currently no Swedish limit values for electric and magnetic fields in the frequency range used by ordinary electrical equipment. However, there is a recent EU directive that covers all frequency ranges. The Swedish Work Environment Authority is adapting this directive to Swedish limit values, which should be ready before year 2008. The directives are based on acute effects – the fields should not induce too much current in our bodies. The EU directive will essentially affect only certain highly exposed groups in the industry, such as welders. Electric and magnetic fields in the office environments are normally far below the recommended limit values in the directive.

The Swedish Radiation Protection Authority (SSI) has formulated recommendations for public exposure to electric and magnetic fields. These are based on an EU recommendation on public exposure and include electric and magnetic fields around common electrical equipment. The recommended limit values lie substantially above the levels we normally see in an office environment.

Precautionary principle

In 1996, several government agencies in Sweden, including the National Board of Health and Welfare, the Swedish Work Environment Authority, and the Swedish Radiation Protection Authority, formulated guidance for decision-makers on issues dealing with low-frequency electric and magnetic fields and their possible health risks. The guidance is based on published scientific results, and they highlight the technical and economic aspects of the measures that can be taken using limited community resources. As opposed to the limit value discussion on acute effects, this guidance deals with long-term exposure to medium-strength magnetic fields – field levels that can be found in office environments. The authorities recommend a precautionary principle which is chiefly based on the fact that a slightly increased cancer risk cannot be ruled out.

The following text can be read in the guidance for decision-makers:

If steps that generally reduce exposure can be taken at a reasonable cost and consistently, you should attempt to reduce fields that deviate strongly from what is considered to be normal in the environment concerned. For new electrical installations and buildings, you should attempt to design and locate them at the planning stages so that exposure is limited.

For example, in new office buildings make sure that permanent workspace are not placed directly above substations.

Read more

EU directive that covers all frequency ranges

http://www.europa.eu.int/eur-lex/sv/refdoc/L_159/L_2004159SV_1.pdf

The Swedish Radiation Protection Authority (SSI)

http://www.ssi.se/forfattning/pdf/2002_3.pdf

The Swedish Work Environment Authority:

Low-frequency electrical and magnetic fields - the precautionary principle for national authorities - guidance for decision-makers.

http://www.av.se/dokument/publikationer/adi/adi_478.pdf

Electric and magnetic fields in office environments

In-depth – Monitors

The most common used technologies to produce an image on the screen are the cathode ray tube (CRT) and liquid crystal diode (LCD) techniques. The degree of electric and magnetic fields around monitors depends on the technology used but most monitors now meet the requirements for reduced fields, so they can hardly be said to contribute to our daily exposure to electric and magnetic fields in the office. However, it is important to remember that the monitor needs to be grounded for this electric field reduction in modern monitors to have any effect.

Screen image quality

In-depth

– How to measure the electromagnetic fields around a monitor?

There are two standard methods for measuring monitor fields:

The Swedish standard Computers and office machines - Measuring methods for electric and magnetic near fields (SS 4361490) and TCO'03 Displays, which is a fourth-generation quality and environmental labelling standard from TCO Development. The TCO standard includes monitors of both the cathode ray tube and liquid crystal technology types. Both refer to measurements made in a highly controlled laboratory setting.

The Swedish standard reports on measurements of monitors in office environments, but points out the difficulties with such measurements.

TCO labelling, which is used around the world, involves not only the measurement of the electric and magnetic fields found around monitors, it also includes many other criteria in the areas of ergonomics, energy, and ecology. Read more about TCO labelling on their website: www.tcodevelopment.se



What recommendations are available?

In the Swedish Work Environment Authority's directive regulating work with monitors, the following is found in Section 9: "Emissions from the display screen and its related equipment, such as noise, heat, chemical substances and electric and magnetic fields, must not disturb the operator or cause the operator discomfort or displeasure that constitutes a risk to his/her safety and health" (AFS 1998:5, www.av.se/regler). The text is written in general terms and does not state any levels for the different fields that surround monitors. TCO has recommended values for all fields around monitors.

Maximum levels for the various fields around monitors to fulfil TCO'03 requirements

Field type	Level	Comments
Electrostatic field	± 500 V	
Alternating field 5 Hz-2kHz		
Magnetic field		0,2 μ T
front of the monitor		50 cm on all sides and 30 cm in front of the monitor
Electric field	10 V/m	30 cm directly in front of the monitor
Alternating field 2-400 kHz		
Magnetic field		0,025 μ T
Electric field	1 V/m	50 cm on all sides of the monitor
monitor		50 cm on all sides and 30 cm in front of the monitor

Read more

TCO

<http://www.tcodevelopment.se>

The Swedish Work Environment Act

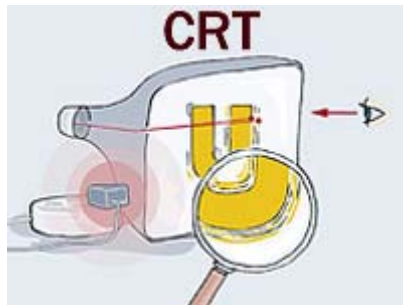
<http://www.av.se/inenglish/lawandjustice/>

Picture interference

A poor screen image can be caused by poor technical quality, by settings such as brightness, contrast and colour, but also by external factors such as an incorrect placement of the monitor in the room or too high magnetic fields in the room. The Swedish Work Environment Authority explains this in the AFS 1998:5 directive: "The image on the screen shall be free from disturbing flicker and other forms of instability." There are two types of interference on the screen that are covered by this text and that should be dealt with if they are disturbing: jitter and flicker.

Jitter

A shaky picture on a CRT screen (jitter) can be caused by a magnetic field in the room. This means that the picture has an extra movement that can be very disturbing to the monitor user.



External magnetic field (in this case illustrated by a low voltage transformer near the monitor) can cause jitter on a CRT screen.

The jitter can occur with different movement patterns depending on the monitor's video frequency and the interference source. Studies have shown that magnetic fields of $0.5 \mu\text{T}$ in a room can cause a visible disturbance on the screen. The interference field can be caused by magnetic fields from electrical appliances that are too close to the monitor, but it can also be caused by external and internal sources, such as power lines, stray current at the location, or substations in the building. LCD monitors are not affected by external magnetic fields.

How can jitter be avoided?

- Avoid placing electrical equipment that generates magnetic fields, such as power supplies, too close to the monitor.
- Try to reduce strong magnetic field levels in the office. See the section "How can we reduce magnetic fields?"
- Switch to an LCD monitor.

Flicker

Our experience of modulated light is called flicker and can be visual, i.e. we can see it, or non-visual. In the latter case our brain records the flicker but we can not see it with our eyes. Each pixel on the screen of a CRT-based monitor has 100% light modulation with the same frequency as the refresh rate, normally 60-100 Hz. The pixel is light or dark 60-100 times per second. The perception of flicker differs between people. A light screen with a refresh rate of 60 Hz mostly experienced as a flickering screen, but if the refresh rate increases to 80 Hz most people experience the screen as flicker-free. Fluorescent tubes are another example of flickering light sources in our offices.

To increase the refresh rate is one possibility to avoid flicker, which is especially important when you work with a large screen. How annoying we experience flicker varies between people. Some people are very sensitive to flicker.

An LCD-screen is in principle free from flicker and can be a good alternative for flicker-sensitive people.

How can flicker be avoided?

- The refresh rate on the CRT-based screen needs to be as high as possible. The Swedish Work Environment Authority recommends a refresh rate above 70 Hz, while TCO'03 states 85 Hz.
- Switch to an LCD-screen.

Read more

Does your monitor have any imaging problems?

TCO

<http://www.tcodevelopment.com>

Work With Display Screen Equipment 1998:5 6§

The Work Environment Authority's Statute Book (AFS)

What is wireless communication?

Over the past decade, wireless systems have literally invaded the offices. Today we work with wireless computer mice and keyboards, computers use wireless communication, and phones are wireless. All this signal transfer is done with the help of radio waves, which are electromagnetic waves in the megahertz range (millions of cycles/second). Transmission occurs at different power output depending on how far the signal needs to travel.

DECT

The wireless telephony systems that are used in offices are called DECT, an abbreviation of Digital Enhanced Cordless Telephony. Information is sent and received in time intervals. The telephone transmits only when a call is connected and is otherwise completely passive. DECT phones transmit during the entire call, while ordinary mobil phones (GSM) mostly transmit only when you speak and not when you are listening. GSM phones can also adjust to lower power outputs if you are near a base station, which DECT phones cannot.

Bluetooth

This technology is used for fast data transfer over short distances (a few metres). It is often used for communication between computers and their peripherals (mouse,

keyboard, printer) and between mobile phones and their peripherals (wireless hands-free devices).

WLAN

A WLAN system (Wireless Local Area Network) is a locally built wireless network. The installation of WLANs is becoming increasingly common in offices, schools and universities. These networks allow wireless communication between computers via a server, but you also have contact with the Internet.

Furniture for computer work

There are many brands and designs of office chairs and tables on the market that are suitable for computer work. New models are constantly being developed, which makes it difficult to get an overview. There is no objective, comprehensive testing being conducted from a work environment perspective on furniture or computer equipment. TCO Development has elaborated a certification system for certain types of computer tables and chairs. Your occupational health services can also give you advice on the choice of computer furniture.

Read more on TCO Development's web site.

The work chair

The chair you work in needs to swivel and have a base with at least 5 legs and castors. Fewer legs on the base imply a risk of tipping over in the chair. It needs to be easy to adjust your chair vertically and you need to be able to tilt the backrest (AFS 1998:5 5§). The backrest should be high enough to support your upper back and preferably your neck as well, but not so wide as to prevent backward movement of your elbows. Any armrests should be designed so that they don't prevent you from sitting close to the edge of the table while working. Armrests should be vertically and laterally adjustable to suit your body size. Your chair should preferably have a rocking feature that allows you to rock back and forth. Rocking provides variation in working posture, which reduces the strain on your neck, back and buttocks. If you are to sit comfortably in a reclining position, a neckrest is quite important.

A good chair can provide comfortable support for your body and allow variation while you are sitting still.

The upholstery fabric needs to be coarse so that you don't slide. It also needs to "breathe" so that no moisture accumulates between you and your chair.



Ideally, each employee should be able to test a number of chairs, choosing the one that is most suitable. You may need to try sitting in your chair for a couple days before forming an opinion.

Read more about adjusting your chair in the chapter [Adjusting your chair and table](#).

The work table

It needs to be easy to adjust your work table vertically to suit your body size (AFS 1998:5 4 §). Vertical table adjustment has traditionally been accomplished by changing the height of every table leg separately. It is difficult to adjust such tables and, therefore, they should only be used for workstations dedicated to one person. Modern computer tables are now available that can be raised and lowered using, e.g., an electric motor. It is easy to adjust such tables vertically, making them particularly appropriate for workstations that are shared by several employees. They also allow you to alternate easily between working in a sitting and standing posture. Thus, there is a double advantage associated with motorized, vertically adjustable tables: They allow quick adjustment of table height to suit the user's height and quick alternation between a sitting and standing posture. To avoid making fine adjustments in table height after each change from, e.g., a sitting to a standing working posture, there are programmable motors available that adjust to heights previously determined to be optimal.

Your table should also allow adequate room for your legs and feet, so you can stretch them out and vary your working posture. Make sure no table legs, pedestals or other objects are in the way. The tabletop should not be thicker than 3 cm, so that your knees and legs fit easily under the table. The front of the table should not have a wide skirt or sharp edges.

The table size needs to be sufficient to accommodate the necessary equipment and allow you to rest your forearms and hands while working with the keyboard and mouse (AFS 1998:5 4 §). The depth of the table should be at least 80-100 cm, depending on the depth of your display screen. A 19" CRT screen is usually so large it requires a table depth of 100-120 cm. Thus, it is advisable to place CRT screens on a corner table. A flat screen can be placed on a table that is 70-80 cm deep. It is preferable that the front edge of the table be curved inward to provide support surfaces on both sides.

The table surface should be medium-light in colour and have a matt finish (to avoid reflections). It is generally preferable to have a completely smooth tabletop without, e.g., a pull-out keyboard tray. A large display screen may need to be placed on a vertically adjustable section at the back of the table so that the user does not have to look up to see the screen.

Modern computer tables are often very heavy. It is easier to move a table if it is equipped with wheels, for example on one side. Tables should also be equipped with fittings that allow cables to be gathered together and housed, so that they do not lie

on the floor and make cleaning difficult. The table base should be earthed to the mains earth. This prevents it from acquiring a static electric charge.

Read more about adjusting your table in the chapter Adjusting furniture and computer equipment to achieve sound working postures and Electric and magnetic fields in office environments.



A good computer table is vertically adjustable and provides sufficient room for computer equipment as well as for forearm and hand support.

What does the law say?

Statute Book of the Swedish National Board of Occupational Safety and Health 1998:5 "Work With Display Screen Equipment "

4 § The workstation shall be dimensioned, designed and equipped so that the operator can find comfortable work postures and vary work postures and working movements. The work desk and work surface shall be large enough to allow a flexible arrangement of the screen, keyboard, computer mouse or other operating device, documents and related equipment. The space at the keyboard and the space for a computer mouse or other operating device shall be sufficient to provide support for the hands and arms of the operator.

5 § The work chair shall be stable and allow the operator easy freedom of movement and a comfortable position. The chair shall be easy to adjust. The seat shall be adjustable in height. The backrest shall be adjustable in both height and tilt.

Computer Equipment

There are many types of computers and other related equipment. Computers and computer networks should be dependable, and technical support should be assured during installation, operation and in the event of malfunction. Modern computer applications (particularly graphics processing) and the Internet often require high-

capacity computers. Slow computers and technical troubles are well-known stressors in today's computer work environments.

Computer security needs to be good with respect to protection against viruses, break-ins or losses, e.g. as a result of hard disk crashes. Anxiety and stress caused by such complications should be minimized through technical solutions, e.g. regular, automatic backups.

Computer equipment located within your field of vision (particularly your display screen and keyboard) should have surfaces that are matt and medium-light in colour to avoid reflections and sharp contrasts with the surrounding environment that place demands on vision.

The display screen

The quality of your display (computer) screen is important (AFS 1998:5 2§). TCO Development has a regularly updated quality inspection system for display screens. The present version is from 2003 (TCO'03). Certification takes into account the screen's ergonomics, radiation, image quality and external environmental effects during manufacturing, use and scrapping. Screens should satisfy TCO requirements that do not predate 1999 (TCO'99).



The traditional CRT (Cathode Ray Tube) screens are usually large, require a great deal of space and often radiate a fair amount of heat. CRT screens can cause troublesome flicker if the picture repetition frequency isn't set at at least 80 Hertz. Flat screens take up less space, don't flicker and produce considerably less heat and electromagnetic fields than do CRT screens. Flat screens are usually called LCD (Liquid Crystal Display) or TFT (Thin Film Transistor) screens, although all are based on the same technology. Display screens, particularly large ones, should be vertically adjustable so that users don't have to look up at them. An alternative is that they stand on a part of the table that is vertically adjustable.

The image quality of your display screen can be adjusted in various ways, using controls on the screen itself as well as settings on the computer. You should try to adjust your screen so that it is flicker-free and has optimal definition, contrast and brightness. CRT screens can be disrupted by electrical and magnetic fields from nearby cables or equipment, resulting in an unstable picture or poor picture quality.

Read more about Screen image quality and Electromagnetic fields.

Portable computers ("laptops") aren't appropriate for use at permanent workstations, because their small size often leads to a constricted working posture and a viewing distance to the screen that is too short. One alternative is to supplement your laptop with an extra display screen, keyboard and mouse.

Read more about use of Laptop computers.

What does the law say?

Statute Book of the Swedish National Board of Occupational Safety and Health
1998:5 "Work With Display Screen Equipment "

Screen and keyboard

2 § A computer display screen and keyboard shall be easily readable and shall be designed in such a way as to facilitate use. The image on the screen shall be free from disturbing flicker and other forms of instability. The screen shall be free of reflective glare and reflections liable to cause discomfort to the operator. The characters on the screen shall be well-defined and large, and shall have sufficient contrast. The distances between characters and lines shall be sufficient for good readability. The brightness or the contrast between the characters and the background shall be easily adjustable by the operator, and also be easily adjustable to ambient conditions.

5 § The keyboard and the display screen shall as far as is practically possible be rotatable, adjustable and moveable to suit the needs of the operator. A document holder, if used, shall be stable and adjustable and shall be positioned in such a way that unsuitable head and eye movements are avoided.

Read more

Screen image quality

Electric and magnetic fields in office environments

Adjusting furniture and computer equipment to achieve sound working postures

Use of laptop computers

Information on computer labelling – TCO Development www.tcodevelopment.se

Work With Display Screen Equipment 1998:5 6§

The Work Environment Authority's Statute Book (AFS)

In-depth – The keyboard and pointing devices

Your keyboard should be as low (thin) as possible so that your wrists aren't forced into an upwardly angled working posture (a maximum of 3 cm from the table surface at the row containing the "a" and "s" keys). For the same reason, you should not angle your keyboard upward by extending the feet sometimes found on the keyboard's underside. It can be advantageous to have a keyboard that is narrower than the standard keyboard. A narrower keyboard allows you to place the mouse in a more central position. There are also keyboards without the numeric keypad that is usually found at the far right. If number entry is required, a small separate numeric keypad may be used. Various types of angled keyboards have been designed to provide a more relaxed working posture for the computer user's wrists. These can reduce muscular exertion, but often require that the user be able to type without looking at the keyboard.

A cordless keyboard/mouse increases the user's ability to vary keyboard/mouse placement without cords getting in the way. Communication between the keyboard/mouse and the computer occurs via radio waves. This flexibility needs to be weighed against the possible disadvantages of radio transmitters.

Read more in chapter Electric and magnetic fields in office environments.

The computer mouse and other pointing devices

There are no unanimous research findings showing that one type of pointing device is superior to others. When choosing a pointing device, you should test different types. Avoid devices that result in uncomfortable or angled working postures for your wrist as well as those that require unnecessary precision of movement.

The computer mouse, trackball or other pointing device should be matched to your hand size and designed so that your hand can rest on it comfortably and not in an upwardly angled posture. The pointing device should be suited to both left- and right-hand use, allowing you to alternate. Otherwise, you will need a device for each hand. Some vertical pointing devices are designed like a pen or a joystick to provide a relaxed working posture for the computer user's wrists.

Adjust cursor speed according your skill level. The more skilled you are at moving the cursor with accuracy, the more sensitive the cursor can be (see: Adjusting cursor sensitivity below). If cursor sensitivity is set too high (large cursor movement for small mouse movement), you can move the cursor very quickly, but this places increased demand on hand precision, which can increase the risk of neck and arm/hand pain. The sensitivity of other pointing devices, e.g. the pointing pads common on laptops, can also be adjusted. The traditional computer mouse has a small ball on its

underside that rolls when you move the mouse. The ball needs to be cleaned occasionally if it is to function properly. The optical mouse has a light-emitting diode and sensor system that registers the mouse's movements. For more on the cordless mouse, see the above section: The keyboard.

In order to gain a better work-posture when using a pointing device, there are devices that are positioned in front of the keyboard (see illustration below). The arm can be held close to the body. Not in an awkward extended position.

Wrist supports

Wrist supports and other extra support surfaces are not usually necessary, but may provide relief if the keyboard or control device is high or if it is otherwise difficult to find a comfortable and strain-relieving working posture.

Computer software

Computer software should be thoroughly tested and self-instructional, including instructions that are pedagogical and easy to understand, especially for beginners. Applications should not encumber the user's visual field, attention or memory with, e.g., unnecessary features. The user should be able to control the application using shortcut keys as a complement to the control device. The advantages of changing or upgrading applications, which is always necessary sooner or later, should be weighed against the disadvantage of the user having to learn something new.

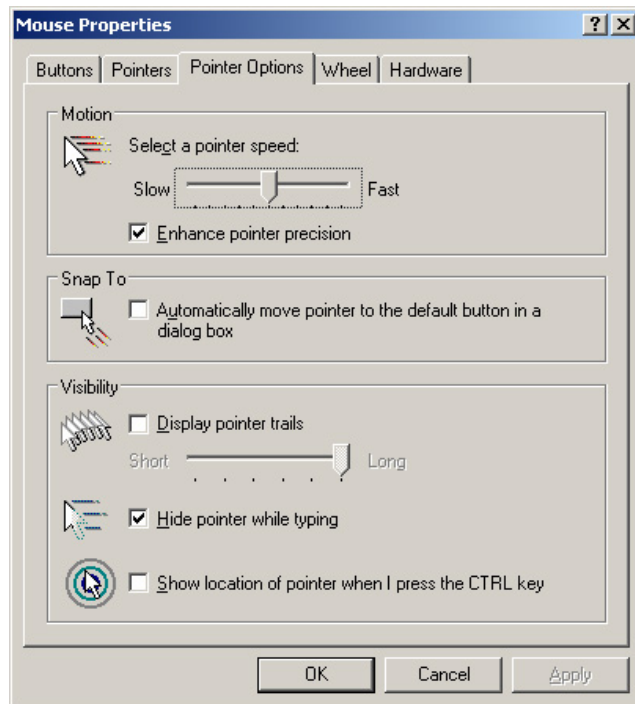
Read more about Software systems and user interfaces.

Read more about the Workplace Checker, a tool for effective workplace assessment, on TCO Development's site.

How to

Adjusting cursor (and double-click) sensitivity (In Microsoft Office)

1. Open This computer
2. Select Control panel
3. Select Printer and other hardware
4. Select Mouse – see adjacent figure
5. Select Pointing alternatives
6. In the dialog box Select Pointing speed – move the arrow towards Slow or Fast
7. Select Improve the pointer's precision. The cursor will then move a somewhat shorter distance for a given mouse movement.
8. Select Execute at the bottom of the dialogue box. You can adjust your double-click speed in a similar manner in the dialogue box Activities.



Use of laptop computers

It is becoming increasingly common for laptop computers/notebooks to replace traditional desktop computers. Laptops were previously used mostly as a complement to stationary desktop computers or for travel and working at home. We cannot yet accurately assess the health and productivity implications of using laptop computers. Below are some of the advantages and disadvantages of laptops compared with traditional desktop computers.

Advantages of laptop computers

- Occupies little space.
- Easy to carry when travelling etc.
- Increased access to data (same computer at work, home and when travelling).

Disadvantages of laptop computers

- Often a smaller screen making it more difficult to read.
- Screen, keyboard and mouse are all in the same unit which allows for little adaptation, e.g. increasing distance between screen and keyboard, height of screen etc.

- The built-in mouse demands great precision, which can lead to increased tension in neck and arms.
- Less comfortable working postures (increased forward-bending of the neck).

For individuals with small hands and narrower shoulders, laptop computers with their smaller keyboards can be an advantage since in these cases it can lead to more neutral (not bent and twisted) working postures in wrists and shoulders.

Text and English translation: Jens Wahlström and Tohr Nilsson

In-depth **– Recommendations**

Based on the scientific research available in this field, regulations for computer workstations (AFS 1998:5) and general ergonomic principles, the following recommendations are provided:

If the laptop computer is used as the primary computer, a separate keyboard and mouse (or alternative control) and an external screen are recommended.

If the laptop computer is moved often, a docking station can help avoid repeatedly connecting and disconnecting the keyboard, mouse and screen.

If the laptop computer's screen is large enough to allow good visual ergonomics, you can test using a stand for the laptop to raise the screen and reduce forward bending of the neck.

In-depth **– Handheld computers**

Like laptops, handheld computers are becoming increasingly common. Handheld computers are designed like calendars but with considerably more technical advantages than a normal calendar.

Handheld computers allow you to manage e-mail and read and edit documents and presentations. Handheld computers are often controlled with a type of pen but it is possible to connect them to a separate miniature keyboard.

The advantage with a handheld computer is increased flexibility but the disadvantages are fixed working postures and high demands on eyesight.

In-depth

– Scientific literature

There are around ten studies published that focus on work with laptop computers (see references). The following is a short summary of current knowledge, after which some of the studies are referred to in more detail.

Conclusions

- In order to reduce stress and forward-leaning of the neck and to improve visibility conditions, an external screen (or stand) and separate keyboard and mouse can be connected to the laptop computer.
- Work at laptop computers involves more forward-leaning of the neck compared with traditional desktop computers.
- Work at laptop computers means that the distance between the eyes and screen is reduced compared with traditional desktop computers and this can involve more strain and discomfort for the eyes.
- It is important to vary working positions if the laptop computer is used for longer periods (hours).
- Using a laptop computer seems to reduce productivity compared with traditional desktop computers.

Read more

Laptops compared with desktop computers

Working postures

Work With Display Screen Equipment 1998:5
The Work Environment Authority's Statute Book (AFS)

TCO Development – Certification of laptop computers
In-depth – Laptops compared with desktop computers

Most of the studies that have compared laptop computers with ordinary desktop computers have studied the differences in working postures (Saito et al., 2000; Straker et al., 1997; Szeto & Lee, 2002; Villanueva et al., 1998). These four studies show that forward leaning (flexion) in the neck is greater when using a laptop than a desktop.

This working postures could involve a greater risk of developing neck pain, since several high-quality scientific studies have shown that neck flexion $> 20^\circ$ for a large part of the working day is a risk factor in developing neck pain (Andersen et al., 2003; Ariens et al., 2001). An important reason for forward leaning is probably the lower position of the screen.

Three of these four studies also examined productivity and all three showed lower productivity in the use of laptops compared with desktop computers (Straker et al., 1997; Szeto & Lee, 2002; Villanueva et al., 1998) Lower productivity could be a consequence of the increased demands on eyesight, but also of the fact that individuals included in these studies did not have much experience of using laptop computers.

Two of these studies also examined the differences in reporting discomfort between the different types of computer. Both studies found that feelings of discomfort tended to be greater after using laptop computers compared with stationary computers (Straker et al., 1997; Villanueva et al., 1998).

Laptop computers are replacing desktop computers

In Norway, a major daily newspaper carried out a study in which a large group of 310 individuals replaced their ordinary desktop computers with laptop computers with 14-inch screens.

In a pilot study carried out by the company healthcare department, it was observed that perceived productivity, screen legibility and the possibility of adjusting the computer workstation in order to achieve a comfortable and relaxed working position were reduced by the introduction of laptop computers.

The company then decided to buy 15-inch screens and separate keyboards and mice for all computers. Six months after all personnel had begun using the new laptop computers, 100% were using the separate keyboards and mice and 46% were using the external screens (Hafting et al., 2004).

In-depth – Working postures

One survey has studied the differences in working postures and muscular stress when using two different laptop computers and whether the positioning of the computer was significant (computer on lap or desk) (Moffet et al., 2002). The results showed no difference between two laptop computer models.

There were however advantages and disadvantages with both working methods. These results indicate that it is important to vary one's working postures when using a laptop computer for longer periods. But with a laptop computer, the user is not bound to a chair and a desk. It is quite possible to use it when reclining on a sofa. This is one of many ways of creating variation in working postures.

Laptop computers on table surfaces or stands

In a Swedish study, researchers examined the significance of a stand and separate keyboard and mouse compared with the same laptop computer without this peripheral equipment (Berkhout et al., 2004). The results showed less stress on the

neck (smaller action in the C7-Th1 segment) and less discomfort in the neck and increased productivity when using a separate keyboard and mouse.

In-depth

– What does the law say?

Technology, the work organisation and work assignments need to be designed so that the employee is not subjected to physical or psychological stresses that could lead to ill-health or accidents.

1 § The Provisions do not apply to ... portable systems during brief, non-permanent use at a workplace.

4 § The workstation shall be dimensioned, designed and equipped so that the operator can find comfortable work postures and vary work postures and working movements.

5 § The keyboard and the display screen shall as far as is practically possible be rotatable, adjustable and moveable to suit the needs of the operator.

In-depth

– References

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Software systems and user interfaces

Today we use computer systems everywhere in society. Most of us have a daily contact with computers and technological support systems at work and in our daily life. Many of us spend most of our day in front of a computer.

Even if computers can facilitate and support both work and other activities, most of us have experienced different kinds of problems in the use of the systems. Small problems can be irritating but relatively easy to eliminate. Computer systems that are not effective or efficient can lead to severe problems with regard to stress and health. In contexts where safety and security are important, e.g. in health care, traffic systems, process industry, nuclear power plants etc., deficiencies in usability can also result in incidents, accidents and hazards for the users.

Terminology

Users

Users are those who really interact with a computer system in order to fulfil their tasks, at work or in other contexts.

Usability

The international standard ISO-9241 defines usability as “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use “. This also means that it is possible to measure usability in terms of how well a system supports a user in his/her tasks, how efficient the system is and how satisfied the users are.

When we discuss the usability of a computer system, this is often related to the user interface, i.e. the part of the system with which the user interacts when using the system. Unfortunately it is not always possible to eliminate usability problems only by changes in the user interface. Not even the introduction of a new better system can always solve the problems related to the whole work situation. Often also the work processes and organisation need to be changed.

Different work situations and environments demand different software solutions. In administrative work many use standardized products for word processing, calculations, e-mail, Internet etc. Many of these programs have millions of users worldwide. The possibilities to make major changes in such systems are very limited.

Many companies and organisations often use large business systems, e.g. ERP-systems (Enterprise Resource Planning) as integrated solutions for economy, accounting, product planning and control, inventory etc. These systems can sometimes be adjusted to company specific requirements, but it can be difficult to

change the intended pattern of use. The structure and interface of the system will have a large impact on the work processes and the work organisation.

In some organisations the computer systems are tailor designed to support the local users' work tasks. Examples are case handling systems in an authority or agency. Here it is in principle easier to influence the design of the system. Both the management and the users can here contribute with important information during the requirement and design phases. User centred development models are here important.

We see more and more situations where computer support systems are used in a mobile context. Here the work environment leads to extra high demands concerning usability.

Computers are becoming more and more reliable, even if viruses and junk mail often cause problems and frustration. Today we know a lot about stress and strain caused by bad technical solutions, controlled and static work, physical problems caused by intensive use of pointing devices etc. It is important to not only limit the symptoms, but to eliminate the underlying problems.

What the Swedish law says?

Regulations for computer work The regulation "Internal Control of the Working Environment" (AFS 96:6) describes how the employer needs to regularly follow up and document work environment policies, working conditions, health hazards, employee qualifications and the like. Regulations for computer work are found mostly in "Work with computers" (AFS 1998:5). Apart from the legal text, it also contains advice and instructions for good computer work. When software systems are being developed, ergonomic principles for how humans perceive, understand and utilize information.

Our most common software systems and user interfaces, provided by the large software suppliers such as Microsoft (Microsoft Office, Internet Explorer etc.) or LINUX, often have a reasonable usability. The individual user or buyer can normally not influence the design of such systems.

Large usability problems can often be found in computer systems designed for specific users and specific applications in companies and organisations. Examples are systems for economy, accounting, customer registers, case handling systems, documentation and communication. In such systems, to be used by skilled professionals in their everyday work processes, a high usability is necessary. If not, the result can be low efficiency, high error rates, stress and health problems.

Text and English translation: Bengt Sandblad and Eva Olsson.

Pictures: Mattis Jansson and others.

Adjusting furniture and computer equipment to achieve sound working postures

There is no single "correct" working posture that you can/should maintain during your entire work day. But there are several principles and guidelines concerning how you should work at a computer. The longer you work at a computer and the more stressful your work situation is, the more important it is that you adhere to these principles. People who work at a computer most of the time should pay special heed to this advice.

Work with your arms and hands near your body.

Avoid prolonged working postures that are highly bent or twisted.

Support the weight of your arms and hands by resting them on the table or armrests.

Vary your working posture and movements.

Work in a relaxed manner.

Alternate computer work with other activities, or take breaks and rest periods.



Good working posture for shoulders and arms. Arms are held near the body and are supported on armrests or the table surface.



Placing the computer mouse far out to the side can lead to inappropriate lifting of the arm.



Placing the computer mouse far out to the side can lead to inappropriate outward turning of the arm.

Underlying these guidelines is the notion that you should avoid prolonged work with constantly twisted or bent joints, as this can expose joints, tendons and nerves to increased pressure that will be harmful in the long run. You should also avoid prolonged, low-intensity but static muscular action, as this can damage particularly vulnerable parts of your muscles.

Therefore, you should work with your hands near your body and without highly twisted or bent working postures; this applies to your back, neck, shoulders/upper back and wrists. Your keyboard and mouse, thus, need to be in front of your body, not far to the side. By supporting the weight of your arms and hands, you decrease not only the strain on your arm muscles, but also on your neck and shoulder/upper back muscles. You should rest your arms/hands on the tabletop or possibly on your chair's armrests. Your chair and table need to be adjusted correctly so that the support surfaces are in the appropriate places. Your display screen should be placed correctly in relation to your body so that you are not forced to twist or bend your neck.

It is also of great importance that you vary your working postures and movements as well as alternate computer work with other activities or pauses.

Everyone should be aware of the importance of these factors and of how furniture can be adjusted correctly. This is crucial if the computer user doesn't have an own workstation, but needs to choose a vacant workstation. In such cases, the chair, table and display screen need to be adjusted at the beginning of every work shift.

What does the law say?

The Work Environment Authority's Statute Book
(AFS) 1998:5

Work postures and working movements

4 § The workstation shall be dimensioned, designed and equipped so that the operator can find comfortable work postures and vary work postures and working movements. The work desk and work surface shall be large enough to allow a flexible arrangement of the screen, keyboard, computer mouse or other operating device, documents and related equipment. The space at the keyboard and the space for a computer mouse or other operating device shall be sufficient to provide support for the hands and arms of the operator.

5 § The display screen and keyboard or equivalent shall be positioned so as to be adaptable to the body measurements of the operator, so as to achieve a suitable working height and visual angle in relation to the screen. The keyboard and the display screen shall as far as is practically possible be rotatable, adjustable and moveable to suit the needs of the operator. A document holder, if used, shall be stable and adjustable and shall be positioned in such a way that unsuitable head and

eye movements are avoided. The work chair shall be stable and allow the operator easy freedom of movement and a comfortable position. The chair shall be easy to adjust. The seat shall be adjustable in height. The backrest shall be adjustable in both height and tilt.

In-depth – Adjusting your chair and table



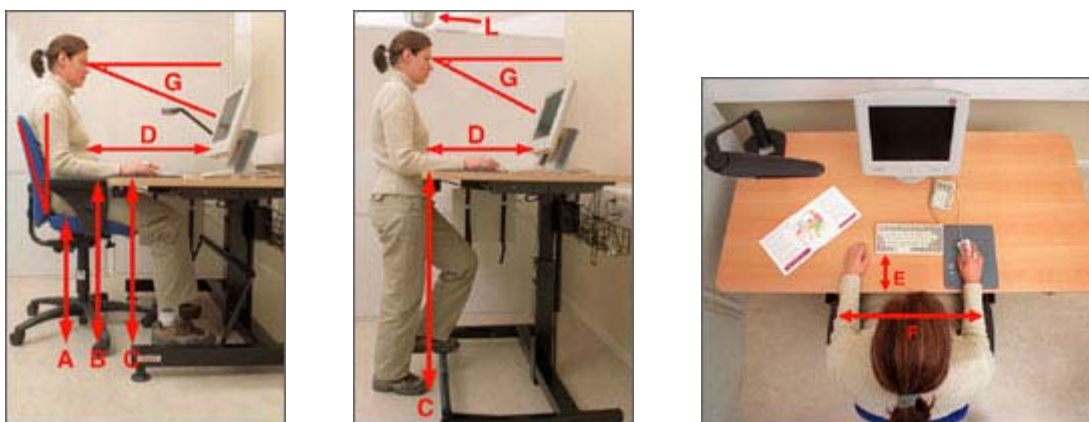
Sitting with open hip angle.

1. Adjust your seat height so that you can sit comfortably with your feet on the floor and with your knees and hips at approximately a 110-120° angle (see picture above). If your chair is too low, your working posture will be constricted; if it is too high, the front edge of your chair will press against the back of your thighs. Some chairs are designed to give an 'open hip angle' (greater than 90°), which relieves strain on the back. These chairs result in a somewhat higher sitting height than do conventional chairs (see the picture to the right).
2. Adjust your seat depth so that your back comfortably reaches the backrest, without your seat pan pressing against the back of your knees.
3. Adjust the angle and height of your backrest so that your lower back and shoulders are well supported; your backrest should be angled back about 20°. If your backrest is angled too far forward, your back will not receive adequate support. If you don't have a headrest, leaning too far backward will cause neck discomfort in the long run.
4. Adjust your armrests vertically and laterally so that your elbows can rest on them when your upper arms are hanging straight down with your elbows at about a 90° angle (see B in picture, below). If your armrests are too low, they will not relieve the strain on your shoulders, upper back and neck. If they are too high, your shoulders will be pressed upward into an uncomfortable working posture. Your arms will not receive good support if your armrests are too far out to the sides (see F in picture, below).

5. Thereafter, adjust your table height so that your forearms can rest on the tabletop (see C in picture, below). If your tabletop is too low, arm support will not be adequate and the position of your keyboard/mouse will likely force your wrists into an upwardly angled posture. A prolonged posture such as this can result in wrist complaints. If your table is too high, you need to raise your shoulders or move your arms outward so that your forearms can reach the table surface. This often leads to neck, upper back and/or shoulder problems.

The same principle of correct table height also applies to computer work in a standing position. Your arms should hang loosely at your side and your elbows should be at about a 90° angle.

Read more about adjusting your computer workplace in the chapter Computers at school.



A=Chair height so that feet can rest on the floor.

B=Armrest height so that forearms can rest on them.

C=Table height so that forearms and wrists can rest on it.

Often the same height as in B.

D=Distance to the screen=60-80cm

E=Distance to the keyboard=10-15 cm.

F=Armrest breadth so that forearms can rest on them.

G=Visual angle about 20-30° downward.

L=Ceiling light fixtures above front edge of the table.

In-depth – Placement of computer equipment on the work table

1. Place your display screen at arm's length distance (about 60-80 cm) so that you can look straight forward and obliquely downward (see D and G in pictures, below). A large screen (e.g., 19" CRT) needs to be placed at a greater distance so that the entire screen is within your visual field. If your screen is too close, it is more difficult to get an overview and this puts more strain on your eyes. No part of your screen's display surface should be above your eye level. A screen that is placed too high can easily lead to eye and/or neck complaints.
2. Place your keyboard directly in front of you and far enough away (about 10-15 cm) so that your wrists can rest on the tabletop, between the edge of the table and the keyboard (see E in picture, below).
3. Place your computer mouse or other control device at the same height as the keyboard and such that you can work with your arms near your body and your forearms resting on the tabletop.
4. Avoid resting your wrists against, e.g., a sharp table edge; this could cause harmful compression of the tissues in your wrist.



A good working posture for wrists and hands. The wrists are held straight and are supported by the tabletop.



The wrists are held straight and are supported by the tabletop.

Screen image quality

These pages are about adjustments that can be made on computer monitors in order to enhance image quality and increase work comfort. A well adjusted monitor will help avoid some of the negative symptoms of computer work on your health and well-being.

Users of traditional CRT-monitors

The most common problem that computer users have with CRT monitors is flicker. Flicker is rapid fluctuation in the light-intensity of the screen. It may be so rapid that it is barely noticeable, but it can still cause problems. Flicker may make the user feel fatigued and can also cause other types of discomfort such as headaches or eyestrain.

Users of flat-panel screens (LCD or TFT)

Instead of flicker symptoms, TFT (LCD- or Flat Panel) monitors may show moiré distortion if the screen resolution is not properly set to its native resolution. Moiré distortion adds unwanted patterns to textured surfaces on the screen.

In-depth

Advanced adjustments need detailed knowledge and experience. The link below leads you to in depth information for those users who would like to have the best screen image quality.

In-depth

– Screen adjustments

If you are not used to making computer adjustments this may take some time. Before starting, make sure that you can set aside some time, approximately 1-2 hours, to learn about the procedures and to make the necessary adjustments. The section [The Monitor at the Computer Workstation](#) below, it is a general introduction to the problem of monitor adjustments.

[How to Determine your Present Components?](#) A guide to help you determine what hardware and software is installed on your computer that is involved in the generation of the screen image.

The chapter [Do You Notice any Imaging Faults on Your Screen?](#), describes common imaging problems that occur on monitors screens with links to the sections on how these problems can be solved.

Chapters Basic Operating System and Graphics Card Adjustments deals with adjustments made using the computer mouse and/or the keyboard with software interfaces.

Basic Screen Adjustments describes adjustments made by using the monitor control panel adjustment buttons.

If New Components are Needed – recommendations for qualities that the new component should have if it needs to be replaced. There is also some more technical information regarding the different screen technologies and graphics card interfaces.

If you will be adjusting your screen for the first time, please follow the Recommended Order of Adjustment. It may even be useful to printout this section!

The section Suggestions for Organisations with Administrated Intranet contains some advice for people working in these groups and the people in the computer administration department.

The Monitor at the Computer Workstation

Computer monitors are, with the exception of notebook/laptop computers, stand-alone hardware. For visual ergonomics it is important to adjust the screen so that it is as user-friendly as possible thus minimizing eye strain especially when working for long periods at a time in front of a computer screen.

There are several kinds of display monitors used with computers. The two most common are CRT (Cathode Ray Tube) and TFT (Thin Film Transistor, also known as LCD or Flat Panel) monitors.

For normal-sighted people, the computer screen is the most important interface with the computer. It shows the location of the mouse pointer, displays what we are typing on the keyboard, and the visual results of anything else that has been computed, such as text, illustrations or pictures.

Communication between the screen and computer takes place via the graphics card.

All information from the computer memory is transferred by the graphics card to the screen and is displayed there, so we can perceive the information in a form suitable for humans – as text or images. All computer components involved in the dialogue between humans and computers are called Human Interface Devices (HID).

How Working at Monitors Affect the User

The monitor is the most visual device for the computer user. The eyes and the visual centre of the brain are both affected not only by what is displayed on the screen but by the illumination of the surrounding work area. This can be very pleasant, but sometimes it can produce symptoms such as headaches and eye strain. If the user feels adversely affected by this visual stimulus, it should be dealt with immediately.

This does not necessarily mean that the monitor is unusable if you experience any negative symptoms from computer work. The image quality of the screen depends on other factors such as the operating system (e.g. Windows, Mac OS, Linux.), software, graphics card, signal cables and the monitor itself. All these factors influence the performance of the screen and a simple adjustment may solve the problem. Poorly adjusted screens may cause headaches, concentration difficulties or make one unmotivated to work at the computer.

These symptoms are not chronic but often they are serious enough that they persist after work when the user should be enjoying some leisure time. The way you feel after work obviously will influence the way you spend your spare time. If you come home tired, with a headache or aching burning eyes, you surely don't feel up to any form of recreation with your family or friends. Maybe you just decide to sit and watch TV. Most TVs usually have a low refresh rate of 50 Hz which causes flickering images – worse than a poorly adjusted computer screen and this does not improve your visual health!

Adjusting the Monitor for Best Visual Ergonomics

Before adjusting your monitor, it is a good idea to learn something about the factors that influence the adjustment. If you are not familiar with different screen technologies and computer adjustments, this might, at first, appear difficult to you. It is not important that you understand everything in order to adjust the image quality of your monitor, but it is good to be familiar with certain terms. Understanding some of this will make it easier and more enjoyable making the adjustments. In time you'll learn more about your computer and monitor.

If you have to adjust a CRT (Cathode Ray Tube) monitor, it may take several attempts until you are really satisfied with the results. This is because certain adjustments take a bit of experience. In time you may become more aware of defects in the generated image: We tend to see only things that we know about.

Before starting to adjust your monitor you should read through the sections on the left and even the sub-topics in the window above.

If you are unable to improve the quality of your screen image after going through these sections, it is recommended that you search for more information on the manufacturer's web site for your monitor, graphics card or operating system.

With recurring problems it is recommended that you consult your system administrator. If there is no system administrator where you work it could be helpful to discuss the problems with friends who know more about computers. If this is not an option, professional help from specialists can be obtained. You can find specialists on the internet by using the keywords +Ergonomics +Screen +Adjustments on the web search engines.

Similar help for adjustments of the screen image and print-out quality may also be found at different web pages, e.g. www.displaymate.com.

In-depth

– How to determine present components

It is a good idea to be familiar with the computer components that are involved in adjusting your monitor before you begin making adjustments to improve its image quality.

Do you experience any imaging problems? Use this step-by-step guide below to check your computer components.

Operating System

To determine the current version of your operating system, use the mouse and:

click on Start,
--> choose Settings
--> and then Control panel

Or for Windows XP

--> Start and then directly to Control panel.

If you are working in Windows XP's Category view you can change to Classic view while you are making new adjustments.

You can change back later at the same place by choosing Switch to Category View.

--> Now double click on the System icon (circled in red)

--> System properties is shown.

Please note everything between System and Registered to. This might be important if you have to download a new driver.

Monitor and Graphics Card Information

To find out what kind of monitor and graphics card is installed on your computer,
--> right-click anywhere on the desktop background
--> choose Properties in the dialogue box
--> click on Settings.

This dialogue box provides information about your monitor, graphics card (display adapter), the current resolution and colour quality.

--> Advanced

Brings up a new dialogue box.

--> Choose the tab marked Adapter. This provides more detailed information about your graphics card (display adapter).

There is a button at the lower left of the box marked List all modes that when clicked, brings up another dialogue box showing all available modes, i.e. all combinations of desktop resolution, refresh rate and colour depth that your graphics card/display adapter supports. Sometimes this information is already shown in the Adapter dialogue box.

As a rule, only the combinations that are supported by your monitor are shown. The highlighted line is your current setting. You should remember these highlighted values or make a note them on paper. When you are done, close all dialogue boxes that have popped up during this process.

Monitor

You need the manual for your monitor to determine its properties in order to adjust it. However, if you don't have the manual you can often download it from the manufacturer's web site. There you can also find the latest drivers and software updates.

If you don't have your manual:

You will need to test different adjustment parameters:

Start with 800 x 600, 60 Hz and 16bit colour quality if you have a small monitor (15 – 17 inch) or with 1024 x 768, 60 Hz and 16 bit colour quality if you have a large monitor (19 inch or larger).

Later on, while adjusting your screen, you can increase these parameters, one at a time, until you are satisfied with the image quality. Please read on at Proceed...

If you have your manual:

Make a note of the make and model of your monitor. Look inside the manual for information about the recommended monitor resolution. These are values such as 800 x 600 or 1024 x 768 etc.

Proceed...

For TFT monitors native resolution is the most important. The refresh rates that are supported are usually from 60 to 85 Hz.

If you have a CRT monitor, you will find a list of different screen resolutions with the maximum refresh rates in your manual. This list will be needed for future adjustments.

If your monitor is installed on the operating system, you can access this list in the same way as described under GRAPHICS CARD.

PLEASE NOTE: The monitor should be certified TCO'99 or higher (at the time of writing this was TCO'03). For further reading and a complete listing of TCO requirements for monitors go to TCO Development's homepage.

Drivers

Hardware drivers are programs that enable communication between the individual computer components. The monitor and all other computer hardware devices have their own components and this makes it necessary to install the correct driver for the particular hardware device. You can look at it this way. All computer components speak different languages and the driver is the dictionary that gives them the ability to communicate with each other.

Unfortunately new products are often put on the market before the driver program is completely ready. Therefore you should check if there are any driver updates available. Newer drivers for monitors could improve image quality. Newer versions of operating systems often provide an automatic update control, but this is only suitable if you have a broadband connection to the internet.

To check the version of your driver proceed as follows:

--> Click on Start

--> Choose Settings

--> and then Control panel

For Windows XP:

--> Click on Start and go directly to Control panel

Then

--> choose System

--> then Hardware

--> then Device manager

This displays a list with all the hardware components connected to your computer. By clicking on the “+” symbol by the icons for Monitors and Display adapters you'll find information about the DRIVER that is currently being used for that component.

If you see Standard or Default listed in one of the descriptions for the monitor or the display adapter/Graphics Card, it is recommended that you install the drivers for that specific device. (How to install the drivers can be seen in the instruction sheet that came with that particular device. If a new driver needs to be installed, download it from the manufacturer's homepage so you have the most recent version available).

--> Right-click on the component that you want to check for the driver version

--> Choose Properties

--> Click on the tab marked Driver

Here you'll find the version of the installed driver. Please make a note of it and check the manufacturer's home page to see if a newer version is available. If there is a newer version, download it and follow the manufacturer's instructions to install it.

To leave the system dialogues click on Cancel and close all windows that have been opened during the process.

Properties

Below you will find a list of what properties your components should have in order to produce a good, user-friendly image on your screen. The numerical values shown can be higher but should not be lower. If you have one or more components with lower values than those listed (for example a CRT screen that supports only 60 Hz refresh rate), consider replacing it with a device that fulfils the values.

TCO'99 or higher

CRT monitor and graphics card/display adapter:
15 inch: 800x600 @ 85 Hz and 24 bit colour depth
17 inch: 1024x768 @ 85 Hz and 24 bit colour depth
19 inch: 1280x1024 @ 85 Hz and 24 bit colour depth

All CRT monitors:

Analogue output on the graphics card/display adapter (standard).

TFT monitor and graphics card/display adapter:
12 inch: 800x600 @ 60 Hz and 24 bit colour depth
15 inch: 1024x768 @ 60 Hz and 24 bit colour depth

17 inch: 1024x768 @ 60 Hz and 24 bit colour depth
19 inch: 1280x1024 @ 60 Hz and 24 bit colour depth

All TFT monitors:

Check the back of your monitor for a DVI input. If there is a DVI input, check for a DVI output at the graphics card.

If you have a DVI input on your display but no DVI output on your graphics card, consider buying a new graphics card with a DVI output and a DVI cable. This may solve many adjustment problems and will also enhance image quality.

In-depth

- Does Your Monitor Have any Imaging Problems?

This section will describe some imaging problems associated with computer monitors. It will give you some help in recognising the problem and advice on which section to read in order to solve the problem.

Flicker

Do you often get a headache after working at your computer?

Do you often feel extra tired after working at your computer?

These are some of the symptoms that you may experience if you have a problem with screen flicker. Flicker does not occur with TFT monitors since it is related to the technology used to produce the screen image.

Flicker on your monitor screen is caused by a refresh rate that is set too low on your graphics card. Our eyes can distinguish up to 80 image changes per second on CRT screens. This is why the refresh rate should have a value higher than 80 Hz (Hz = cycles per second) for CRT screens whereas 60 Hz is sufficient for TFT screens.

You can test the refresh rate by holding a sheet of paper with an image or text beside the screen and looking at it. If, while looking at the paper, you notice that your monitor is flickering, even slightly, then your screens refresh rate is set too low.

Even if you don't notice that the screen is flickering; you should check the settings of your graphics card anyway. A CRT screen should have a refresh rate of at least 85 Hz.

To remove flicker read the section on Operating system and Graphics card adjustments.

Moiré effects

Moiré distortion can make your screen look washed-out and blurry. The distortion is most noticeable with text and small details.

Moiré distortions can show up on both CRT and TFT screens. On TFT screens the effect is often much worse than on CRT screens. They can be caused by poor graphics card or screen adjustments. It can be very difficult to get rid of Moiré distortions from either CRT or TFT screens.

The following test images will help you to determine whether or not you have a problem with Moiré. The images consist of very thin equidistant white and grey lines.

Please note: For CRT monitors Moiré distortion shows up as wavy lines. Unfortunately it is not possible to show these wavy moiré distortions on the web because they would look different depending on the type of monitor.

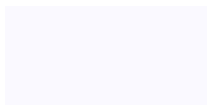
The same is true for vertical Moiré. Vertical Moiré is not adjustable on TFT screens. If you have a TFT monitor and the picture on the left in the table below shows Moiré distortion, please contact your screen manufacturer's support service.

If you have this problem, read the sections on Operating system and Graphics card Adjustments and Screen adjustments.

Colour Problems

Colour temperature

Daylight colour is measured as colour temperature in degrees Kelvin. Monitor "White", which on computer screens, is often a bit bluish. This is the default setting for most monitors and is as a rule the brightest setting possible (9300 Kelvin). This bluish tone affects all other colours displayed but it is easiest for us to detect in white areas. The average neutral "daylight white" is about 6500 Kelvin. Paper white is 5000 to 5500 Kelvin (a "warmer" reddish tone). It's up to the individual to decide which white tone is preferred for computer work. Usually 6500 K is the best, although graphic professionals usually favour the warmer white of 5000 to 5500. The white tones below will give you some idea of the slight differences between these white settings.



Bluish
(~9300 Kelvin)



Daylight
(~6500 Kelvin)



Reddish "Paper White" (~5300 Kelvin)

To change the colour temperature of your monitor, please read more at [Screen adjustments](#).

Colour quality

If the colours on your monitor don't seem natural, if you see pixel structures in areas where shades of colour meet, or there are fewer colour nuances than in a photograph, the colour quality is probably set wrong.

Colour quality is the number of colours generated by the computer and displayed on the screen. It is measured in bits.

Read more in the section [Operating system and Graphics card Adjustments](#).

Colour shadows

The image to the left shows the letter L magnified 10 times. You can see where the "white" background is actually made up of red, green and blue pixels.

It is common on CRT screens to see colour fringes on the edges of black text on a white background. Unfortunately it is not possible to illustrate this defect via internet because it is caused by a hardware adjustment. The letter to the left shows a letter without colour fringes.

With a white background set at the highest brightness, a black character on the screen and a magnifying glass or microscope, you can see that the "white" background is in fact composed of red, green and blue dots.

In the area where the pixels for a specific character are located, the colour signals for red, green and blue are switched off – this produces black.

This an image of the structure of a letter magnified 42.5 times. The left edge shows a blue shadow fringe, while the right edge shows a red - green shadow. The signal for

the colour blue has not converged (is not in alignment) with the signals for the colours red and green. When this defect occurs, it can be seen without any magnification.

Colour convergence refers to the alignment of the red, green, and blue electron guns inside your CRT monitor. If you can see colour fringes while editing black text on a white background, you have a problem with the colour setting on your screen. Most monitors offer a screen adjustment option for this defect.

To test and adjust the screen for colour convergence you will need a test image from a calibration tool that you will find in the section Screen adjustments/Colour Convergence.

You will find more information about adjusting colour convergence in the section Screen adjustments.

Geometric Defects

Geometric problems only occur with CRT monitors. Some example of geometric defects could be – circles appearing more oval-like, lines that are not straight and parallel with the monitor's frame.

Unfortunately, using only the automatic adjustment button on the monitor doesn't always give the best results. To test your screen you need special images that come with most monitor testing programs. A selection of some of the screen testing programs that are available can be found in the section Monitor Adjustments.

The active area of the screen should be as large as possible and the thin black frame surrounding it should be as thin as possible. Be sure to check the geometric shapes while adjusting the size of the active area of the screen so as not to create any distortions.

Read more in the chapter Screen adjustments.

Brightness and Contrast

If your monitor is too dark and the text is difficult to read because of poor contrast, it is recommended that you use a test image to adjust both the brightness and contrast. Brightness and contrast can be adjusted either with the graphics card or with the monitor's adjustment controls, usually found on the lower front of the monitor frame. Since it is more common to use the adjustment controls on the monitor, that's what we will discuss here.

The new digital signal input or DVI connection on most TFT monitors along with advanced software that often comes with the graphics card make adjustments such as brightness, colour tones and contrast also available through the operating system.

This is mainly of interest for users who work with graphic design and photographers and will not be discussed any further here. For more information on these adjustment possibilities contact your graphics card manufacturer or take a look through the graphics card manual.

Please note that some problems with brightness, or possibly glare, may be due to poor monitor placement in relationship to the main light source. The screen should appear slightly brighter than your surrounding working area to avoid glare problems.

Read more how to adjust brightness and contrast in the chapter Screen adjustments.

Sharpness

Problems with image sharpness often occur because of moiré distortion, poor colour convergence or your screen resolution is set too high or too low.

Some monitors may offer a focus adjustment, but not many.

If you cannot find a focus adjustment on your screen's adjustment controls or in your screen manual, please check the problems mentioned above.

In-depth – Operating System and Graphics Card Adjustments

This section is about adjusting the components inside your computer.

These adjustments are made using your mouse and/or keyboard. All of the adjustments are done with the help of dialogue boxes that pop up on the screen, helping you to navigate through the process.

Older operating systems may require you to restart your computer after you have changed a parameter. Therefore it is a good idea to make a list of all your adjustments. You can print out this list at the section Recommended order of adjustment. There you can check-off the settings that you have adjusted or controlled.

Setting the Refresh Rate

Please proceed as follows:

- > right-click anywhere on the desktop background
- > choose Properties
- > then Settings

This dialogue box provides information about your type of monitor, graphics card, current resolution and colour depth.

--> Click on Advanced

This brings up another dialogue box.

--> choose the Monitor tab

If you have a TFT monitor, a value from 60 Hz to 85 Hz is suitable. If you have a CRT monitor choose a value of least 85 Hz.

--> Confirm your selection by clicking Apply then OK.

Proceed to the next adjustment.

Setting Colour Quality and Screen Resolution

If you have a TFT monitor

Make sure you know the highest resolution (also called native resolution) your monitor can display, usually 1024x768, 1280x1024, 1600x1200 etc. This is the only resolution setting where it is possible to completely remove moiré defects.

Read on at To continue...

If you have a CRT monitor

Make sure you know the resolution suggested for your screen size discussed in chapter How to Determine Present Components?/Properties.

To continue...

The picture below shows where to set colour quality and screen resolution. Select a colour quality in the drop down menu on the right and the screen resolution on the left. Colour quality should be set to at least True Colour (24 bit), but can also be set higher (32 bit).

Please note that the value for the screen's colour quality may drop below 24 bit if you choose a higher resolution. If you have a CRT monitor select a lower resolution or if you have a TFT monitor select a lower colour quality.

Adjust colour depth (right) and screen resolution (left).

--> Click on the Apply button and

--> Click on Advanced

--> Choose the tab marked Adapter

--> Click on List of valid modes

Check if the highlighted settings on the List of valid modes complies with the values you just set. If this is not the case, select the right combination of settings from the drop down menu. If the combination you want is not on the list, either your graphics card and/or monitor are not up-to-date and do not fulfil the criteria of TCO'99.

--> Click on OK or Cancel

--> Now choose the tab marked General

Side effects after resetting screen resolution:

The screen resolution influences the size and appearance of your desktop. A low resolution on a large screen gives the appearance of a rasterized or “pixely” image. The following three images show the same font type and size at different resolutions:

When you increase resolution, font types and icons become smaller and when you decrease resolution they become larger. This has to be compensated for by an additional adjustment of the internal font size of the operating system.

NOTE: Adjusting the internal font size might require the OS (operating system) installation CD.

In the General dialogue box (shown above) under DPI setting, you have the option of choosing the size of the fonts used by your operating system. You can choose either Large size or a Custom setting (user adjusted magnification).

--> Click on Apply and then OK when you have finished.

Close all windows that have popped up.

In-depth – Screen Adjustments

Before adjusting your screen, it is necessary to install a calibration tool. There are commercially available test programs but also free tools, often provided by screen manufacturers, on the internet. If you work on an administrated internet network, please contact your system administrator before installing the software or ask the system administrator to calibrate your monitor. Before discussing this with your administrator it might be a good idea to check the screen using the images on this website first.

A good, free calibration tool can be downloaded from Iiyama.

The test images used in this section come from this calibration tool.

Other calibrating tools: Little CMS and Monitor Calibration Wizard.

If you are not satisfied with this tool, you can search the web using the keywords: +screen +”calibration tool” +adjustment.

To start the calibration, reset your monitor to its default settings by pressing the AUTOMATIC button on your monitor control panel. There should also be a menu button to access the on-screen menu for making the necessary adjustments in this section.

If you have any problems navigating through your screen menu, check the monitor manual, where you should find a section on how to use the screen adjustment controls.

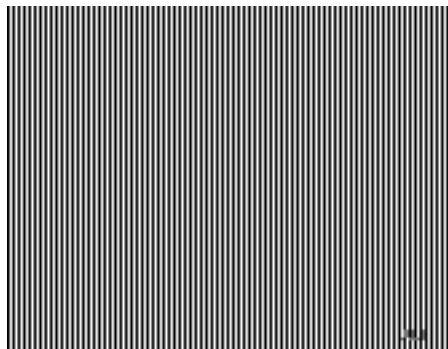
Adjusting Colour Convergence

Choose the test image for colour convergence.

Adjust colour convergence with the help of your monitor's adjustment controls by aligning the horizontal and vertical lines with each other as closely as possible. Keep in mind when you try to adjust your screen's colour convergence that it can be improved upon but it's difficult to get it perfect.

Removing Moiré Distortion

Switch to the Moiré test images in the screen calibration software.



You should see an even grid of straight black and white lines across the entire screen.

If there are some areas of reduced sharpness, or you see wavy lines instead of straight ones this need to be adjusted.

If you have a CRT monitor, adjust the Moiré setting using the adjustment controls.

If you have a TFT monitor with an analogue connection, use the image lock function from the screen adjustment menu.

Using the test image, keep adjusting until you see a fine grid with good contrast across the screen.

If you have a TFT screen using a digital connection, and the test image it is not sharp with high contrast and fine lines, your monitor resolution is set wrong.

Colour

Choose the colour test images.



These images will help you see if your monitor displays an even colour tone over the entire screen. By adjusting the monitor's colour temperature you can influence the brightness of the three colours compared to each other.

A higher colour temperature results in colours with a "colder" more bluish cast, whereas a lower colour temperature results in "warmer" colours with a reddish cast.

Almost all screens have the possibility to save a user generated colour profile. This feature should only be used if there is a serious colour imbalance. For more accurate colour adjustment, advanced calibration tools are needed. One such tool is Eye One from Gretag MacBeth.

Adjusting Geometry

Select the GEOMETRY option

Press the monitor's adjustment controls and find the menu button and adjust the geometry: circles should be round not oval, rectangular objects should be straight and lines should be truly horizontal and vertical. Also adjust the size and location of the active area so you use the whole screen area.

Brightness and Contrast

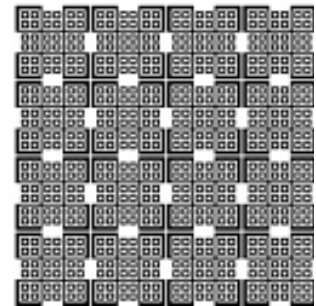
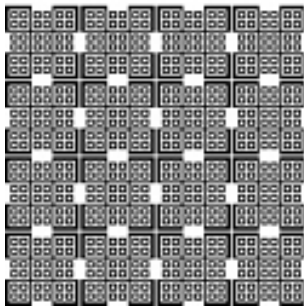
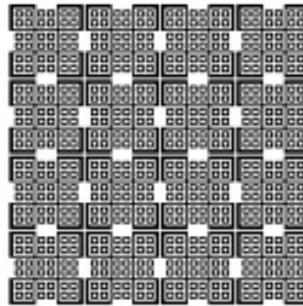
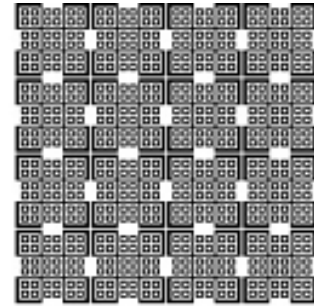
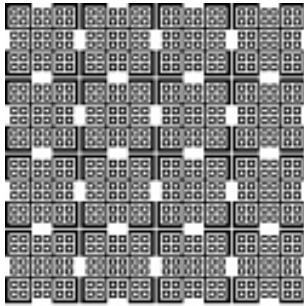
Switch to the readability control image.

Set your brightness control as low as possible and contrast as high as possible. Begin by optimising brightness and then adjust the contrast to a level that you feel comfortable with.

If your workspace is mainly dependant on daylight as a light source, you may want to adjust the brightness several times a day. This is why there is often a direct and easy-to-access brightness control on the front of the monitor.

Sharpness

Now check edge sharpness on your screen with these test images. When you have performed all the adjustments properly, you should see perfectly sharp images.



If the images are not clear and sharp after calibration, you will have to start over and try again.

In-depth – New components are needed

If you need to buy new components, this does not necessarily have to be expensive. Of course a high quality monitor has its price, but then it is often worth it. The graphics card and the monitor cable should be chosen according to the type of monitor you have selected.

A good graphics card, with a Digital Video Interface can be purchased at a very reasonable price if you are not out to buy one with the latest in 3D technology. When buying a new computer the components are usually up-to-date as well.

Please note: You seldom get a really good monitor in a package deal when buying a new PC. It is important to first choose a good monitor and then the computer i.e. the graphical interface at the computer. This section will help you choose the right components.

Choosing the Right Screen

Your work environment and what kind of applications you use determine which kind of monitor you should choose. At most work places today both Flat Panel (TFT) screens and CRT screens are used. For office work and office applications, TFT screens may be recommended.

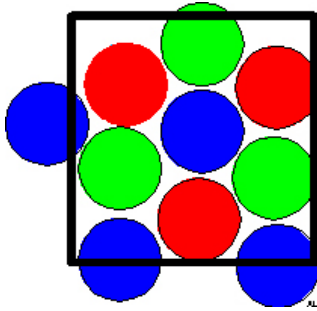
For more specific tasks, such as graphic applications, CRT monitors are often preferred. A CRT screen enables the user to switch between different resolutions while still using full screen size and sharp image quality. A TFT screen is limited to its native resolution because at other resolutions it can produce faults in the displayed image, or it will display a smaller image. TFT screens are also much brighter than CRT screens and sometimes it is necessary to adjust the ambient light at the workspace to accommodate the TFT monitor.

When buying a new monitor, the colour of the frame should blend in with the background of your workspace (a wall for example) as much as possible. This should be considered if you are thinking of buying a monitor with a black or other coloured frame. The screen should also be TCO certified, this ensures that it complies with ergonomic regulations.

Introduction to screen technology (advanced)

The major differences between CRT and TFT screen technologies are the picture elements (pixels) and the light source of the screen. Pixels are the smallest unit of image information. All images, icons, font types, menus are made up of pixels. The resolution of the screen is defined by how many pixels are displayed on the screen horizontally and vertically. For example: 1024 x 768 means 1024 pixels displayed horizontally and 768 pixels displayed vertically.

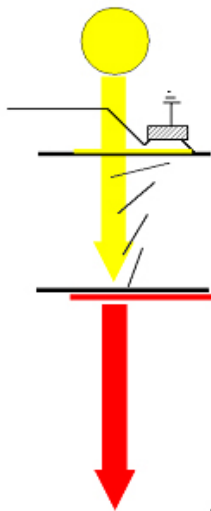
To the left: The analogue signal from the graphics card is linked to an electron canon. Depending on the analogue signal, the intensity of the electron beam aiming at the screen varies. The electric field is directing the electron beam. Where the electron beam hits the shield, visible radiation is emitted. The colour mask filters the visible radiation into blue, green or red signals.



To the left: The physical pixel at CRT screens is variable. Depending on the size needed, the amount of colour filters is varied

A CRT screen does not have a physically located pixel on the screen. This is why you can adjust the size of the whole displayed image any way you want, without losing focus, sharpness and image information. These image components are very flexible but on the other hand this makes the CRT screen very sensitive to imaging faults. The light source for a CRT screen is a pulsed beam, which “scans” the surface of the panel. Due to the pulsed imaging method, there is no stable illumination of the image. Our limited eyesight perceives the image as steady if this happens fast enough. The refresh rate of the image is the factor that determines how often the image information is renewed. It needs to be set to a high updating interval so we can see the image without straining our eyes. This way of producing an image is referred to as analogue.

A TFT screen has a different concept in imaging. The pixels are fixed at certain positions on the panel. The number of pixels is fixed and cannot be changed. This is why this pixel is referred to as “physical pixel” or “hardware pixel”. The illumination is a steady light source without flicker. The TFT (Thin Film Transistor) maintains the image information until it is updated (or refreshed) again by the graphics card. This allows for a lower refresh rate to achieve a steady image. This way of producing an image is referred to as digital.



A white light source is located behind the TFT panel. In the panel is located a liquid crystal that can permit the light to pass through the panel or to stay inside the panel. Filters colour the trespassing light into red, green and blue colours.

Some TFT monitors have such manual adjustment possibilities as rotating the screen itself 90° to a portrait view, changing the viewing angle or adjusting the height. For greatest flexibility it is recommended choosing a screen with at least some of these adjustment possibilities. Such features make it easy to change the position and orientation of the screen and help your body to find a more healthy working position.

Information needed before choosing a screen

Before a screen is chosen, the following questions should be answered:

- How large do you want the screen and how high a desktop resolution do I want/need?
- Which signal interface (Analogue or Digital) should the screen have?

Choosing the Right Graphics Card

Another aspect of graphics cards that should be looked into is what kind of hardware interface (connecting signal cable) it comes with.

There are two types of hardware interfaces that are used for connecting your monitor to the computer through the graphics card: the analogue interface (RGB) and the digital interface (DVI). The analogue interface is the most common. Both TFT and CRT monitors can be connected with this kind. There are several TFT monitors and graphics cards that also have a DVI interface.

To understand the difference it is important to know that information inside the computer is digital. The computer memory is made up of only ones and zeros, which are coded in a special way. To transmit the information to a monitor with an analogue interface, the digital code needs to be converted into an analogue signal. This is done by the graphics card.

A CRT monitor uses only analogue signals

Many TFT monitors can manage incoming digital signals. Using the analogue input interface for a TFT monitor results in the digital signal from the computer being converted into an analogue signal through the cable and then being re-converted into a digital signal which is then sent to the monitor. In order to obtain improved image quality, the DVI – Digital Video Interface - was developed right after TFT monitors came on the market. With this interface it is no longer necessary to convert the digital information in the computer memory to an analogue signal.

Using the DVI signal cable disables some screen adjustments because the information in the computer memory already contains the required information. Important user adjustments such as setting brightness and colour can still be accessed using DVI. Using DVI is problem free compared with the analogue interface and significantly enhances image quality for TFT monitors.

Choose a new graphics card only when you have decided which kind of interface you want to use for your monitor.

Advantages and Disadvantages

Advantage CRT	Advantage TFT
----------------------	----------------------

<p>Cheaper</p> <p>Can change screen resolutions and still maintain good quality image</p>	<p>Very sharp image</p> <p>Some have analogue and DVI input</p> <p>Light-weight, easy to move so screen can be easily adjusted to different working positions</p> <p>Thinner = more working space on your desk</p> <p>Less heat emission</p> <p>Less electro-magnetic radiation</p>
<p>Disvantage CRT</p> <p>Heavy and bulky, not so easy to move around on the working space</p> <p>Large, takes up a lot of space leaving less workspace on the desk</p> <p>Less sharp image</p> <p>Needs high refresh rates for best image quality, may flicker at low refresh rates and often needs manual geometric adjustments</p> <p>Only an analogue signal input</p> <p>Less contrast</p> <p>Higher energy consumption</p> <p>More sensitive to disturbances (Jitter) from external electro-magnetic fields</p>	<p>Disdvantage TFT</p> <p>Only one good resolution at full screen size</p> <p>More expensive</p> <p>The screen, itself, is very sensitive</p>

In-depth – Recommended Order of Adjustment

When you first begin to adjust your monitor, it is recommended that you follow the steps in the order listed below.

1. Make sure all drivers are properly installed and reboot the computer.
2. Set the Refresh Rate to 85 Hz if you have a CRT monitor or to 60 Hz if you have a TFT monitor.
3. Desktop resolution:

If you have a TFT monitor, set the resolution to its highest native resolution.

If you have a CRT monitor use the information below as a guideline for the best resolution setting: 15 inch: 800x600 17 inch: 1024x768 19 inch: 1280x1024

4. Colour depth: Set the colour depth as high as possible, at least at 24 bit.

5. Start a screen calibration tool with test images.

- First choose the geometry test image.
- Press the automatic adjustment button on the front of your monitor.
- Press the menu button and adjust the geometry: circles should be round, squares should have straight lines parallel with the borders of the active area. Adjust the size and location of the active desktop area so it covers the entire screen.
- Then choose the test image for colour convergence and adjust colour convergence with the help of the on-screen menu, aligning the "+"s as best you can.
- Switch to the Moiré test images. You should see a grid of black and white lines covering the screen. If sharpness is reduced in some areas, use the Moiré tool in the on-screen menu to adjust this or use the image lock function on TFT screens until you see a fine grid of lines with good contrast over the entire screen.

6. Now switch to the brightness and contrast control image. Set brightness as low as possible and contrast as high as possible. Now start with optimising contrast and afterwards set the brightness to a level that you feel comfort with. If your workspace is dependant on daylight, you might want to adjust brightness several times a day. This is why there is always a direct and easy to access brightness control on the front of the monitor.

7. Now check sharpness and readability with a test image. If you have performed all the adjustments properly, you should now have a perfectly sharp image.

8. Choose the colour test images. With these you can check if the screen displays an even colour tone over the entire screen. By adjusting the colour temperature you can control the tone of the colours. A higher colour temperature is more bluish and a lower colour temperature is more reddish. Most monitors have the possibility to save a user-generated colour profile. This feature should only be used if there is a strong disharmony in the colours.

In-depth – Suggestions for Organisations with Administrated Intranet

Software

Before buying a new software program, it is to your advantage to test a trial version first, if one is available. Often trial versions can be downloaded from the application

software's homepage. The combination of monitors set to a high resolution together with applications using small font sizes can create visual problems especially for people needing reading glasses and may be incompatible with the The Work Environment Authority's Statute Book (AFS) Work With Display Screen Equipment 1998:5, §10.

Many such programs put people at a disadvantage when they are trying to set up their computer monitors for the best possible visual ergonomics. Sometimes you can remedy the situation by setting your program to display larger font sizes, but this doesn't work for all programs. If you have this problem with an e-mail program, for example, you can work around it by asking your e-mail correspondents to write to you using a larger font size. In the long run, contact your administration department and ask them to help you with the problem.

Databases

If a database is shared between many users, an all-purpose graphic user interface is usually set up. Dialogue boxes are often displayed with standard normal/small font and icon sizes. Especially older people have difficulty seeing these small fonts with screens set at a high resolution. For good visual ergonomics it may be necessary to provide multiple graphic user interfaces with different font and icon sizes.

In-depth – Step-by-Step Guide

Operating System

1. Open Windows Explorer.
2. Right-click on My Computer
3. Choose System Properties
4. Note all information between System and Registered to
5. Close all windows and go back to the guide.

Monitor and graphics card

1. Right-click anywhere on your desktop background
2. Choose Properties
3. Click on the tab marked Settings
4. Note the values that are marked in the picture below:

The red rectangle on top tells you about your monitor and the graphics card it is connected to. On the right you see information on the colour quality, and to the left you see the current screen resolution.

5. Click on the button Advanced
6. Choose the tab marked Adapter
7. Click on the button List All Modes
8. Note the highlighted values, they show the current screen resolution, colour quality (colour depth) and refresh rate.

The window shows a list of all modes that can be displayed by the screen and the graphics card. The highlighted line is the current setting.

9. Close all windows and go back to the guide.

Hardware drivers

1. Open Windows Explorer
2. Right-click on My Computer
3. Choose Properties
4. Choose the Hardware tab
5. Choose Device manager

Click on the “+” –symbols at the icons for Display adapters (graphics card) and Monitors to get information about the driver that is currently used for the components.

In case there one device is listed as Standard or Default, please install the current driver for that specific device.

6. Right click on the device name
7. Choose Properties
8. Click on the Driver tab
9. Note the version of the driver. You might need the version number for eventual updates.
10. Close all windows and go back to the guide.

In-depth – Removing Moiré Distortion on TFT Monitors

Make sure you know the highest resolution (also called native resolution) your monitor can display, usually 1024x768, 1280x1024 or 1600x1200 (sometimes higher). You can find this information in the manual that came with your monitor, the specifications on the package or by searching on your monitor manufacturer's website. This resolution is where you have the possibility of removing Moiré distortion completely.

To get there:

--> right-click on the desktop background and

--> choose Properties then Settings

Where you see Screen resolution move the slider towards More until you see the maximum resolution your screen can display.

Adjust colour quality (right) and screen resolution (left).

--> Click on Apply and continue reading:

Side effects of adjusting desktop resolution:

Screen resolution influences the size and appearance of your desktop. A low resolution on a large screen will give the appearance of a rasterized image. The following three images show the same font (text) type and size at different resolutions.

When you increase resolution, font types and icons will become smaller and when you decrease resolution they will get larger. You can fix this if you want by an additional adjustment – adjusting the internal font size of the operating system.

Please note: Adjusting the internal font size might require your WINDOWS installation CD!

You can access this option by clicking on the Advanced button of the Properties window and then choosing the tab marked General.

Under DPI setting you can choose the size of text for the operating system. You can choose between Normal size (96 dpi), Large size (120 dpi) or Custom setting (for user defined magnification).

--> Click Apply and then OK when you have finished.

--> Close all windows that have popped up.

In-depth – Terms

Analogue, analogue interface

Traditional RGB interface for computer screens. The digital information in the computer memory is translated into an analogue signal. This takes place at the graphics card. The analogue cable connects the screen via the analogue interface with the computer.

Brightness

Refers to the visible intensity of the light source coming from inside the screen.

Cable, connection cable

A cable connecting the graphics card and monitor; may have either a digital or analogue interfaces.

Calibration tool

Software tool used to adjust the imaging properties of a computer screen

Colour convergence problem

Refers to how sharply an individual colour pixel on a monitor appears. Each pixel is composed of three dots – a red, blue, and green one. If the dots are badly misconverged, the pixel will appear blurry. All monitors have some convergence errors, but they differ in degree.

Colour depth, colour quality

The number of distinct colours can be displayed on a computer screen. The unit is measured in bits because it is related to the number of bits used for each pixel. A 24-bit colour quality setting, for example, has a colour depth of 2 to the 24th power (about 16.7 million) colours. One would say that its colour depth is 24 bits.

Colour temperature

Parameter describing the relative distribution of intensity in the optical spectrum. For computer screens this refers to the intensity distribution for the colours red, green and blue: the higher the colour temperature the more bluish the colour distribution and the lower the colour temperature the more reddish the colour distribution.

Contrast

The difference in light intensity between the brightest white and the darkest black of the monitor.

CRT

CRT is short for: Cathode Ray Tube. This is the type of colour monitor generally used with PCs from the early 1980s until 2000. Today they are often being replaced by TFT screens.

Driver, version

A driver is software without a graphical user interface. It works like a translator between the computer components and enables communication between all the hardware components which have a driver. The driver version helps to determine whether or not the driver is up to date. Often performance is increased or problems are solved with a new driver version. The version number counts upwards from 1.0 or 1.0.0 or 1.0.0.0.

DVI, Digital Video Interface, DVI input, DVI output, DVI cable, digital

DVI is a signal transfer mode for monitors that need a special DVI port or interface.

One advantage of DVI technology is a very low loss of image quality when the image is transferred from the computer to the screen.

Graphics card

Hardware that plugs into a computer and gives it display capabilities. May also be called a video adapter, video card, video board, video display board, or a graphics adapter.

Computer hardware, hardware

Refers to optical or electronic devices inside or connected to the computer that you can actually touch, such as discs, monitors, keyboards, mouse etc.

Signal Interface

Connector for the cable between the monitor and graphics card. Different kinds of interfaces are available - the traditional analogue RGB interface and the more modern DVI interface.

Moiré, Moiré distortion

Also known as screening effect. A problem for computer screens. The number of pixels in the computer memory is not matched to the amount of screen pixels. The image fault is seen as a periodically loss in shape, contrast, and edge sharpness.

Operating system

The most important program that runs on a computer. Every computer needs to have an operating system to run other programs. Operating systems perform basic tasks, such as recognizing input from the keyboard and sending output to the display screen, keeping track of files and directories on the disc, and controlling hardware.

Refresh rate

The refresh rate for a monitor is measured in hertz (Hz). A refresh rate of 80 Hz means that the monitor redraws the display 80 times per second. The faster the refresh rate, the less the monitor flickers.

Desktop resolution, screen resolution

For monitors, the screen resolution signifies the number of picture points or pixels on a display monitor, expressed in terms of the number of pixels on the horizontal axis and the number on the vertical axis. For example, a 1024 x 768 pixel screen is capable of displaying 1024 pixels on each of 768 lines, or about 300,000 pixels. The same pixel resolution will be sharper on a smaller monitor and gradually lose sharpness on larger monitors because the same number of pixels are being spread out over a larger screen.

Software

Programs which enable us to use features of the computer. They work in dialogue with the operating system or belong to it. Anything that can be stored electronically is software. Storage devices and other peripheral devices are referred to as hardware.

TCO 99, TCO 03

Certification that assures special ergonomic and environmental properties of the monitor. The numbers refer to standards developed in 1999 and 2003.

TFT

Short for Thin Film Transistor, also known as LCD (Liquid Crystal Display) or flat panel screen. Each pixel is controlled by from one to four transistors. This technology began to appear on the computer market in the early 90s but not until the late 90s were they produced in a satisfactory size and quality. Today they have replaced CRT screens.

Good working techniques and work design



It is very important to break up prolonged periods of sedentary work with tasks that are more varied, both mentally and physically (in terms of load and movement patterns). The Swedish Work Environment Authority stresses this in AFS 1998:5 7§: "Display screen work which is closely controlled or restricted in a physical or mental respect or is monotonously repetitive may not normally occur." Living up to paragraph 7 is a challenge for every company and computer user. It can be accomplished in different ways, and measures can be varyingly comprehensive. Plan your working day so that you alternate computer work with other tasks. In other words, do not save all computer work for one long work session and other tasks for another.

Vary your working posture

Vary your sitting posture often (several times an hour) and in different ways. Lean backward and forward, stretch your feet out far in front of you or lift them up onto the chair base. A good office chair is a requirement (see Furniture for computer work). It should preferably have a rocking feature, which gives your body – particularly your back and neck – variation in terms of working posture and degree of strain.

Work standing up

One effective way to vary your working posture and the strain on your body is to alternate between sitting and standing while doing computer work. This requires a work table that is vertically adjustable. There is less strain on your back when you are standing, in comparison with sitting in a forward leaning position or upright without support. Alternate between standing and seated work several times a day. Read more about work tables in chapter Furniture for computer work.

Get moving!

Be sure to walk around a bit, back and forth, as much as your work allows and as often as possible. While on the telephone, take the opportunity to stand up. Bend and

stretch your neck, shoulders, arms and back. You should leave your computer (preferably several times) for a total of 5-10 minutes every hour and perform another work task, e.g., fetch your post, do some copying, place a phone call or talk with a colleague. You could also go to the lavatory, drink some water or maybe clear your head in a quiet place if your work is hectic. The more monotonous, restricted or stressful your work is, the longer and more often you should take such breaks.

Take the opportunity to "steal" chances for movement when they are offered. For example, place your printer outside your office. Having your printer in another room gives you an extra and welcome reason to leave your computer for a few minutes. Use the stairs instead of the elevator when you need to go up or down a few floors in the building.

Broaden your work tasks

Broaden your work to include non-computer tasks. For example, you can read, write, discuss, plan and report on something, preferably with others on your work team. Further education is another possibility. Take the opportunity to stand/walk as often as possible on such occasions as well. Another idea is to hold meetings standing up. Special tables are available for just this purpose.

An even better idea is to perform work tasks that entail more movement. For example, do some maintenance/repair work, make coffee or arrange refreshments and fruit for co-workers. Another example is to do scheduled cleaning work at the workplace. Full-time cleaning work is often strenuous and entails risks for work-related injury. However, if your work is sedentary, weaving cleaning tasks into your working day would seem to be advantageous. If you decide to do this, see to it that everyone receives adequate training and instruction.

Similarly, it is possible to find other appropriate work tasks (both within and outside one's own workplace) that can be alternated with computer work, thereby creating mental and physical variation in work. Such solutions need to vary as a function of the nature of the business and the local labour market conditions. For example, it has been suggested that the highly restricted computer/telephone work at call and contact centres could be combined with work at a local nursing home.

What does the law say?

Statute Book of the Swedish National Board of Occupational Safety and Health
1998:5

Arrangement and organisation of display screen work

7 § Display screen work which is closely controlled or restricted in a physical or mental respect or is monotonously repetitive may not normally occur.

8 § In the event of eye strain or other strain-related disorders resulting from work with display screens in spite of the measures referred to in Sections 2-7, work shall if possible be arranged in such a way that the operator can switch to other, less

strenuous tasks. If this cannot be arranged, the operator shall have sufficient breaks in the course of work for disorders to be avoided.

In-depth – Good working techniques

Variation

You can vary your working techniques in different ways within the framework of your work.

You should learn the various shortcut keys on your keyboard and in this way reduce mouse manipulation. This also provides more variation in movement patterns.

Several common shortcut keys

Hold the Ctrl key down while striking the appropriate letter key, for example:

- Ctrl + A = Select all parts of the opened document
- Ctrl + S = Save the document
- Ctrl + C = Copy selected parts of the document
- Ctrl + X = Cut out selected parts of the document
- Ctrl + V = Paste in what has been copied or cut out

In Microsoft Office you can select Help on the toolbar and then on Help about Microsoft Word, or strike the F1 key. Write the word "shortcut keys" in the entry field and select "Search". Here you can print a list of the various shortcut keys or learn about how shortcut keys work.

Another way to add variation is to alternate between using your left and right hand when manipulating the mouse. This is not suitable for everyone, because some become so nervous about changing to the untrained hand that they risk developing complaints due to tension.

Besides using varied working postures and movements, a good working technique also includes taking advantage of every opportunity to support your forearms and hands in order to reduce the strain on your arms, shoulders and neck. When working with the keyboard or a pointing device (e.g., a mouse), don't allow your hands to be suspended in the air, but instead support them on the tabletop. When you don't need your hands to work – e.g., when you're reading from the screen or when your computer is performing a search – rest your hands in your lap or on the armrests/table surface. Take the opportunity to relax your shoulders and allow them drop down. Make sure this happens often – preferably once every minute, if only for a few seconds ("micro-pauses").

Even your eyes need to "get moving" and rest. It is advantageous and restful for your eyes if you use pauses and other breaks from computer work to focus your gaze on an object that is at least several metres away. Another method is to close your eyes

for several minutes. Alternating computer work with completely different work tasks usually satisfies your eyes' need for variation and recuperation.

Leave your computer at least once every hour.

Work in a relaxed manner

If you frown often, you will get headaches. If you elevate your shoulders and shoulder blades because you're feeling tense, irritated or stressed, etc., you will easily develop neck and upper back problems. Sitting for prolonged periods with your mouse finger suspended above the mouse button can easily result in "tennis elbow". Try to observe how you work, particularly when work is stressful.

Don't work with your shoulders elevated.

Work in a relaxed manner.

Don't work with your mouse finger suspended in the air.

Let your mouse finger rest on the mouse button.

After work

You should engage in some form of physical activity, e.g. biking or walking briskly to and from work, for a total of at least 30 minutes a day. This does not need to be so strenuous that you become sweaty or noticeably out of breath.

Twice or three times a week (45-60 minutes per occasion), you should engage in a form of physical activity that causes you to become sweaty and out of breath. Such activities include callisthenics, jogging, dancing and heavy gardening.

Don't take work problems home. If you have trouble falling asleep and sleeping well because of things that are happening at work, you should see this as a warning signal that something is wrong.

"Vaccination" against "mouse arm"

- Always – work in a relaxed manner, with strain-relieving support and variation.
- Every minute – take a micro-pause.
- Every hour – leave your workstation several times, for a total of at least 5-10 minutes.
- Every day – be physically active for a total of at least 30 minutes.
- Every week – exercise 2-3 times for at least 45-60 minutes per occasion.

Pauses in computer work

Today's society and working life are characterized by a constant high tempo, efficiency and competition. Variation and recovery time are important to both body and soul. One way of creating space for variation and recovery is to pause frequently or take other breaks in computer work. This is particularly important in sedentary work in front of the computer.

Physical variation is important, but it's also important to take a break from the mental stress that this work involves. Besides lunch breaks, most workplaces also have coffee breaks in the mornings and afternoons.

If work involves a lot of sitting, a good way of creating variation is to stand up while drinking coffee. Try taking a walk during the lunch break as this can often be relaxing for both body and soul.

In today's working life, more and more people have a computer as their main working equipment. Depending on how work is organized, one can be more or less bound to the workplace. Today, many people remain sitting at their workplace all day long, without natural pauses for discussion, meetings, copying, archiving documents and so on.

Text and English translation: Jens Wahlström and Tohr Nilsson

In-depth – Variation

Sitting at the computer for hours doesn't mean that we are exposed to high levels of physical stress (compared for example with building or cleaning work). Sitting in a fixed working position involves monotonous working movements where muscles move continuously and in the same way. It has also been shown that mental stress creates similar continuous pressures.

It is suspected that monotonous, long-term muscle stress is one of the factors that causes aches and pains in our muscles. One way of stopping monotonous muscle stress and creating increased variation for the muscular system is to take shorter breaks of minutes or seconds several times per hour.

Longer breaks, 5-10 minutes, should be taken once per hour if you work with the computer 3-4 hours per day. The more monotonous, static and stressful computer work is, the more frequently long breaks should be taken.

The same applies if the computer workstation is unsuitably designed, for example if you can't work with support for arms and hands. The longer your working day at the computer, the more careful you have to be to create breaks and pauses. Try changing to other tasks (meetings, copying and so on).

In conjunction with breaks, it is helpful to carry out some form of physical activity (stretches, relaxation/deep breathing, walking in the corridor, making coffee, cleaning and so on). It's important to move as often as the opportunity arises.

You can also create opportunities, for example by placing the printer outside the room. If your printer is in another room, this gives you a reason to leave the computer for a minute or two.

It is important to pay attention to your body's signals. Take a break when you start to feel tense and stiff. You can install a break software tool on your computer to help remember to take breaks. Some of these break software contain suggestions for exercises and stretches to increase activity. Advice and tips on these computer programs can be obtained from company healthcare or other local organizations.

Pull your shoulders toward your ears and hold for a few seconds, let your shoulders fall down – relax! Repeat 5-10 times.

Sit comfortably on your chair, close your eyes, take a deep breath, and slowly breathe out – relax! Repeat 5-10 times.

Recommendations

Break/pause 5-10 minutes every hour.

This applies to "ordinary" computer work 3-4 hours per day and a well designed workplace. For less suitably designed workplaces or for repetitive/monotonous, pressured and/or stressful work, you should have breaks/pauses more often. The longer your working day at the computer, the more frequently you should break it off.

Take shorter minute/or seconds-long pauses in between.

In-depth – Scientific literature

The scientific literature contains studies that have studied the effect of breaks in computer work on a number of different factors including productivity, strain, discomfort, aches and pains (see references). There are no accepted definitions of how long a break should be. The lengths of the breaks studied in the literature vary from 7 seconds to 10 minutes. Here is a short summary of current knowledge after which we refer to certain of the studies in more detail.

Summary

- Several studies agree that breaks in computer work reduce discomfort and problems.
- Several studies agree that productivity is not negatively affected by pauses in computer work.
- Breaks are important in providing variation and recovery from the mental and physical strain involved in work.
- No conclusions can be drawn on whether active or passive breaks are preferable, since several studies have shown different results.
- Break software installed in computers appears to be beneficial. Few studies have been undertaken however, so it is impossible to draw incontrovertible conclusions.

In-depth – Aches, pains and discomfort

A review of scientific literature published in 1997 showed no proven connections between breaks in work and aches/pains in the neck arms and hands (Punnett et al., 1997). Studies published in 1997 or later show universally positive effects in the form of increased comfort and reduced problems (Balci & Aghazadeh, 2003; Ferreira Junior et al., 1997; Galinsky et al., 2000; Henning et al., 1997; McLean et al., 2001).

Break software

Two studies have studied the effects of break software in computers. One study showed that those who had the break program installed in their computers took more breaks than those who did not have the software (Monsey et al., 2003).

The other study observed positive effects with less discomfort when the break program was introduced (van den Heuvel et al., 2003).

Lack of rest and recuperation

It has been suggested that a lack of rest and recovery time can be a greater health problem than the physical and psychological stresses that the work in itself involves (Lundberg, 2003).

In-depth – Active/passive breaks

More studies have examined passive breaks than active breaks. An active break means a break during which some kind of stretching or movements of muscles are carried out. A passive break means that one simply sits still and rests. Several studies have studied the differences between active and passive breaks on muscle activity and discomfort and so on.

A Swedish study by Sundelin & Hagberg (1989) studied various types of breaks and their effects on muscle activity in the shoulder musculature “trapezius” and feelings of

discomfort in different parts of the body. The results showed that through an active break, one could change the pattern of muscle activity, which is positive for breaking static patterns.

These studies also observed indications of reduced discomfort in the eyes, neck and arms. The reason why these differences were not greater could be that the experiment only lasted 30 minutes and that the individuals who participated did not develop discomfort to any great extent during this short period of time.

The motor unit is the muscle's smallest functional unit and consists of a nerve and a number of muscle fibres controlled by the nerve. One of the possible explanations why muscle pain can occur during computer work, for example, is that certain motor units are active over very long periods.

The background to this damage mechanism is that when the muscle develops strength, the motor units are activated in a special order (more active muscle fibres = increased strength). When strength is reduced, the motor units are disconnected in reverse order and this means that certain motor units are always active when a muscle works.

It is possible that the motor units that are often active risk being overloaded and damaged, which would lead to pain in the muscle. In some studies, however, it has been observed that when an active motor unit is "switched off" another is activated and in this way the strength that a muscle develops is kept constant. This phenomenon is called motor unit substitution and is probably connected with reduced risk if the muscles work in this way.

In a Norwegian study, researchers examined how the motor units that worked at a constant low level reacted when they developed more strength during a short period (Westad et al., 2003). It became clear that in direct conjunction with a short period (2-4 seconds) of increased strength development, some of the active motor units were disconnected and that some recruited during the increased strength development remained active. These results indicate that muscular work with an element of increased strength development could be a way of creating a more suitable muscular pattern. One way of increasing strength development in the trapezius muscle is to pull the shoulders towards the ears and hold them there for a few seconds.

A Dutch study (van den Heuvel et al., 2003) studied how participants' symptoms were affected by break software installed in their computers. The participants (219) were divided into three groups.

The first group functioned as a control group (no remedial measures), the second had a break program installed and the third group had the break program installed with instructions via the computer to carry out certain movements.

The break software functioned in such a way that participants were given instructions to take a break (5 minutes) after 35 minutes of continuous computer work and a micro-break (7 seconds) after 5 minutes of continuous computer work. These

instructions did not appear if work was broken off by a natural break or micro-break. The breaks (5 minutes) could be delayed by 15 minutes at a time.

During the breaks and micro-breaks, the computer was blocked so that it was impossible to carry out any computer work. The results showed that, after the 8-week-long follow-up period, the two groups with the break software installed reported greater recovery from their symptoms than did the control group. There were, however, no clear differences between those who had had active and passive breaks. There were also no clear differences between the three groups in relation to the severity of the symptoms reported in the neck, arms and hands.

An interesting detail in this study is that a break program was used in the computer that could only be delayed once, after which the computer was blocked during the break period.

The authors did not discuss what consequences this could have had on the perception of stress and how participants experienced this control over their work. It is vital that attempts are made to answer these important questions in future studies.

In-depth – What does the law say?

Statute Book of the Swedish National Board of Occupational Safety and Health
1998:5, Work with Display Screen Equipment

7 § Display screen work which is closely controlled or restricted in a physical or mental respect or is monotonously repetitive may not normally occur.

8 § In the event of eye strain or other strain-related disorders resulting from work with display screens in spite of the measures referred to in Sections 2-7, work shall if possible be arranged in such a way that the operator can switch to other, less strenuous tasks. If this cannot be arranged, the operator shall have sufficient breaks in the course of work for disorders to be avoided.

Guidance on Sections 7 and 8

Variation by means of breaks and alternation with other tasks aims at preventing the strain in the course of a working day from causing excessive fatigue or other discomforts which can be harmful in the long run. It is essential for the individual to be free to alternate tasks or take breaks according to his/her own needs. The length of time for which work with a display screen can be continued depends to a great extent on the nature of the work. There are some jobs where 1-2 hours' continuous work is feasible, while others may demand such close attention or such a degree of visual exertion as to necessitate shorter sessions. It is an advantage for work with a display screen to be organised from the very outset in such a way that it will naturally alternate with other tasks.

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Text: Jens Wahlström and Tohr Nilsson

Training and support

Poor correspondence between the computer system and the user's knowledge. It is often the case that the computer system, applications and information presentation on the display screen are not suited to the user. Such a lack of correspondence can easily lead to feelings of insecurity and stress on the part of the user. This also makes it difficult to achieve good work results.

Read more about poor adaptation of computer systems in chapter Software systems and user interfaces.

The introduction of computer technology at businesses and governmental authorities has entailed large investments in choosing and purchasing computer equipment and applications. However, it is often the case that the personnel who are to use this technology are provided with inadequate information and training. Thus, many lose their self-confidence and feel stress because they cannot manage the new technology.

Similarly, companies seldom provide help and support so that employees can advance in their use of, e.g., new applications. It is tempting for employees to keep quiet about their difficulties; after all, they don't wish to appear less talented and knowledgeable. Those who protest are sometimes viewed as "conservative" or "non-flexible". Naturally, saving money by cutting back on information and training is very short-sighted. The result of such cutbacks is employees who cannot make use of the expected advantages of the technology. Instead, many suffer from feelings of discomfort, stress and perhaps ill health.

Need for support when technical problems arise

An additional problem accompanying new computer technology is that there is often no help or support when technical and practical difficulties arise, e.g., when computers or software are not functioning. Such malfunctioning often leads to stress and feelings of powerlessness, especially when it occurs during periods of work under pressure, e.g., approaching project deadlines.

Good training and technical support

Introduction of or changes in computer work should take place in consultation with the affected personnel. For many, this makes it easier to participate in and feel they are part of developments in their work. Employers can also get a picture of the need for information and further training among affected employees. Information

dissemination and training can take place parallel to or in connection with the acquisition of new computer equipment or applications.

During new development or acquisition of computer systems and applications, user participation may be one way of increasing the user-friendliness of a new system/application.

Read more about user participation in chapter **Software systems and user interfaces**.

Training should preferably take place in stages and be adapted to users' circumstances with regard to previous training, language and similar factors. It is also important to design good information and training for the large group of people in working life who have reading and writing difficulties. Older and otherwise untrained computer users often require a bit more time, among other reasons because they are not familiar with "computer thinking" and the new computer terminology.

What does the law say?

Statute Book of the Swedish National Board of Occupational Safety and Health
1998:5

Software and systems

10 § Software and systems shall be suitably designed with regard to the requirements of the task and the aptitudes and needs of the operator. Software must be easy to use and, where appropriate, adaptable to the operator's level of knowledge or experience. Systems shall as far as possible give the operator's feedback with regard to the work done. They shall display information in a format and at a pace which are adapted to the operators. In the design and selection of software, special consideration shall be paid to the ergonomic principles applying to human capacity for perceiving, understanding and processing information.

Guidance on 10 §

It is essential for the software proposed and the systems planned to be evaluated in terms of their positive and negative effects on the working environment.

When introducing a new or modified software or system, it is vital for the employer to find out whether the employees have sufficient skills for using the new or modified computer support. If their skills are insufficient, it is important that the employer should ensure that they acquire the knowledge that is lacking, e.g. by means of training and information. Training measures accompanying the introduction of new or modified computer support need to be planned with due allowance for individual differences of prior knowledge and professional experience. The training should not only be concerned with the people working with certain equipments learning the best

way of doing their own work and how to handle the equipment. It is also important that the training should confer a knowledge of the purposes of the computer system and the main outlines of its structure, knowledge of the entire operation, and knowledge of the working process and of the goods and services produced. In addition to preparatory training measures, of course, recurrent training will also be needed.

It is important to make plans for averting and alleviating the negative effects of disturbances and failures right from the dimensioning and design of the system. The system should tolerate the occurrence of errors and the interruption of dialogue without information being lost or other vital factors being jeopardised. This applies both to faults caused by technical failure and to errors resulting from the human factor.

It is important that a reasonable amount of time be allocated to training and information dissemination. Merely giving employees a training video or CD to be used "when there's time" is too often insufficient, as immediate and daily demands usually take precedence. The outcome is often frustration and additional stress, but no training.

Similarly, technical and practical support are required when computer equipment and applications are installed and maintained as well as when unexpected problems and errors occur. The aim should be to attend to common errors/problems within 15-30 minutes. Thus, a full-time computer technician may be needed to support 15-25 computer users, if the systems are uniform and not too advanced.

Security

Computing systems, both the computer and its software, can be afflicted by different technical problems which will interfere with their use and, in worst case, loss of data. In the same manner, computer virus, worms, trojans, spyware and other nasty things can afflict the computer with more or less serious harm. This could cause serious problems and stress. You should therefore minimise the risk of such loss of data by regular back-ups of your files. The computer should also have a fire-wall that shields it from unauthorized encroachment. This should include an anti-virus program that is updated on a regular basis (every week).

It is important to plan for prevention of such negative effects already at the construction of the system. The system should be able to tolerate failure and interruptions in its operations without permanent loss of data or vital functions. This applies both to hardware and software failures and also problems caused by human mistakes.

Computer work at home

Computers are not only used at our workplaces. About 80% of the Swedish population between 16 and 74 years of age had access to a home computer in 2003 [SIKA, 2004; Nordicom; 2005]. Home computers are used for many purposes – playing computer games, searching for information and contacts via the Internet and e-mail, paying bills, etc. About 10-15% use their home computer for their paid work. Once home, many continue the work they couldn't finish at their regular workplace. For some, the home computer workstation is their regular workplace. About 40% of all businesses in Sweden report that their employees have the option of teleworking.

Just as a good work environment and working techniques are important for computer work at the workplace, conditions at the home computer workstation are also important. If work at home is assigned by an employer, the employer is equally responsible for work environment conditions at the home computer workstation as for those at the workplace.

What does the law say?

Work at home, teleworking

The Swedish Work Environment Act's and the National Board of Occupational Safety and Health's ordinances apply regardless of where work is performed. There are no special work environment regulations for work performed in the employee's home. Chapter 2, 1§ of the Work Environment Act states: "Technology, work organisation and job content shall be designed in such a way that the employee is not subjected to physical or mental strains which can lead to ill-health or accidents." The employer is responsible for the work environment regardless of whether the work is performed at the main workplace or another place, e.g., the employee's home. However, the employee should also help to create good work environment conditions.

An agreement needs to be reached between employer and employees (their representatives, safety officers/health and safety committee) regarding how good working conditions can be created when work is performed in the home and how the parties can co-operate to bring about such conditions. The employer may need to visit the employee's home computer workstation to evaluate the conditions and assess the risks.

If the parties agree that a portion of the employee's work is to be performed from home, the employer needs to ensure that the prerequisites for working there are in place. If work performed at home entails that the employee use equipment that, e.g., is required to be connected to an earthed power outlet, the employer needs to ensure that this is possible. If it is not, then the employer can establish that the prerequisites for working from home are not in place or see to it that the prerequisites are created. Who is to pay for what with respect to equipment needs to be agreed upon by employer and employees (their representatives).

What measures need to be taken in the home to create good work environment conditions need to be assessed from case to case. In making such an assessment,

the following factors need to be considered: how often work is performed at home (one or several days a week), the length of time spent working there, what equipment is to be used, etc.

Very little is known about working conditions for computer work in the home. Most information is based on anecdotal knowledge, which usually suggests that conditions at home are not as good as those at the workplace. People seldom go to the expense of buying a table and chair that are suited to prolonged computer work [Kaminsky et al., 1998]. The possibility to rearrange furniture and place the computer workstation appropriately is often limited by the fact that the home also serves purposes other than merely being a good workplace.

There are often constraints regarding space and furniture for computer work at home.

Sound computer work at home

Follow the basic rules presented in our other web pages on computer work. These include: work in comfortable working postures; arrange strain-relieving support for your arms and hands; ensure you get both mental and physical variation and recuperation.

A. Choice of room

Choose a room in which your workstation can be placed such that the display screen is not in front of or just beside a window (risk for glare) or such that there are no reflections on the screen. Ensure that there are curtains or blinds that can reduce bright sunlight. If this is not possible, avoid working at your computer during bright daylight. Wait until evening.

B. Choice of furniture

It is best if you can acquire a chair and table that are vertically adjustable. It is important that your chair and table fit well together, allowing you to sit with your arms in a working posture recommended in our web pages. It is important that the upper edge of your display screen be below your eye level.

C. Working techniques

If it is not possible to design your work room and computer workstation optimally, it is very important that you limit the time you spend sitting at the computer. Avoid sitting for several hours at a time. Take frequent pauses and breaks – many short breaks are better than a few long ones. Five to ten minutes, two to three times an hour is a good rule. Leave your computer. Move around and stretch your body. Take the opportunity to perform other tasks, e.g. household chores, now and then. The poorer your working conditions are, the more important it is that you work short sessions separated by breaks.

Computers at school

From the 1990s to the present, the number of computers and the use of computers have increased markedly. More and more, computers are being integrated into the organization and educational work of schools. Neck, shoulder, arm, hand and eye problems as well as headaches are common among computer users, regardless of their age.

New opportunities and new risks

Increased access to computers in the schools offers new educational opportunities, but also means the introduction of new work environment risks.

It is important that children and youth do not lay the foundations for computer-related musculoskeletal problems during their school years, because such problems may highly restrict their future choice of profession.

Things to consider

A comprehensive view of the entire computer environment needs to be applied when investing in computer and other IT solutions. Long-term efforts to create good computer workstations for students and all school staff are important. These efforts should include the capacity to adapt workstations to each user's needs and prerequisites.

Just as important as a satisfactory physical environment is that all users and other involved parties receive information and instruction on good workstation design and appropriate ways of working at a computer. A user with such knowledge is better able to safeguard against computer-related ill health and to work towards a good computer environment.

Read more

Hur ergonomiundervisning relaterad till datorarbete bör utformas för att väcka intresse hos elever (How instruction on the ergonomics of computer work should be formulated to arouse students' interest). Master's Thesis in Ergonomics (Swedish text; abstract in English).

More sedentary time

Increased computer use among children and youth, both at school and during leisure time, has resulted in more sedentary time and less physical activity. It is not uncommon for children/youth to spend several hours a day in front of a computer.

Things to consider

When using a computer, it is important to change your sitting posture often, preferably alternating between sitting and standing. Long and continuous working periods should be avoided. You should be away from the computer at least five to ten minutes every hour and do something completely different during those periods. The longer you sit still, the more important it is that you compensate for this by taking advantage of opportunities for physical activity, for example walking up the stairs instead of taking the elevator, walking or cycling to school/work, taking a walk

outdoors during lunch and engaging in some form of exercise/athletics at least twice a week.

Get moving!

Insufficient physical activity is a risk factor for many diseases found in modern welfare states, for example heart attack, high blood pressure, osteoporosis and adult-onset diabetes. Children and youth should learn about the importance of physical activity as early as possible to decrease their risk of developing problems and illnesses in the future.

What does the law say?

Since 1990, all students in Sweden (about 1.5 million), beginning from preschooling, are covered by the Work Environment Act. The Act states, among other things, that working premises need to be arranged and equipped in such a way as to provide a suitable working environment and that working conditions need to be adapted to people's differing physical and mental aptitudes.

It also states that the employer needs to ensure that the employee acquires a sound knowledge of the conditions in which work is conducted and that he is informed of the hazards which the work may entail. The employer needs to make sure that the employee has received the training necessary and that he knows what measures need to be taken for the avoidance of risks in the work.

With regard to computer use, there is a special ordinance from the Swedish Work Environment Authority called Work with Display Screen Equipment. Municipal politicians are ultimately responsible for ensuring that the Work Environment Act and its ordinances are complied with, but daily work with the work environment in the schools is often delegated to the head teachers. To achieve a good and sustainable work environment for computer use in the schools, however, it is important that everyone at the school, staff as well as students, see this as their common aim.

Working with the work environment

If you wish to read more about regulations pertaining to the schools and about how a positive work environment can be achieved at your school, go to the Swedish Work Environment Authority's web pages on work environment efforts in the schools. Information on these pages is aimed at all school students and staff as well as at municipal politicians and others responsible for the schools.

The School Environment 2000

You can also read a doctoral dissertation entitled "Arbetsmiljö och utveckling i skolan" ("Work environment and development in the schools"; Swedish text, summary in English). The main objective of this dissertation was to develop and test a structured approach to cooperation concerning work activities and the work environment in the schools. The resulting cooperation model is called "Skolmiljö 2000" ("The School Environment 2000").

Skolliv.nu

The National Swedish Institute for Working Life's website Skolliv.nu contains more information on "Skolmiljö 2000" as well as aids for achieving a better work environment in the schools.

Facts - Computer use in the schools

During the 1990s, great investments were made to increase the computer density in upper secondary and compulsory schools and to develop positive technical solutions for computer communication within the schools and between the schools and the surrounding world.

In the municipal upper secondary schools, the number of computers used in teaching increased from about 24,000 in 1993 to more than 72,000 in 2001. This means that the number of students sharing a computer decreased from 11 to 4.

The number of laptop computers also increased greatly during the latter part of the 1990s, primarily in upper secondary schools.

During the same period, the number of students per computer in municipal compulsory schools decreased from 38 to about 8.

Computer use in working life

In a few years, many of today's students will have jobs in which computers are important work tools. Today, two-thirds of all gainfully employed in Sweden use a computer in their work and slightly more than one-third use a computer during at least half of their working hours.

Musculoskeletal problems among computer users constitute an increasing occupational health problem.

Musculoskeletal discomfort

A large number of studies have shown that pain/aches in the neck, shoulders, arms and hands as well as problems with the eyes and headaches are common among adult, gainfully employed computer users. Factors such as poorly designed computer workstations and long, continuous working periods without pauses have been shown to increase the risk of problems, and computer work techniques, for example use of arm support, can affect the degree of muscle strain and muscle problems in the neck and shoulders.

Musculoskeletal problems among young people too

Computer-related problems have even been observed among children and youth. Several studies from the US have shown that 30% of students had problems with their neck/shoulders and wrist/hands in connection with computer work at school. Project work by ergonomists and opticians in Sweden has also revealed that neck, arm and hand problems are common among children/youth who use computers at school.

An Australian study of students (10 to 17 years of age) who used laptop computers at school indicated that 60% experienced problems when using the computer. The

longer the time period at the computer, the more frequently problems were reported. The occurrence of discomfort increased particularly when the computer was used for long, continuous periods without pauses.

A Swedish study of working conditions and health among students attending an IT upper secondary school, where use of laptops was intensive, showed that neck/shoulder problems occurred largely to the same extent among students as among adult, gainfully employed computer users. This means that about half of the students experiencing musculoskeletal discomfort also reported reduced working capacity, less enjoyable leisure time and disturbed sleep. Many of the students were taking pain-killers to alleviate or eliminate aches and pain.

Arbetsförhållanden och hälsa bland elever på ett IT-gymnasium med intensiv användning av bärbar dator, Arbetslivsrapport nr 2003:1 4 (Working conditions and health among students at an IT upper secondary school where laptops computers are used intensively. Arbetslivsrapport no. 2003:1 4; Swedish text, summary in English).

In one study, American university students who used the computer at least four hours a day and who had or had previously experienced computer-related arm and hand problems were interviewed. The aim was to discover, among other things, whether and how these problems affected the students' everyday lives and future plans. The students reported that their arm/hand problems kept them from using the computer to the extent required by their studies. They also experienced that these problems interfered with daily activities such as carrying a shopping bag, holding a newspaper and driving a car, which in turn had emotional consequences. Several students reported that their computer-related problems had influenced their choice of profession. Fear of further problems had caused them to choose a professional orientation that required less computer use.

Computer workstations are not adapted to students

In Sweden, the US, Japan and other countries, studies of children/youth have shown that computer workstations in the schools were not properly adapted to students. Furniture was often not vertically adjustable, which is a particular disadvantage in the schools, where a given workstation should be suitable to many users of various body sizes. The tables were so small that there was not room for the user's forearms and working material on the tabletop. If chairs lack armrests, users need to hold their arms up in the air, which results in increased strain on the shoulders and arms. What's more, the chairs were so high that above all the youngest children could not sit with both feet on the floor.

If you are to sit in a balanced and steady manner, your feet need to provide support, either against the floor or a solid footrest, and you need to have a backrest to relieve the strain on your back. If you have solid support under both feet, the strain and pressure on your buttocks and thighs are reduced. These studies also showed that the computer screen was often placed so high that students had to bend their necks backward to look up at the screen. Bending your neck backward and looking up in this way increases the strain on your neck and eyes.

When working at a computer screen, it is recommended that you hold your neck straight or bend it forward slightly and that your gaze be angled downward, about 20-30 degrees.

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Compters at school - Advices

Advice and guidelines on creating a good computer work environment

The following section contains advice and guidelines on creating a good computer work environment and appropriate working methods when using a computer. It is aimed at people with various functions in the schools – people who should work together to ensure that children/youth, during their school years, do not lay the foundations for computer-related musculoskeletal problems.

Advice to students and others who wish to adjust their computer workstations.

1. Sit in your chair so that your back is supported by the backrest. Adjust the height of your chair so that both your feet rest firmly on the floor. The seat should not press against the back of your thighs. The angle of your knees should be between 90 and 100 degrees.
2. The tabletop should support your forearms when you are sitting upright with your shoulders lowered and the angle of your elbows at about 90 degrees. If your chair has armrests, adjust them to the same height as the table.
3. You should be able to move your legs freely under the table.
4. The computer screen should be placed directly in front of you and at least 50 cm from the edge of the table. This amounts to about an arm's length between you and the screen.
5. The upper edge of your screen should be somewhat lower than your eye level. When you look at the screen, your neck should be straight and your gaze angled somewhat downward. Remember that you should not project your head forward.
6. Place your keyboard directly in front of you and inward a bit on the table, about 15 cm from the edge. You should be able to rest your arms on the table and work with your arms near your body.

7. Position your mouse so that you can work with your arm near your body and with your forearm resting on the table. To work with your arm near your body more easily, you can place the mouse to the left of the keyboard or directly in front of you on the table, between the edge of the table and the keyboard.
8. It is preferable that daylight come from the side. This way you won't experience glare or reflections on your screen. If daylight is irritating, you should draw the curtains or blinds.
9. Sit in different ways. Change your sitting position often. It is also good to stand while using the computer.
10. Do not sit at the computer for a whole hour without pausing. Do something else – get up and move around for at least five to ten minutes every hour.

Advice to buyers of computers and computer accessories

This section is aimed particularly at those in charge of purchasing computers, computer accessories and furniture for schools. The person in charge of purchasing has a great responsibility to create appropriate conditions for computer use.

Features of a good chair

- The chair is stable.
- It is easy to adjust the seat vertically.
- The backrest is high enough to provide good support for the back, at least up to shoulder level.
- The backrest is vertically adjustable and can be tilted.
- A footrest may be needed, especially for younger students.

Features of a good table

- The depth of the table is at least 100 cm for a CRT screen and at least 80 cm for a flat screen.
- It is easy to adjust table height.
- The tabletop is medium-light in colour and has a matt finish.
- The tabletop and skirt measure not more than 3 cm at the front edge.
- The table is equipped with fixtures for hanging up cables and cords, if no other solution exists.
- Standing workstations of various heights are a good complement to sitting workstations.

Features of a good display screen

- The screen is TCO-labelled, TCO'99 or later.
- The screen is tiltable and turnable.
- The screen frame is light and matt.
- Brightness and contrast are adjustable.
- To avoid flicker on CRT screens, the refresh rate should be as high as possible – 85 Hz according to TCO'03.
- A flat screen is essentially flicker-free and requires less room than a CRT screen.

Features of a good keyboard

- The keyboard is narrow enough that both it and the mouse may be placed within the user's shoulder width. A keyboard narrower than the standard measure of 46- 48 cm is suitable in a school environment and is particularly important for younger students.
- The keyboard is low; there is not more than 3 cm from the tabletop to the typing surface of the middle row of keys. With a low keyboard, the user doesn't need to angle his/her wrists upward.
- The keyboard is medium-light coloured and matt to minimize the contrast between the keyboard, the tabletop and any paper lying there, as well as to avoid reflections.

Features of a good computer mouse

- The computer mouse is adapted to the user's hand size. This is particularly important to consider when buying equipment for younger students.
- The mouse is symmetrical, so it can be used just as easily with the right or left hand.
- The mouse is low, so that the user doesn't need to angle his/her wrist upward.

Features of good lighting

- Main lighting and any local lighting are well screened to avoid glare and reflections. The lighting does not produce glare for anyone in the lighted area.
- Main lighting and any local lighting are provided with high-frequency electronic ballasts (HID ballasts) to eliminate the risk of "flicker." Remember that a transformer for local lighting may cause interference with the display screen.
- Main lighting is directed both upward and downward and illuminates walls and the ceiling to provide good surrounding light.

Advice to persons responsible for IT - Arrange a good computer environment

This section is aimed particularly at those in charge of computer workstations in schools. Close cooperation with the person in charge of purchasing helps the person responsible for IT create appropriate computer workstations.

1. Place the computer so that daylight comes in from the side. The user should not sit with his/her face or back towards the window or sit quite close to the window.
2. Screen irritating daylight with curtains, blinds, etc.
3. Position the computer so that the main lighting does not cause glare or reflections on the display screen.
4. Place the screen directly on the tabletop and directly in front of the user, at least 50 cm from the edge of the table. The upper edge of the screen should be somewhat lower than the user's eye level.
5. Adjust the display screen to have a light background and dark characters (positive polarity).
6. Place the keyboard directly in front of the user, about 15 cm from the edge of the table.
7. Make sure there is sufficient leg room under the table so that the user can sit naturally and have his/her legs in different positions.
8. Make sure no cables or cords are lying on the floor.
9. Chairs and tables that can be easily vertically adjusted make it easier to find a good working position and to vary how the user sits at the computer. Another alternative is to equip workstations with non-adjustable chairs and tables of different heights.
10. Sitting/standing tables offer additional opportunities to vary the working position. One good alternative to such tables is to offer fixed standing workstations of different heights.

Advice to teachers involved with students who use computers at school - Teach good working methods

1. Create routines that let the students themselves adjust their workstations before they start working at the computer.
2. Encourage students to vary their working postures and to be away from the computer five to ten

minutes every hour. It is best if they do something completely different and move around.

3. Encourage students to use shortcut commands instead of clicking with the mouse.
4. Teach students correct keyboard fingering.
5. If several students are working with one computer, make sure the student using the keyboard and mouse is sitting directly in front of the screen and place the mouse so as to achieve the best working posture.

Advice to head teachers and school administration - Create conditions for good computer work

This section is aimed particularly at head teachers. Head teachers, however, should be familiar with the content of all advice and guideline sections.

1. Acquire knowledge about computer work ergonomics. Such knowledge provides, among other things, valid arguments to be used when discussing the purchasing of equipment.
2. Prior to major purchases, reconstruction and choice of premises, make use of ergonomic expertise, for example from your occupational health service.
3. Provide teacher training in computer work ergonomics.
4. Encourage teachers to convey their knowledge about computer work ergonomics to their students.

More information

Technical and educational aspects of computer use in the schools are not dealt with here. To read about these issues, see:

[Svenska kommunförbundet och Landstingsförbundet. IT i skolan.](#) (The Swedish Association of Local Authorities and the Federation of Swedish County Councils. IT in the schools; Swedish text only).

[Myndigheten för skolutveckling. IT i skolan.](#) (The Swedish National Agency for School Improvement. IT in the schools; Swedish text only).

[Stiftelsen för Kunskaps- och Kompetensutveckling. IT i skola och utbildning.](#) (The Knowledge Foundation. IT in the schools and education; Swedish text only).

Computer work at call centres

Call centres constitute one of the fastest growing labour market sectors in Sweden as well as many other countries. Work at call centres involves, among other things, booking tickets, taking orders, dealing with complaints and customer service. Other call centre services include providing medical advice, answering financial or insurance questions, troubleshooting for computer systems and, lately, exercising certain governmental functions.

It is common to deal with customers and clients over the telephone. Contact via telefax, SMS and e-mail also occurs.

Call centre operators work at a network-connected computer that is used for retrieving and sending information about the matter being dealt with. The computer is the central "tool" at a call centre. Operators do most of their work at the computer, which may mean five to seven hours of computer work a day. Therefore, the design of working conditions for computer work at call centres is of great importance for operators' health, well-being and performance.

Although working conditions at Swedish call centres are usually relatively good in many respects, many people working at call centres complain of aches and pains, particularly in the neck, shoulders and arms. Headaches are also common, as well as eye and throat discomfort or problems with clear vision and the voice. Many of these complaints can be attributed to the computer work situation.

For this reason, major efforts should be made to optimize working conditions at call centres, particularly conditions for computer work. The general advice and suggestions described here on the National Swedish Institute for Working Life's web pages on Computer Work can serve as guidelines for this. Advice and guidelines on good working methods specific to call centres, where aspects other than computer work are also considered, have been developed and may be accessed through the links at right.

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In-depth – What is a call centre?

Call centres, or contact centres, constitute a relatively new organizational entity that has shown strong growth on the labour market since the mid-1990s. They may be described as "businesses that manage customer and client contacts at a distance using telecommunication and computer support".

A call centre may be organizationally and physically internal to a mother organization, such as customer services within banks and insurance companies. Yet a call centre may also be an external independent company that mainly offers call centre services and that sells these services to other companies.

Call centre activities include answering telephone directory enquiries, booking tickets, taking orders, dealing with complaints or providing customer service for mobile telephone companies, but may also involve giving medical advice, answering financial and insurance questions, troubleshooting for computer systems and, lately, exercising certain governmental functions.

Most common are incoming telephone calls, for example, in the case of customer service, order receiving, ticket sales and alarm centres. Outgoing calls are made for sales calls and market surveys. Telefaxes, SMS and e-mail messages are also dealt with. Work with e-mail is increasing significantly in certain areas.

Call centres constitute one of the fastest growing labour market sectors. The number of call centres increased dramatically during the second half of the 1990s. Information on the number of call centre employees is highly uncertain. Some sources estimate approximately 90,000 employees in 2003, which amounts to slightly more than 2% of the working population in Sweden.

Frequently cited figures indicate that about 5% of job opportunities in the US are found at call centres, and the corresponding figure for Europe is 1.3%. Similar figures are given for Australia. The rate of increase in number of job opportunities at call centres is often estimated at 20-30% annually.

In-depth – Who works at call centres?

Swedish studies report that a large proportion of call centre personnel are permanently employed [Toomingas et al., 2003a]. Hourly employment is also utilized to deal with call load peaks. The number of personnel from temporary agencies is limited.

For many, work at a call centre is the first experience of regular gainful employment. Consequently, the average age of employees is often relatively low, though there is great variation. The majority of call centre employees are women.

Concurrent with the increased outsourcing of advanced job assignments to call centres, for example within public authorities and healthcare, increasing numbers of well-educated staff will be working under call-centre-like conditions.

In-depth – Computers at the call centre

Telecommunication to and from a call centre passes through a central computer, often called an Automatic Call Distributor (ACD) or router. The ACD directs incoming calls to the next available, logged-in operator.

The ACD also keeps track of the time before the customer is connected, the number of unanswered calls, the total time for each call as well as the time in which the operator is not actively working with calls or is disconnected. An operator may be disconnected because he/she has left the workstation, for instance to visit the lavatory.

The same types of measurements are made for outgoing calls. In-/outgoing call measurements form the basis of reviews of agreements between call centres and their client companies.

Every employee also has a network-connected computer for retrieving and sending information on the matter being dealt with.

In-depth – Working conditions at call centres

Working conditions at Swedish call centres vary, but seem to be generally good in an international perspective. The following description of working conditions in this branch is based on information from Swedish and other international studies.

The indoor climate in Sweden is often satisfactory, despite the usual problem of dry air during the winter. This problem is unavoidable and difficult to solve in our climate, where we draw in cold outdoor air and warm it to room temperature. Dry air can cause problems with dry mucous membranes in the eyes, throat and respiratory tract. In call centre work, which places great demands on operators' vision and voices, dryness places extra strain on these organs. Eye and throat complaints are common. Almost every call centre operator has a water bottle on his/her table.

Sound levels are often high when a large number of operators sit close together and talk in the same room. This may disturb their concentration ability and make work more difficult. This, in turn, may lead to discomfort caused by headaches and tiredness, both of which are common among call centre operators.

The visual ergonomic conditions are often not optimal, including glare and reflection on the display screen from windows and other light sources. In open-plan offices, ceiling light fixtures and the local lighting of others can easily cause such problems. These may lead to eye complaints, headaches and neck pain, all of which are quite common among call centre operators.

At Swedish call centres, work chairs, tables and other equipment often maintain a high standard. However, all operators would benefit from having motorized vertically

adjustable tables to increase their ability to vary their working posture and to make vertical adjustment easier for those sharing a workstation with others.

Many inappropriate working postures are observed at call centres, partly as a consequence of non-optimal adjustment of furniture and computer equipment. It is quite common that keyboards and computer mice are placed too far from the body. In the long run, this may lead to development of musculoskeletal problems, primarily in the neck, shoulders, arms and hands. This can be partly explained by insufficient knowledge about creating a good working environment and about appropriate working techniques.

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In-depth – Work content

Most of a call centre operator's working time is usually spent dealing with customer calls. The limited scope of call centre companies' activities makes it difficult to bring about great variation in operators' daily work tasks. On the other hand, many operators appreciate variation in the content of calls as a positive feature of their work.

Several studies have indicated the importance of work content. The greatest concern here is about work that may become monotonous and that lacks stimulation and chances for further development. Also emphasized is that even call centre work that seems low in complexity places high mental demands on the operator owing to the need for constant attention, often in combination with high demands for work quantity and quality. Work situations such as this are often associated with physical and mental stress reactions.

The number of customer calls a day and the length of calls can vary considerably depending on the type of assignment. There are typically around 100 calls a day, but this figure can be much higher. Call length is typically 4-5 minutes, though 1-2 minutes is common for more routine tasks. When asked what they don't appreciate about call centre work, operators commonly mention the excessively high pace, the stress and the pressure to deal with a large number of calls.

In-depth – The demands of call centre work

Call centre work is often reported to be mentally demanding. In this case, mentally demanding means, among other things, that the operator needs to be constantly service-minded, able to work quickly, able to concentrate although the environment is generally disruptive and able to come up with his/her own solutions to customers' problems, and that he/she needs to have the required expertise.

One specific mental requirement that personnel encounter in their customer and client contacts is emotional demands. This may involve refraining from showing spontaneous emotions even when the operator is angry, irritated or sad. Call centre operators sometimes encounter customers who are threatening, insulting or unduly demanding. Naturally, this in itself may be unpleasant and stressful.

What's more, a professional approach requires that the operator still treat such customers in a controlled and correct manner, which adds yet another stress factor.

In-depth – Quality/production control and reward systems

Quality/production control through call logging and call monitoring has often been presented as particularly prominent at call centres. Call logging (number of calls a day, call length, etc.) often forms the basis of feedback to the operator and, sometimes, bonuses for the group or an individual operator.

Call monitoring is common. During monitoring, a supervisor or coach often sits beside the operator, listening to customer calls via an extra headset. Call monitoring often occurs as part of training, further competence development and quality control of work.

Operators may experience both call logging and call monitoring as good ways to bring attention to their own performance. Call monitoring may even be a good way to develop customer call techniques. The drawback, however, is that many feel observed, controlled, stressed and nervous, especially when call logging is used. Call logging emphasizes the quantity of work, and call monitoring the quality. These two aspects can easily end up on a collision course that leads to role conflicts in operators.

Campaigns and prize competitions, with various rewards, as well as openly displayed call or sales statistics, on an individual or group basis, have been reported to occur frequently at call centres.

In-depth – Work organization

The nature of work at call centres may come to be monotonous, repetitive, highly controlled and restricted, both physically and mentally. This is contrary to what is stated in the Work Environment Ordinance, AFS 1998:5 7§.

"Display screen work which is closely controlled or restricted in a physical or mental respect or is monotonously repetitive may not normally occur".

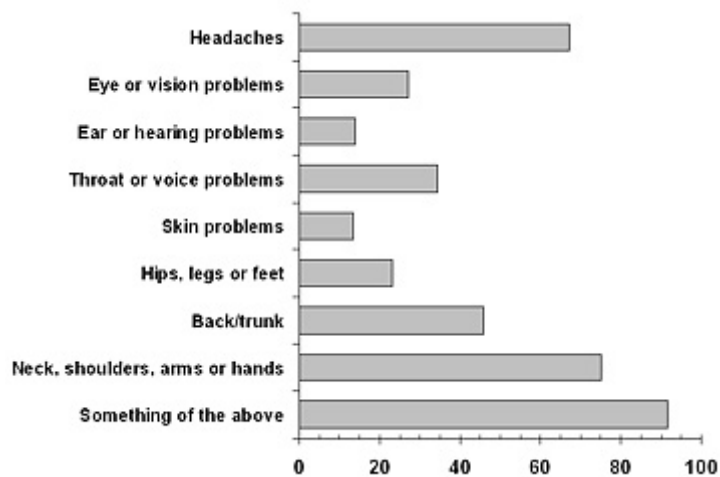
Work organization and conditions such as these may constitute a risk for development of discontent and various forms of discomfort and ill health, particularly if such work is performed for long periods of time without breaks, at inappropriately designed workstations or under stress. Working life researchers have warned about the risks of such work arrangements, referring to the large amount of reputable knowledge in this area.

Read more

Work With Display Screen Equipment 1998:5
The Work Environment Authority's Statute Book (AFS)

In-depth – Physical complaints and health status

Physical complaints are quite common among call centre operators. In a study of call centres in Sweden, slightly more than nine of ten operators reported having had physical discomfort during the past month (see the figure). This was usually a matter of headaches or aches and pain in the neck/shoulders or arms/hands. The prevalence of discomfort among call centre operators is similar to or somewhat greater than that among others who perform intensive computer work.



Proportion (%) of 1,183 operators reporting pain, aches or other discomfort during the past month in a study of 28 call centres in Sweden.

Medical examination of the operators participating in the above study showed that only one in three was in a state of good health. One in two of those examined were judged to be suffering from ill health likely entirely or partly caused or aggravated by their work. Disorders commonly concerned the neck/shoulders and upper extremities.

Similar results showing high prevalence of physical discomfort and ill health upon medical examination have been reported in several studies of call centre staff. High prevalence of illness absence has also been reported by various sources.

Read more

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Tools for investigation of working environment and health

Questionnaire about computer work and computer input devices

This questionnaire was developed at the National Institute for Working Life in Stockholm to be used in a prospective study among computer users. The questionnaire consisted of questions about physical and psychosocial working conditions, symptoms in the musculoskeletal system and stress related symptoms.

The questionnaire has been used in research. The whole, or a part of it can also be useful to ergonomists in occupational health work and others concerned with computer related health problems and other computer related questions in private and public companies.

Download (pdf)

Questions about computer work and computer input devices

http://www.av.se/dokument/Teman/datorarbete/Questionnaire_970814.pdf

Ergonomic checklist for observation of workstation design, work postures and working technique at computer work

Download (pdf)

Ergonomic checklist-computer work

http://www.av.se/dokument/Teman/datorarbete/Checklist_970916_en.pdf

Key to Ergonomic checklist-computer work

http://www.av.se/dokument/Teman/datorarbete/Nyckel_epimus_970820_en.pdf

Checklist for observations and measurements of working conditions at computer work stations

This checklist was developed at the National Institute for Working Life in Sweden to be used in the study "Work and health at call centres in Sweden". The protocol covers issues about the working premises, room climate, electromagnetic fields, noise, visual ergonomics, furniture and computer related equipment. It also covers observations of working postures and of the knowledge level among the operators regarding good ergonomics and optimal working technique.

The protocol is designed to be useful for observations and measurements of most computer work-stations. The Swedish work environment legislation has guided the design of the protocol and the judgement of what is good or bad. References are given to specific paragraphs in the Work Environment Act and to other relevant sources, when possible.

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Checklist for observations and measurements of working conditions at computer work stations

<http://www.av.se/dokument/Teman/datorarbete/CCXlist.pdf>

Questionnaire to operators at call centres

This questionnaire has been developed at the National Institute for Working Life in Sweden to be used in the study "Work and health at call centres in Sweden". The questions are about physical and psychosocial working conditions, rest, recuperation and sleep, ache and pain in the musculoskeletal system and other health related troubles and their consequences for the work and the leisure time activities.

Download (pdf)

Questionnaire to operators at call centres

<http://www.av.se/dokument/Teman/datorarbete/CCBaselineQuest.pdf>

A Sound Working Environment in Call and Contact Centres - Advice and Guidelines
This document contains advice and guidelines to help create a sound working environment. It has been developed in Sweden primarily for the Swedish market and reference to what is allowed by law implies, unless otherwise stated, Swedish law, which is harmonised with the directives of the European Union. Much of the intention of the document is, however, more universally applicable than merely for Sweden. It is intended for those responsible for call centre operations and others with an interest in them. The document has been produced by the employers' federation ALMEGA-forum for service companies, the Swedish National Institute for Working Life, the Swedish Work Environment Authority, the CallCenter Institute (CCI), the Salaried Employees' Union (HTF) and the Swedish Call Centre Federation (SCCF). The

guidelines are based on current knowledge, international standards, EU directives and Swedish law.

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A Sound Working Environment in Call and Contact Centres - Advice and Guidelines (Full Text Version)

<http://www.av.se/dokument/Teman/datorarbete/callcentre-guidelines.pdf>

A Sound Working Environment in Call and Contact Centres - Advice and Guidelines (Short Version)

<http://www.av.se/dokument/Teman/datorarbete/callcentre-guidelines-short.pdf>

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Swedish version

This information about computer work is also available in Swedish.
(Denna information om datorarbete finns även tillgänglig på svenska.)
<http://www.av.se/teman/datorarbete/>