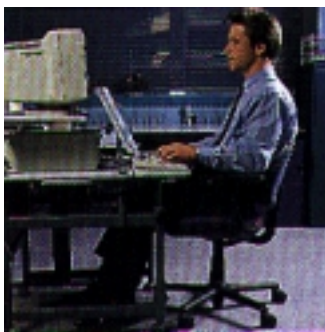


HOW TO USE YOUR
VISUAL
DISPLAY
UNIT
Safely



ABOUT THIS BOOKLET

This booklet has been written to help you, the VDU user, to make the best use of your computer, with a maximum of comfort and a minimum chance of discomfort or injury. It contains specific advice to help you keep comfortable at your workstation, and related advice on your office environment.

It accompanies the *Approved Code of Practice for the Safe Use of Visual Display Units*, which contains more detailed information for employers and others with responsibility for the welfare of employees.

If this “how to” guide leaves you with any questions, then you can always refer to the code of practice itself, or contact your nearest office of the Occupational Safety and Health Service (OSH) for further information or advice. OSH is listed under the “Labour Department” in your phone book.

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1. WHY WE GET DISCOMFORT

DISCOMFORT STEMS FROM MUSCLE TENSION

Unlike a book, a computer can't be moved about. So, to look at the screen, we need to keep our heads still.

If the head has to be held still, other body parts must also be still.

When we use a keyboard, our fingers don't move over large distances. This, and the need to position the fingers accurately over the keys, means that the shoulders also stay very still.

The result of all this stillness may be muscle discomfort. In the extreme, Occupational Overuse Syndrome (OOS) may develop. Here, the constant movement of fingers is misleading. Movement is not the cause of OOS. It is rather thought to happen because muscles are held tight and tense.

WHY OOS IS PAINFUL

Muscles and tendons get blood through very fine vessels (capillaries) passing between the muscle fibres. A tense muscle squeezes on these vessels and they collapse, slowing the blood flow, just as when you squeeze a sponge.

When blood flow stops, the muscle has enough stored energy to cope with brief periods of tension. When this is used up it switches to a form of working (anaerobic) which is inefficient. This uses up the energy stored in the muscle quickly, and leads to a build-up of acid wastes in the muscle (lactic acid). It is these acid wastes that cause the discomfort and pain — they stimulate pain receptors in the muscles that send pain messages to the brain.



This muscle pain makes the neighbouring muscles come out tense in sympathy by a reflex action (the splinting reaction). In the extreme a vicious

cycle may result because the cause of the splinting reaction was muscles being held tight for too long. If nerves are caught up in the muscle spasm, you may feel numbness and tingling. Relaxation is a useful way to approach the prevention of this discomfort.

WHY DO PEOPLE GET TENSE AT WORK?

IN TERMS OF WHAT PEOPLE DO:

- People overwork.
- People have a poor posture.
- People have poor “body skills”.
- People have a tense reaction to work.
- People have a tense reaction to uncertainty.

IN TERMS OF WHY PEOPLE DO THESE THINGS:

- The way work is organised creates an unreasonable workload.
- Poor ergonomics creates a poor fit between the person and their work.
- A lack of specific education and training prevents skilled “body use”.
- Social relations at work are unhappy.
- People don't have information, and apprehension remains.

Relaxation — the reduction of tension — is a unifying principle in preventing discomfort. A lack of relaxation is implicit in all the points above.

These points lead to obvious prevention strategies. Computers can be used without discomfort — and are — where these problems are addressed.

The notes that follow are about methods of relaxation, good posture, how to set yourself up at the workstation and workplace exercises.

The environment is covered in four sections which discuss lighting and other aspects of the office — noise, thermal comfort and electric and magnetic fields.



2. RELAXATION

If muscle tension is the basic cause of discomfort, then relaxation is a key to comfort at work. To relax at work we need to know:

- What a relaxed muscle feels like;
- How to find a relaxed posture; and
- About micropauses.

Many people are unfamiliar with what relaxed muscles feel like. This is often because it has never occurred to them to find out! Here are two simple physical methods of relaxation.

USE A FINGER!

Have another person use their finger to support your arm at your wrist, with your upper arm vertical and your forearm horizontal. As you relax and “let go”, they should feel more and more of the weight of your arm and shoulder come on to their finger.

Get the other person to take their finger away



suddenly. Your arm should drop away freely if relaxation is full. (Don't let the arm fall by itself — catch it.)

This may take time to learn. Practice at home in relaxed surroundings with someone you know.

USE A PIECE OF STRING

Get someone else to loop a piece of soft string around your wrist. Get them to swing your arm like a pendulum, across your body. As relaxation deepens, your arm will swing more freely.

Both of these methods will help you get to know what a relaxed muscle feels like.

Some people may learn relaxation easily by themselves, others may do better in a group relaxation class or by reading a book, while others may need one to one help from a person such as a psychologist or an occupational therapist.



WARNING

If you have any pain, don't use the method of relaxation called "differential relaxation". This is tensing the muscles and allowing relaxation to occur automatically when the tension is released. The tensing phase may cause pain. People with pain should just "let go" the tension.

MENTAL RELAXATION

Here is one of the best techniques. It does not need much practice and takes only a minute to demonstrate.

- Sit quietly and comfortably.
- Close your eyes.
- Feel your breathing.
- Feel your breath coming and going.

- Repeat a word or sound over and over as you breath out, such as “one.....one....one...”

Mental relaxation training has three steps:

- Practice the technique above for 10-15 minutes twice-daily, until deep relaxation comes easily and naturally.
- Learn to relax rapidly and be sure to do it several times a day.
- Identify the situations which create tension or make pain worse, and deal with these through rapid relaxation as they occur.

INTRODUCING MICROPAUSES INTO YOUR WORK

A micropause is a short break in work for muscle relaxation. Specifically, it is a 5-10 second break in work for muscle relaxation every three minutes or so.

Micropauses allow for the restoration of blood flow to muscles which have been held tense.

It is when the muscles relax fully that micropauses are of most value.

They help you be more productive.

A variation is simply to count your breaths.

You may benefit even more through attendance at relaxation classes or a technique such as Tai-Chi or Aikido. (There is almost certainly one that you will find enjoyable.) Contact your local occupational therapy department or a psychologist to find out about relaxation classes.



3. BODY POSITIONS

There is more than just one good “posture”— which we refer to as “body position” in this guide.

Everyone needs to find the body position that works for them.

To find a good body position while you work at a VDU you need:

- An awareness of what happens in your body;
- Adjustability in your computer equipment and office furniture; and
- To be prepared to try different positions.

The simple suggestions that follow are all easy to understand and to put into practice. They will help you get more comfortable and be more productive.

Relaxation is a theme behind them all, so learning relaxation will help you to apply them. To allow you to obtain these positions, your computer equipment and office furniture must be adjustable to allow what is desirable. There is no order of priority in the suggestions.

KEEP THE HOLLOW IN THE BASE OF YOUR SPINE

Seated workers experience lower back pain as much as those who do heavy manual work, and more than those who do work needing a medium level of physical activity. Part of the reason is that our sitting position places strain on the lower back.

Allow your lumbar spine to relax onto the lumbar support of the back of your chair.

Change your position often. Make a point of looking down and breathing out to reduce tension then return to your supported way of sitting. Sit with your feet and ankles about a shoulder width apart to take the strain off your back and neck.

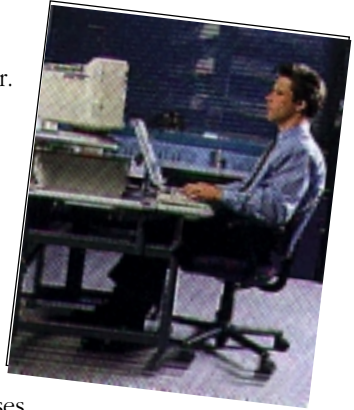
For variation, you should also try sitting with the knee below your dominant hand lower than your other knee, and that leg under your chair. (Swap knees and see if the other leg under your chair works as well.)

FACE STRAIGHT ON TO YOUR WORK

You should be able to see your work without twisting your head. This problem arises mostly when a VDU is placed to one side on a narrow desk. If your neck is constantly twisted, discomfort will result.

LOOSEN YOUR SHOULDERS

We often experience (and express) tension in our shoulders. They rise when we become tense, for example, as deadlines approach. We need to keep our shoulders low and relaxed. To let your shoulders down,



maintain your height in your spine then breath out. Let your tummy relax into your waistband. Your shoulders will gently sag down. Get used to how it feels when your shoulders are low and relaxed.

When you are tuned in to the feeling of relaxed shoulders, consciously try to reproduce this feeling every time you sit down at your computer. Perhaps you need to alter your workstation. If your elbows touch your backrest, or if they hit your armrest, you may need to remove the armrest or get a thinner backrest. If your keyboard is too high, you will need to raise your chair and use a foot-rest.

Try to get tuned in to your shoulders and what they do when an outside source of stress (other people perhaps, more work, bad news) approaches. When this happens, breathe out and let your tummy relax into your waistband. Soon it will become habitual and you will get the benefit of mental relaxation in periods of stress. Mind and body work together.

ELBOWS GENTLY AT YOUR SIDE

Muscle tension is required to hold your elbows outwards or forwards. The best position for your elbows is when they hang free below your shoulders. To find



this position, stand relaxed with

your hands at your sides. Your elbows will be loose and free to move. Keep this position when you are seated.

If you have a chair with a wide backrest, or if the armrests are too high, you may be holding your elbows outwards or forwards. Get a different chair or remove the armrests.

KEEP YOUR WRISTS STRAIGHT

Your wrists are able to pivot upwards, downwards and from left to right. Holding the wrists in any of these

positions for any time requires muscle tension.

Do you operate with your wrists bent round to the side of your little fingers?

This may be because your elbows are pushed out, or because you

have a wide backrest or high armrests. You may then need to get a narrow backrest or remove the armrests.

If your workstation is well set up and you still operate with your wrists bent up, use another method. Try typing with a slight rotation in your forearms (right forearm rotated clockwise along its own length). Try straightening your wrists and curling your little and 4th fingers under your hand a little.

Don't rest your wrists on the desk or wrist rest while keying. It is important that you don't rest your wrists in front of the keyboard with your wrists bent up — whether using a wrist rest or not.

LOOKING DOWN

There are many ways to look down. A good way is to pivot your head about the joint at the top of your neck. When this happens the weight of your head is taken by your spine — just as it should be.

Where is the top of your neck? It is easily found — put a finger from each hand just under each ear and



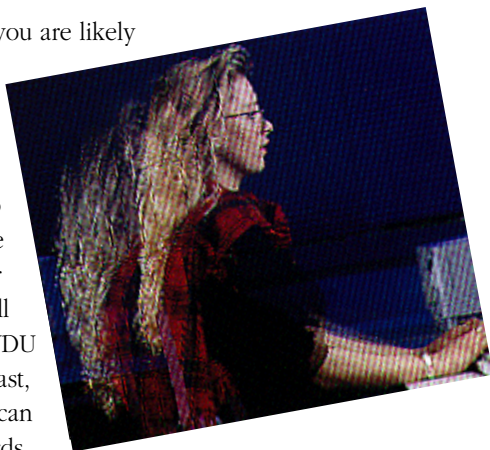
point them at each other. You are pointing at the top of your neck. (Yes, it really is this high up). Keep your fingers still and nod gently about this point.

To look down, nod your head down at the same time as you breathe out. Let your tummy relax. Your feet and knees should be a shoulder width apart. Let your breastbone sink in a little. This helps to reduce the strain on your lower neck and upper back.

Bad neck position is when you tilt your head forward or poke your chin forward. When you do this, you use your muscles to stop your head tipping further forward. This means prolonged muscle tension. This will be tiring in itself, and can also reduce blood supply to the head. You can also look down by rotating your eyeballs downward. This is better than a forward lean.

EXPERIMENT WITH DIFFERENT BACKREST ANGLES

If you use a VDU you are likely to have a better posture than if you write at a desk! If you have to bend forward to get your eyes close to your work, your head and spine will be bent forward. VDU operators, in contrast, can sit upright, or can even lean backwards.



There is a difference between leaning back and slouching. There is nothing wrong with leaning back, as long as the base of your spine stays hollow. Leaning back will aid you retain this hollow, as long as you have a backrest that will support you there.

When writing, try using a slanting worktop to get your posture more upright.

DON'T SLUMP FORWARD

The reason for this suggestion is obvious from the above.

CHANGE YOUR POSITION OFTEN

Joints and muscles were designed to move. When we hold a single position for any time we can get tense. So, it is a good idea to relieve static postures by altering your chair and desk from time to time. Children do this naturally — adults call it fidgeting — in an unconscious expression of what is only natural.

It is okay to sit on the edge of your chair with one or both feet under the chair for a time. This is another position you can choose. Whatever you choose should be comfortable.

DO SOME LIMBERING UP MOVEMENTS

To counter the effects of a static position, it is a good idea to get up and do gentle limbering up movements. Once every hour or so is ideal.

One strategy is to arrange for your computer to send documents to the printer that is farthest away from you. You will have the opportunity to get up and walk to it from time to time.



KEEP YOUR THIGHS ABOUT HORIZONTAL

Keep your thighs parallel with the floor. Have the chair low enough to avoid pressure on the underside of your thighs. If the seat pan hits your calves, get a chair with a shorter seat pan.



You should be able to slide your hand in easily between your calves and the front of the chair seat pan.

KEEP YOUR KNEES AND ANKLES AT THE CORRECT ANGLE

Keep the angles at your knees and ankles open (90° or more). Don't bend them too much. If you change your position often, this will help your knees and ankles get relief from fixed postures. Keep your knees and ankles about a shoulder width apart.

KEEP YOUR FEET WELL SUPPORTED

Make sure your feet are well supported. If they dangle, your leg muscles have to stay constantly tense to keep them in place. This will result in fatigue.



4. GETTING COMFORTABLE AT YOUR WORKSTATION

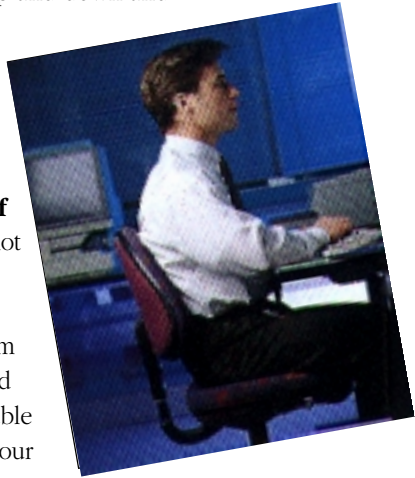
Begin by working out how the adjustments on your chair operate. There should be three, and may be four, ways of adjusting it. Find out how your desk, your VDU screen support and your copyholder adjustments operate.

1. **Set the seat height first.** Your feet should be flat on the floor.
2. There should be **no undue pressure** on the underside of your thighs near your knees or on your calves. Your thighs should be about horizontal.
3. If seat tilt is fitted, **experiment with different angles** of the seat pan. You may need a shorter seat pan if there is thigh interference or pressure on your calves.
4. **Set your backrest height** so that the small of your back is supported. Your buttocks should fit comfortably into the space between the bottom edge of the backrest and the seat pan.
5. **Adjust the backrest angle** to suit you and the work you do. A slightly leaning back posture may be most comfortable. Try to avoid a forward lean.
6. **Think about your shoulders.** Are they low and relaxed? If not, you may need to adjust the desk or chair height and get a footrest.
7. **Think about your elbows.** Are they loose at your sides? If not, you may need to learn a relaxation technique.

If the armrests are too high, or if the backrest is too wide, remove or replace respectively.

8. Draw yourself up to your workstation. See that the height of the keyboard is comfortable. Your upper arms should be about straight up and down and your forearms about horizontal. Adjust the desk height if required. Your wrists should be straight.

9. Adjust the position of the keyboard. It should not be too far away (or your upper arms will slant forward). A space of 50 mm between the desk edge and the keyboard will be valuable for resting your wrists. If your desk is fixed for height you may not be able to get comfortable in your feet, shoulders, elbows and wrists all at the same time. If this happens get a footrest.



10. Adjust the position of your screen. You should have a comfortable eye-screen distance. (This varies from person to person in a range from about 450 - 800 mm). Also check the gaze angle. An angle of gaze of about 20° down to the middle of the screen is acceptable. Check the tilt of the screen.

11. What do you look at most often? What type of work do you do? Do you look at the copy only, the screen only or both about equally? This will help you to decide where to put your screen and copy in relation to each other. Put the most frequently “looked at” items directly in front of you.

12. Check the cabling at your workstation for safety.

13. Check your screen for reflections.



5. WORKPLACE EXERCISES

Exercises are useful to help warm up, stimulate blood flow and keep fresh. There are lots of different exercises that are useful. If you have some favourites, do them.

Here we give a few exercises that have been found very effective for VDU users. Remember three principles when you do them:

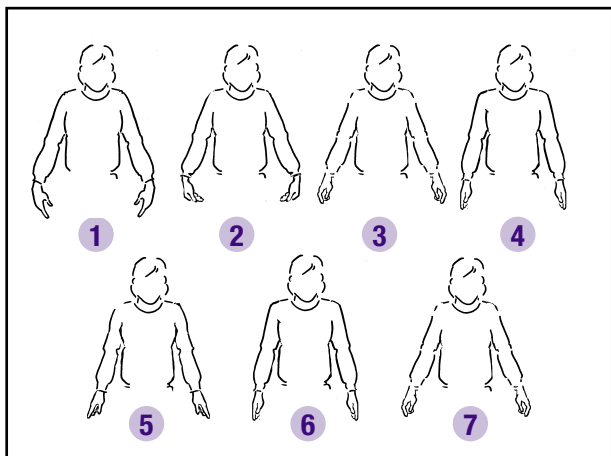
- Never work to the point of fatigue.
- Only exercises carried out with full concentration can be of use.
- Even when exercising a finger joint, the whole body should be kept ready for action in a relaxed posture.

EXERCISES TO PROMOTE BLOOD FLOW

Use the first three exercises that follow to stimulate blood flow — to help reverse the effects of muscle tension. These can help anyone to relax, not just keyboard operators. They can all be done while seated at the workstation.

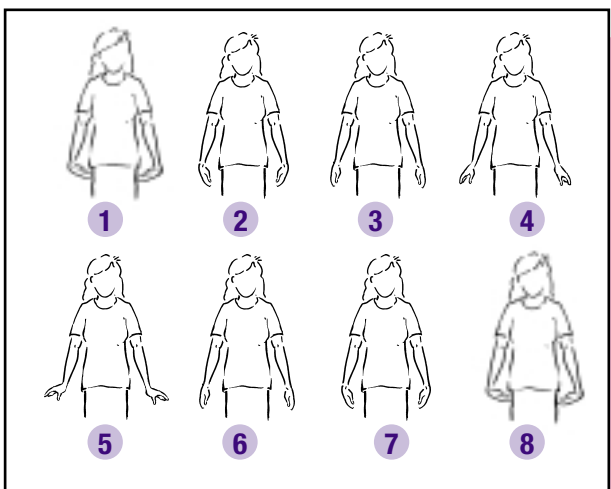
EXERCISE 1: ARM SHAKES

Let your shoulders go loose and shake your whole arm(s), holding your arms straight up and down.



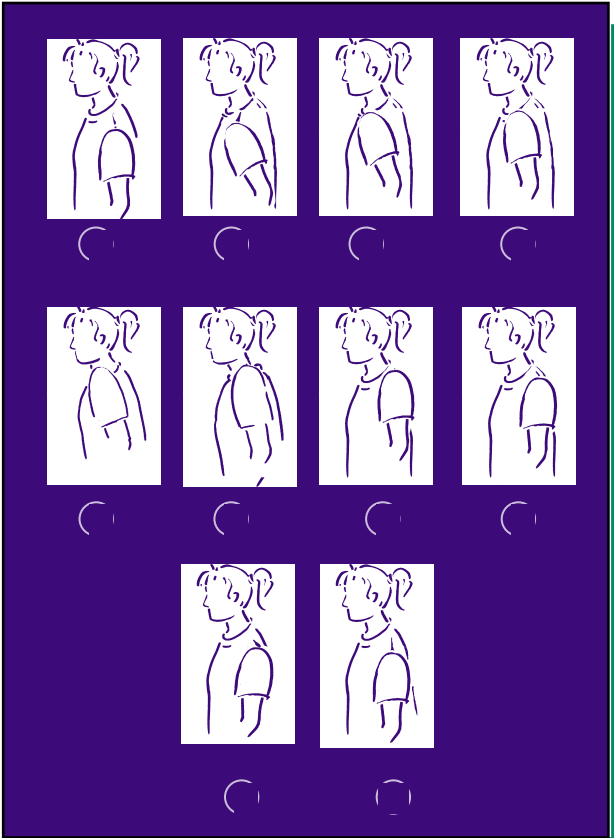
EXERCISE 2: WRIST FLAPS / FOREARM TURNS

Let your wrists go loose, move your arms back and forth to make your hands flap, bending loosely at your wrist.



EXERCISE 3: SHOULDER ROLLS

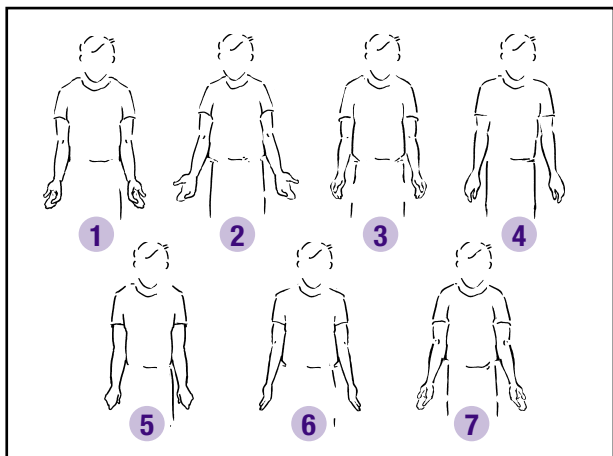
In a relaxed manner, circle your shoulders (hold the rest of your body as still as possible) so they describe the biggest circles possible. Let your arms hang still while your shoulders move. Do big circles in both directions.



EXERCISE 4 : FOREARM TURNS

Sometimes, our work causes us to hold some muscles short and tight. These need gentle lengthening.

Straighten your arms, hold them down by your thighs, hold your fingers loose and turn your arms gently, both ways. Hold for a few seconds at the extremes.



OTHER USEFUL EXERCISES

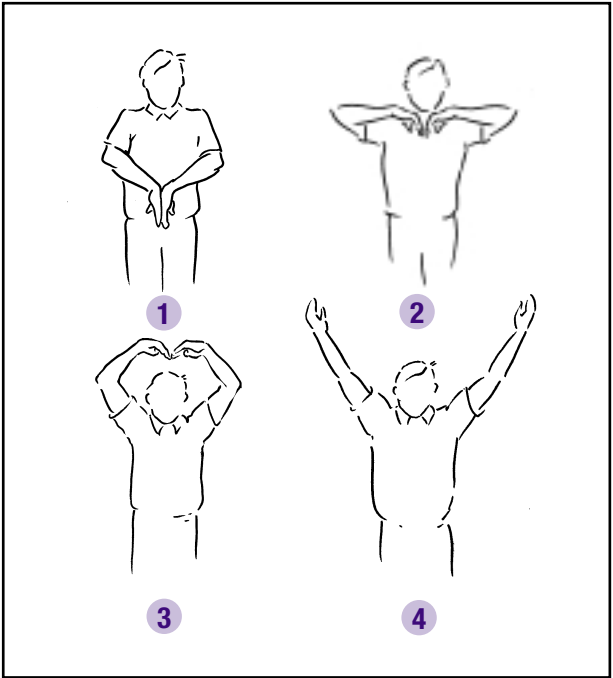
You will need to stand up to do these.

EXERCISE 5: SERPENTINES

Describe a “serpentine line” with your arm comfortably extended upwards. Imagine that you are following a car descending a switch-back road on a hillside in the distance. Imagine reaching out to touch the car. The timing should be slow. Use each arm in turn.

EXERCISE 6: THE SYNTHESISING CIRCLE

Begin with your arms together in front of your body, with the backs of your hands facing each other and touching. Raise your arms with the backs of the hands touching until about waist level. Then separate the backs of your hands gradually as they become horizontal, and at about face level separate your hands and let your fingers move

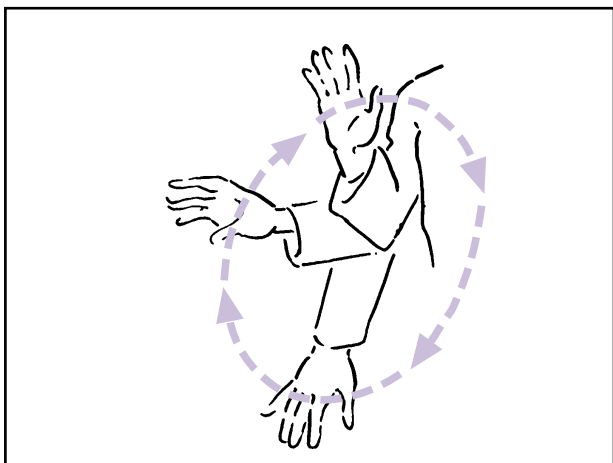


upward. Reach up as high as you can with your fingers and describe as large a circle as possible on the way down. In descending make your palms revolve forward until, at the lowest point, they face inwards.

If fatigue develops, the execution of several synthesising circles in a calm tempo will refresh the tired fingers and the wrist in a short time. The synthesising circle intensifies the blood circulation in the fingers, arms and shoulders and thus relieves exhaustion.

EXERCISE 7: FOREARM CIRCLING

Hold your wrist in a relaxed neutral posture, and rotate your forearm in circles about your elbow. Let your upper arm hang limply (vertically) from your shoulder — it does not take an active part in the movement. (It gives way passively.) To execute this exercise, a perfectly relaxed state of the shoulder joint is required. Practise this exercise with both arms simultaneously with “swingful” circles, executed in opposite directions.



(See these exercises illustrated in cartoon form in the *Floppy Ergonomist*.)



6. PREVENTING VISUAL AND OCULAR DISCOMFORT

VDU users tend to have a very fixed posture. This means that the gaze distance to the VDU and the direction of gaze remain the same for long periods.

This stillness means that the entire upper body must remain still. Also, the muscles in the eye don't get much opportunity to move. This is the main reason why visual and ocular discomfort occur.

There are other possible major causes of visual and ocular discomfort for VDU users:

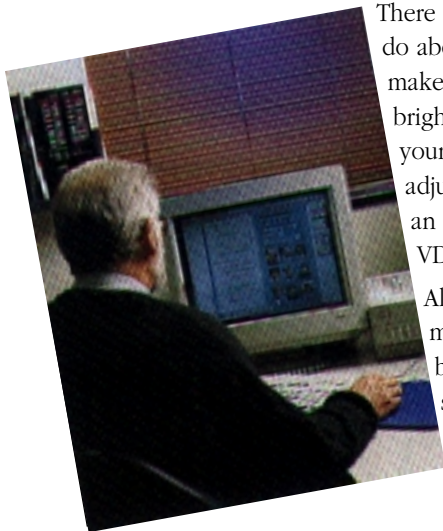
- Visual and postural fixity (as above);
- The lack of image clarity;
- Glare from reflections and lights;
- Concentrating on the work;
- Not blinking or resting the eyes; and
- Vision defects not corrected.

VISUAL AND POSTURAL FIXITY

The obvious solution to stillness is to move. If you take micropauses, focus on distant objects at regular intervals and, if you are doing screen-intensive work, take a break every hour for ten minutes to rest your eyes.

POOR IMAGE CLARITY

Most of us are used to high-clarity black letters on white paper. Character quality on a VDU is not as good as on paper because of the pixel construction of the letters (and the reduced character/ background contrast).



There is not much you can do about this, except to make sure that the brightness and contrast of your screen are adjustable. You may, in an extreme, need a new VDU monitor.

Also, a glare guard may help, but it is better to try other solutions first.

GLARE FROM REFLECTIONS AND LIGHTS

The role of glare from bright lights and reflections in the VDU screen creating visual discomfort is obvious. Removing them is covered in section 8, Lighting VDU work for comfort.

CONCENTRATING ON THE WORK

VDU work requires close visual concentration and this often makes your eyes tired.

Depending on what tasks you do, you will have a greater or smaller amount of intense eye work. The extent of this will bear on the degree of discomfort you may experience. The more concentrated your visual tasks, the more care you will need to take.

NOT BLINKING OR RESTING THE EYES

Some VDU users get problems because they don't blink often enough. (This has been discovered through research.)

Remember the advice to blink often and to take every possible opportunity to rest the eyes by looking out a window at a distant scene.

VISION DEFECTS NOT CORRECTED

As we get older our eyes "age" and lose their ability to see detail and to focus on close objects. VDU work does not cause eye deterioration to happen any faster than it happens normally.

However, VDU work often shows up an eye defect such as short-sightedness. Eye defects are very common. Some people have a major visual defect and don't worry about it at all because it does not bother them. Only when they start VDU work does it become a problem.

If you have any doubt about the health of your eyes, visit an optometrist for a screening check. See your supervisor to ask about your company's policy on vision testing for VDU users.





7. FINGER AND WRIST TECHNIQUES FOR KEYBOARD USERS

Here are some simple suggestions for wrist and finger technique. For a complete review see the reference at the end of this section.

DON'T BEND YOUR WRISTS SIDEWAYS

It is common to see keyboarders operate with their hands close together and the wrists bent outwards towards their little fingers. This poses constant tension on the muscles on the side of the forearm.

To avoid this tension, keep each hand and forearm in a straight line. You may need to curl your 4th and 5th fingers under your hand.

Another good change will be that your knuckles will now tend to tilt, rather than be flat. This means that your forearms will rotate outwards — another advantage, as it lessens tension in various muscles in your forearm.

DON'T BEND YOUR WRISTS UPWARDS, TOO MUCH

If you bend your wrists up too much, there will be constant tension in the muscles on top of your forearm. A little upward bending is normal, but too much will cause discomfort.



LET YOUR ELBOWS SWING FREELY

If you hold your elbows too close to your body or too far away from it, there will be constant tension in (different groups) of muscles in your shoulder region.

If your elbows are too far out, it will be difficult to keep your wrists from bending sideways (see above).

KEEP YOUR FINGERS IN A CURVE

When you are keying, keep your hand and fingers in a smooth continuous curve. Your knuckles should be higher than your wrists. Some typists seem to depress their knuckles. This only leads to unwanted muscle tension.

Another way of “breaking the curve” is reaching forward too far with the middle finger — say to press a function key. It is better to move the whole arm.

KEEP YOUR THUMBS RELAXED

Let your thumbs hang loosely above the space-bar. Let your thumbs hang with a natural curve — don’t try to keep them straight. Avoid tucking your thumbs under your palm.

KEEP YOUR 4TH AND 5TH FINGERS RELAXED

Let your little fingers relax. Very often keyboarders try to reach out sideways with their 5th finger — for the delete key perhaps. This is, again, unnecessary muscle tension. It is better to move the whole arm.

DO YOU NEED TO FORGET SOME THINGS YOU HAVE LEARNED?

Were you told to “Keep your hands still” and “Keep your wrists flat while you reach” in typing class?

Forget these instructions. Forcing your body to obey these artificial rules creates tension and disregards the natural movement instincts of our muscles.

Think “move from the elbows and shoulders”.

DON'T SQUEEZE YOUR MOUSE

You wouldn't squeeze a pet mouse — so don't squeeze your computer mouse. Keep your mouse in a loose grip, with straight wrists.



Reference: *The Hand Book*. Stephanie Brown. Ergonome, 145 West 96th Street, New York 10025.



8. LIGHTING VDU WORK FOR COMFORT

People need good lighting to do good work. At a VDU this is especially important because of two factors:

- VDU users have a gaze direction that is level compared with clerical workers. They are more likely to see glare than clerical workers, who tend to look downwards.
- It is easy to get reflections in VDU screens.

Before we discuss these items, we need to talk about lighting in general.

GENERAL OFFICE LIGHTING

We need enough light on the work to see clearly. But the amount of light is not all. Other factors are more important. People often say: “dull ceilings make me feel gloomy”. This kind of reaction should not be dismissed lightly.

How light is thrown onto surfaces counts a great deal.

THE OBJECTIVES OF LIGHTING

Good lighting:

- Promotes visibility of the task.
- Allows safety and ease of mobility.
- Provides a faithful appearance.
- Provides visual comfort.
- Creates the right mood.

THE AMOUNT OF LIGHT

We need enough light on the work for it to be seen adequately.

350 -500 lux is the traditional level recommended for VDU workstations. With VDUs that have dark letters on white screens (i.e. like paper) the upper end is acceptable. This is good news because it is the level recommended for office work.

If you have a VDU screen that shows light letters on a dark background, you may need less light than this — 200-250 lux. If you use one of these screens and paper copy, you may need more light than this — up to 350 lux, say.

It cannot be emphasised too strongly that providing the correct quantity of light will not guarantee good performance. The qualitative factors discussed below play just as important a part, if not more so.

WHAT TYPE OF LIGHTING?

Generally speaking, office space is best lit with a mixture of daylight, fluorescent luminaires and spotlights.

Spotlights have the advantage that they add “sparkle” to the scene and remove the bland effect of fluorescent lights (especially at night). Spotlights have obvious disadvantages when used alone and can cause problems with reflections in VDU screens, so they need careful positioning.

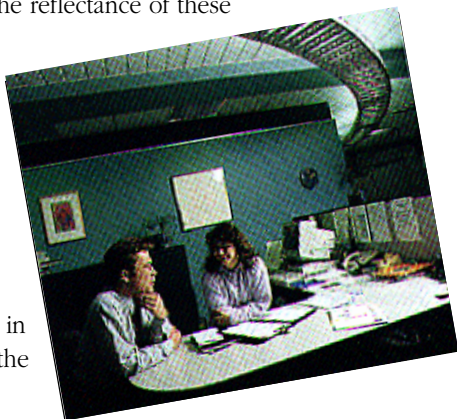
Local lighting for tasks on desks is a good idea, but only if it is positioned and controlled properly. It is easy for their reflections to appear in the screens of other users in the office, and they can also create a lot of heat.

For VDUs, “uplighters” are increasingly popular and are recommended. They bounce light off the ceiling, which must be white and have a reflectance of 95 percent or more. Uplighters have the advantage of being mobile, which allows more flexibility for rearrangement of the office space. The light they throw is bland, and is best supplemented by the use of spotlights.

DECOR AND COLOUR

Walls, the floor and the ceiling all emit light by reflection. Colours influence the reflectance of these surfaces, and the colours used in the office are just as important as all the other attributes of the lighting.

Dark walls, for example, may require an increase in the light output of the lighting system by three times!



Colour influences mood. Many texts on decor discuss the effects of colour on people and how different colours should be chosen for office spaces.

Briefly, conventional practice in offices is to use colours with high reflectances. In particular, the reflectances of ceilings and walls, especially the upper part of them, should be high. This is why pastel colours have traditionally been chosen for walls and white for ceilings.

GLARE

Glare occurs whenever there is a bright light in the field of view or when a luminance contrast is of sufficient strength.

Discomfort glare — such as seeing the sun out of the corner of the eye through a window — does not necessarily cause impairment of vision, but will distract the person and cause fatigue at the end of the day.

To avoid this:

- Don't sit looking at a window.
- Make sure your workstation is placed so that you don't see bright lights on the ceiling in your normal line of sight.
- Make sure your workstation is placed so that you don't see bright lights reflected in your VDU screen.

- It is desirable to be able to control the brightness of the lighting.
- Make sure the lighting is “downward”. Luminaires that throw light out to the side — horizontally — create glare problems.

A common source of discomfort glare is a bright luminaire on a dark ceiling. Naked bulbs, an array of ceiling lights in a large office or a black wall meeting a white ceiling are others.

Another problem — too much “luminance contrast” — can occur when white ceiling meets a dark wall, for example.

These distract the eye and pose a subtle additional load on the operator.

DAYLIGHT

Windows should be carefully designed so that sunlight does not cause glare. Often this is not done, so a second line of defence — curtaining — is needed.

Curtaining needs to be carefully planned and chosen, and expert advice should be taken. Vertical blinds, micro venetian blinds and pleated blinds can be excellent at controlling daylight.

SYSTEM MAINTENANCE

The light output of any luminaire decreases with time due to the ageing of the lamp and the build-up of dirt on the lamp and luminaire. It is a simple matter to get the best out of a lighting system by cleaning the lamps regularly and replacing the tubes as scheduled by the manufacturer.





9. NOISE IN OFFICES

Noise is unlikely to be a source of hearing loss in offices, as the noise level is almost always well below 85dBA. However, low noise levels can, in certain circumstances, cause problems. The following summarises the results of research and makes some suggestions for the reduction of noise levels in offices.

NOISE IS ANNOYING!

Noise creates problems in offices when it is annoying. It can be a stressor (in the sense of contributing to stress) and may contribute to the risk of physical discomfort. It can also create communication problems.

A simple analysis of the effects of noise is difficult because people react differently to it and, indeed, differ in what they define as noise. Complaints about noise may be associated with dissatisfaction with the environment and sometimes with dissatisfaction with the job.

Noise is a special problem in open plan offices. Complaints about interference with concentration from conversations and telephones ringing are common. The extent of annoyance expressed is directly related to the intensity of the sound above the background level, rather than to its absolute intensity. Special problems arise when the noise has a particular character. The throbbing of a ventilation duct need not be very loud to be obtrusive, for example.

Extensive laboratory research on the effects of noise on accuracy and performance shows that noise usually

worsens performance, but sometimes increases it. In the latter instances, the tasks under study were “simple” and the effects are thought explicable because of the increased arousal created by the particular noise. Most of the adverse effects of noise can be explained in terms of the temporary distraction of attention.

MEASURES TO REDUCE NOISE

Acoustical control is a demanding discipline requiring specialist advice. There are many problems that can arise: paint on acoustic tiles, sound-absorbing curtains drawn back, windows reflecting sound back into the room, noise from ventilation ducts, and so on.

Padding under machines, the enclosure of noisy machines (such as printers) in acoustic hoods, the use of carpet on the floor, sound absorbing partitions, acoustical ceiling tiles, and the replacement or isolation of noisy equipment can all be tried. The intensity of noise decreases with the distance from the source, so separation by distance can also be helpful. The ring of a telephone should adjust for volume and pitch.

A maximum background level of 55dbA should be regarded as an acceptable limit, rather than an aim. If the noise level is much higher than this, people will report annoyance and communication problems. 35dBA is a common design aim for unoccupied modern offices. Different types of offices will require different standards.

It is worth pointing out that if the noise level is too low, then any sources of noise may be very loud in comparison. Conversations are a special problem here. Humans can filter out a moderate level of background noise with no difficulty, and a moderate background noise level may be helpful where there are noisy interruptions to the normal noise environment.



10. THERMAL COMFORT AND AIR QUALITY

THERMAL COMFORT

Air temperature, humidity, speed of air movement and radiant sources of heat all contribute to feelings of thermal comfort. Air temperature is not the only indicator of comfort.

VENTILATION

Ventilation is required to prevent feelings of stuffiness and staleness. The recommended level is 10 litres of fresh air per second per person.

Levels of carbon dioxide are often taken as a measure of “stuffiness”. Carbon dioxide concentration is normal at about 400 parts per million (ppm). A rise to 1000 ppm is regarded as unacceptable and 800 ppm as the usual limit. As the level of carbon dioxide rises, it is often thought that a corresponding fall in the level of oxygen is responsible for feelings of stuffiness. This is not the case — oxygen levels can’t drop far enough. Probably, “stale” air is the culprit.

It is expensive to treat large amounts of air. Most of the ventilation air is therefore recycled, with only 10-20% being “make-up” air or fresh air from outside the building. There has been a tendency to increase the amount of make-up

air in recent ventilation standards.

It is common to hear of ventilation air intakes next to the loading bay or on the roof next to the heating system outlet. Diesel fumes and carbon monoxide can enter buildings this way.

Drafts of cold air are undesirable. They can pose a direct risk factor for overuse syndrome. They are also associated with other forms of ill-health.

SICK BUILDING SYNDROME

What is sick building syndrome (SBS)?

Probably the best definition is “a building in which complaints of ill-health are more common than might reasonably be expected”. This definition does not address the question of whether the complaints are justified.

The symptoms of SBS include:

- Eye, nose and throat irritations;
- Skin rashes and sensitisation;
- Sensation of mucous membranes;
- Headaches;
- Mental fatigue;
- Nausea and dizziness;
- Chest infections and coughs;
- Hoarseness, wheezing, itching; and
- Unspecified hypersensitivity.

Typically the symptoms get worse as the day goes on.

Sick building syndrome is a controversial condition.

Investigations of buildings where it has been observed have rarely, if ever, found any atmospheric contaminants present in significant amounts.

It is often said that a “lack of fresh air” is the prime cause of office building ventilation problems.

LEGIONNAIRES' DISEASE

Legionnaires' disease — also called “Humidifier fever” or “Pontiac fever” — is not sick building syndrome.

These diseases are caused by micro-organisms (bacteria, fungi, protozoa and their by-products) that grow in the air-conditioning systems. They are preventable by proper maintenance of the humidifying part of the system and by the use of biocides.





1 1 . ELECTROMAGNETIC FIELDS

HOW DOES A VDU WORK?

Most VDUs (except the flat displays used in laptop and notebook computers) work in the same way as a television set, and are built around a glass picture-tube. An electron beam is fired from the back of the tube onto a phosphor, which coats the inside of the front of the tube. Where the beam hits the phosphor, light is produced. The beam is scanned rapidly from side to side across the phosphor, and more slowly from the top of the display to the bottom. Text and images are formed by turning the beam on and off (under the control of the computer) at the appropriate places.

WHAT EMISSIONS ARE PRODUCED BY A VDU?

No X-rays or microwaves can be detected around a VDU. Light produced by the phosphor is in the visible part of the spectrum. If ultraviolet (UV) is present at all, the levels are hundreds of times weaker than in winter sunshine.

The coils and electrodes which scan the electron beam across the tube generate low-frequency electric and magnetic fields. These are found in two main frequency ranges: around 20-80 kHz in what is referred to as the very low frequency (VLF) range, and 50-70 Hz in what is referred to as the extremely low frequency (ELF) range.

VDUs also produce electrostatic fields. Fields of similar strength are present around other office equipment. There

have been some suggestions that these fields may cause skin complaints, but these have not been confirmed by careful studies and are normally alleviated by ensuring an adequate air humidity.

The levels of electric and magnetic fields around VDUs are considerably below exposure limits recommended by national and international health bodies. Nevertheless, there have been persistent suggestions that the ELF magnetic fields may be responsible for ill-health, although there is little support for this in medical research. The nature of these fields is discussed further below.

WHAT ARE ELF MAGNETIC FIELDS?

A magnet attracts an iron nail, even though the two objects may be several centimetres apart. To explain this, we say that the magnet is surrounded by a magnetic field which attracts anything made of iron. The field is often represented by “lines of force”, whose number or density indicate the strength of the field.

A wire carrying electric current generates a magnetic field around the wire. This field is the same in its nature and properties to that around a bar magnet. If the wire carries an alternating current (i.e. one which undergoes regular changes in its direction), then the magnetic field undergoes regular changes in direction at the same frequency.

Current in cables or equipment carrying mains electricity oscillates at a frequency of 50 Hz (i.e. 50 times per second) and so produces a magnetic field which also oscillates at 50 Hz. This is in the extremely low frequency (ELF) range.

ELF magnetic fields are found around any cables or appliances carrying mains electricity. In a VDU, ELF magnetic fields deflect the electron beam from the top of the screen to the bottom. The frequency of these fields in most VDUs is slightly higher than 50 Hz, but still within the range referred to as ELF. The magnetic field lines loop around the front and rear of the VDU screen.

ARE MAGNETIC FIELDS A FORM OF RADIATION?

No. Radiation is normally defined as energy being given off from some source. Light from light bulbs and the sun, and radio waves from a TV or radio transmitter, are a form of

radiation. The energy can travel long distances away from its source. ELF magnetic fields are fixed in place around the cables or equipment producing them, and do not carry energy away.

HOW STRONG ARE THE MAGNETIC FIELDS PRODUCED BY VDUS?

The field strengths at the rear of the VDU are similar to those at the front. At the sides, the fields may be up to about two and a half times stronger. The strength of the field drops off very quickly with increasing distance from the VDU, and at 700 mm may be only half of the level at 500 mm.

The strength of the field does not depend on the age of the VDU, or whether the display is colour or monochrome. Large monitors tend to produce weaker fields.

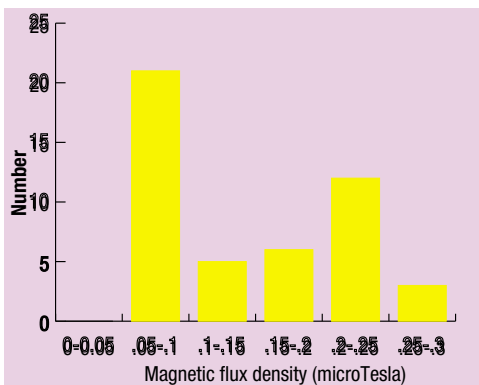
For comparison, the magnetic fields measured 500 mm from other common electrical appliances range from 0.01 microTesla up to a few microTesla. Appliances producing the highest fields are those with motors, such as vacuum cleaners, food mixers, hair dryers, etc.

HOW DOES A VDU USER'S EXPOSURE TO MAGNETIC FIELDS COMPARE WITH OTHER PEOPLE'S?

Measurements of magnetic fields in homes and offices (made away from electrical equipment) are typically in the range 0.05 - 0.15 microTesla, although levels up to 0.3 microTesla or more are not uncommon. Many VDU users' exposures to ELF magnetic fields are no different than if they were doing some other kind of indoor work.

IS ANY PROTECTION FROM THE MAGNETIC FIELDS NECESSARY?

No. Even close up to the screen, the field levels are well below limits recommended by international health bodies. At normal working distances, exposures are little or no different to those to which non-VDU users are exposed.



Magnetic field strengths from a New Zealand sample of 47 visual display units.

SHOULD I HAVE MY VDU MEASURED?

There is no good reason to have the magnetic field levels measured around VDUs, even if there are several used together in an office. Because the fields are fixed in place around the monitor producing them, and decrease rapidly with distance, a person working near several VDUs is exposed to a magnetic field little or no different from if there were only one display.

IF I AM CONCERNED, WHAT CAN I DO TO MINIMISE MY EXPOSURE?

If you are concerned, there are a few simple things you can do to minimise your exposure:

- Keep about arm's length from your VDU, and any other VDUs around you
- If you buying a new monitor, ask for one which meets the Swedish MPR II Standard. This Standard sets guidelines (based on technical, not health and safety criteria) on the field levels. 500 mm from the VDU they should be less than 0.25 microTesla.

(Note, however, that this is the case for almost all VDUs tested anyway — as the preceding graph shows.)

The magnetic fields can only be shielded by special alloys. They are unaffected by gauze or glass shields mounted in front of the VDU.