Office ergonomics : Part 3

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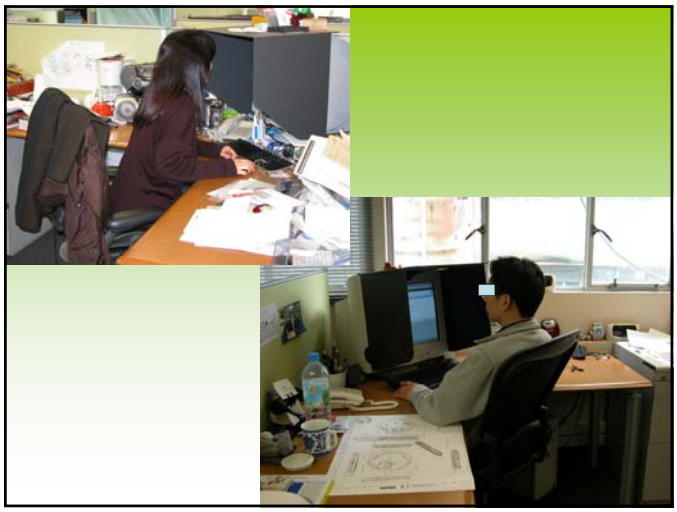
Outline

- Discuss the principles of office ergonomics
- Various components of computer workstation
- Anthropometrics and measurements
- Guidelines and standards
- Regulations and Risk assessment

Overcrowding of desk surface by files and documents

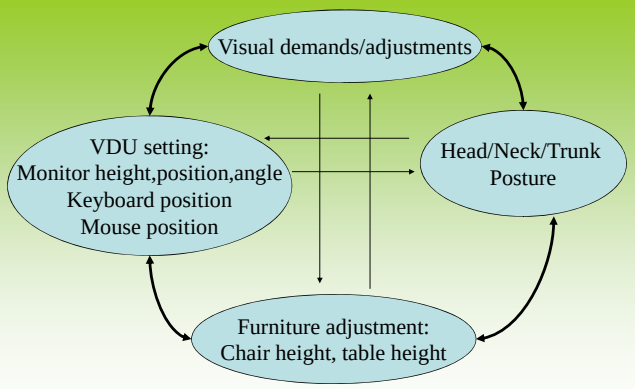
Monitor to one side, mouse too high up and to opposite side - Right arm stretched forward and across

Mismatch of person and chair/desk height



Components of Office Ergonomic Assessment

- The Chair
- The table/desk (working surface)
- The computer - monitor, keyboard, mouse, CPU, printer
- Accessories-document holder, wrist pad, mouse pad, foot rest
- Office environment
- Organisation and nature of work



The Chair

Options to consider:

- Seat height
- Seat pan depth and width
- Seat pan angle, contour
- Backrest - angle, height, lumbar support
- Armrests - full, 1/2, position, height
- Adjustability : Range and mechanism
- Material of seat cover

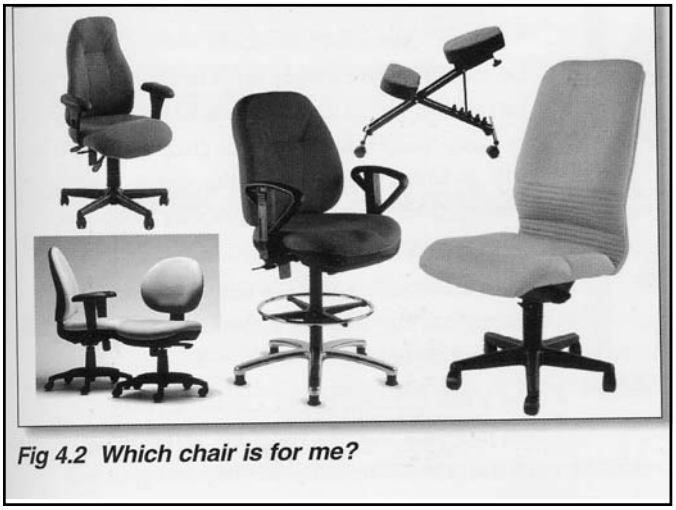


Fig 4.2 Which chair is for me?

The Chair

Options to consider:

- Seat height
- Seat pan depth and width
- Seat pan angle
- Backrest - angle, height, lumbar support
- Armrests - full, 1/2, position, height
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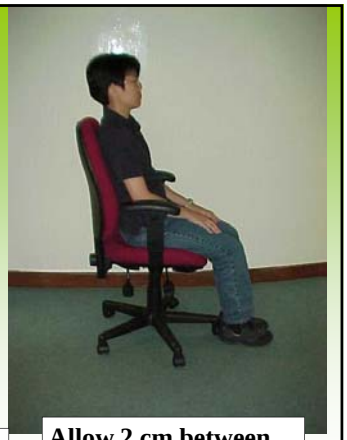
Width of chair should also fit the width of person



Allow 2 cm between back of leg and chair

The Office Chair

- **Adjustable Height: 380-535mm, 420-500mm**
- **Backrest: lumbar support (Adjustable)**
- **Seat pan: Adjustable tilt, depth, position**
- **Arm rests: none, 1/2 or whole**
- **Seat base on castors: 5 points most stable**
- **All controls easy to operate from seated position**

Seated Posture

Grandjean et al (1983) observed that majority of VDT operators preferred leaning backward in the chair

- **Leaning backward can transfer some of the body weight onto backrest, therefore reducing strain on lower back**
- **However, increased forward flexion of the neck to view the screen**
- **May result in more neck pain and visual fatigue**

Dynamic seating

- Changing posture to relieve strain and pressure on different body parts
- to suit different tasks
- Forward leaning, upright and backward lean

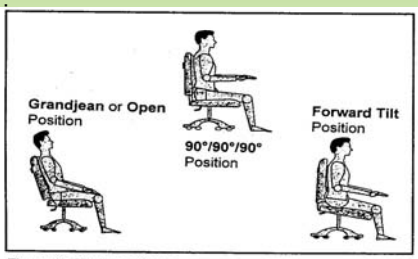


Figure 1. Chair positions.

Advice on good posture

- Each of 3 postures has important advantages and disadvantages
- Depends on tasks to be performed and working conditions
- Individual postural habits may vary
- Can recommend and educate about Good Posture", but cannot stipulate
- Occasional movements or getting out of static posture is good

Seated Posture: *Issue of Comfort vs Activity*

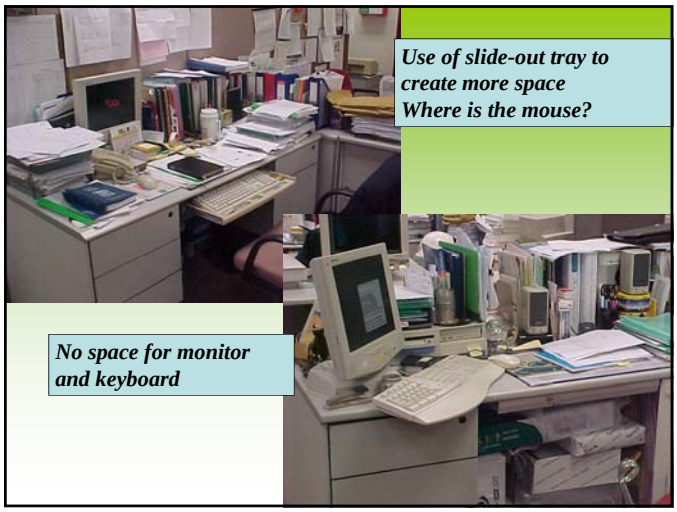
- **Forward tilting (Mandal, 1987)**
  - **Seat pan sloping forward and downward, to allow pelvis to rotate forward, reducing pressure on lumbar discs**
  - **Balans chair (designed in 1980s) - semi-kneeling position**
- **Latest :**
  - **Sitting on Fitball**
  - **Chair (stool) with ball design**
  - **Standing on treadmill**

The Desk (Working Surface)

- **Adjustable(?) Height**
- **?Monitor and keyboard on same surface**
- **Writing: 5 cm above elbow height**
- **Ideally, elbow at 90-100 degrees when working on keyboard**
- ***?separate table for computer and writing work***
- **Allow sufficient leg room for thigh clearance**
- **Sufficient space on desk - VDU directly in front, and better organisation of work**
- **Position of keyboard, monitor, mouse, documents o table**
- **% time spent on VDU and other work**

Office Desk/Table

- Purpose of table/desk - to provide a WORKING surface for you, and to ***PROVIDE SUPPORT FOR YOUR ARMS***
- Suitable SHAPE
- Suitable HEIGHT
- Sufficient DEPTH
- Sufficient WIDTH
- POSITION - in relation to WALL, WINDOW, PARTITION



Use of slide-out tray to create more space
Where is the mouse?

No space for monitor and keyboard

Visual Display Issues

- Screen height and location
- Screen size
- Type of screen
- Display features:
- Variables studied: visual parameters, posture, emg, discomfort

Display features

- Brightness (luminance) - characters and background
- contrast (contrast ratio) -between character and background
- sharpness of characters
- stability of character- distortion, drift, flicker
- geometric elements of characters (size, spacing etc)

Preferred Location of Visual Display

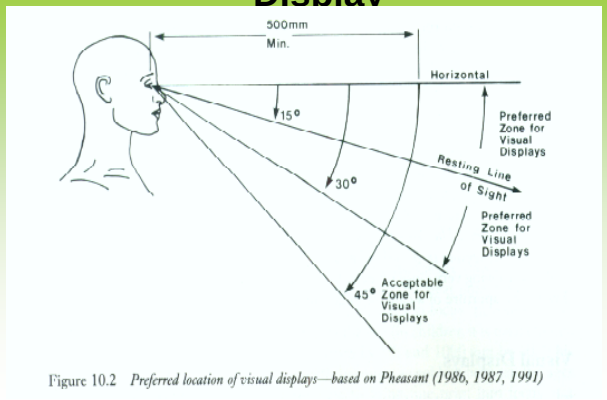


Figure 10.2 *Preferred location of visual displays—based on Pheasant (1986, 1987, 1991)*

Screen and keyboard should be in straight line, avoid looking to one side for long periods.

Eyestrain (visual fatigue)

- **Aching or throbbing sensations**
- **Inflammation of eyes and lids**
- **Headaches**
- **Tension in neck and shoulder muscles**
- **Significant problem in VDU workers**
- **Visual habits affect head/neck/trunk posture**
- **Different habits in persons who wear spectacles, e.g. bifocals,trifocals**

Visual parameters

- Gaze angle - *preferred* gaze angle
- Ocular vergence - to maintain single vision of near objects
- Accomodation and convergence
- Viewing angle and viewing distance
- Relationship to screen angle and distance
- Relationship to neck and head posture
- Eye discomfort, eye strain, deteriorating vision, headache, neck pain

Effects of Screen Heights

- Turville et al: compared 2 conditions(40^0 &15^0)
- Jaschinski et al: compared 4 conditions- effects of screen height and distance on visual parameters
- Villaneuva et al: 3 screen heights and 3 distances
- Burgess-Limerick et al: effects of screen heights on neck biomechanics

Burgess-Limerick (1999)

- Studied the relationship between screen height/angle and neck angles
- Compared the “eye level” and “low” monitor positions
- “Viewing angle” measured from eye to middle of screen
- recommendation - “low” screen with adjustable/tiltable table

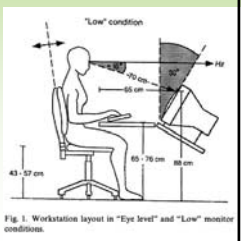
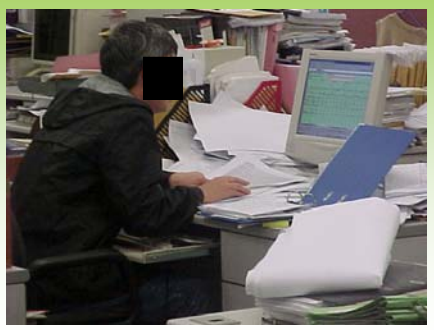


Fig. 1. Workstation layout in "Eye level" and "Low" monitor conditions.

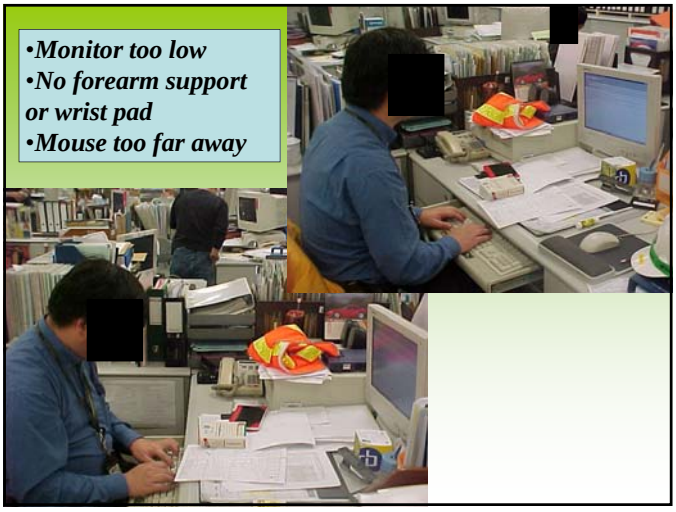
Different perspectives & considerations

- Musculoskeletal :
- Visual :
- Subjective preference: personal habits
- Job requirements:
- User group: anthropometrics
- Recommendations: specific to screen size - 14” vs 17” vs 21”,
- Flat-panel display(FDP) vs cathode ray tube(CRT)

Poor posture - head too far forward and shoulders elevated no forearm support



•Monitor too low
•No forearm support or wrist pad
•Mouse too far away



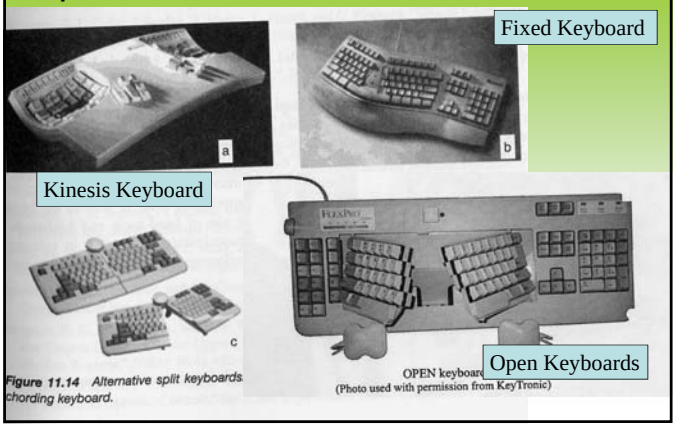
Good Computer Working Posture: Remember 3 Right Angles!!

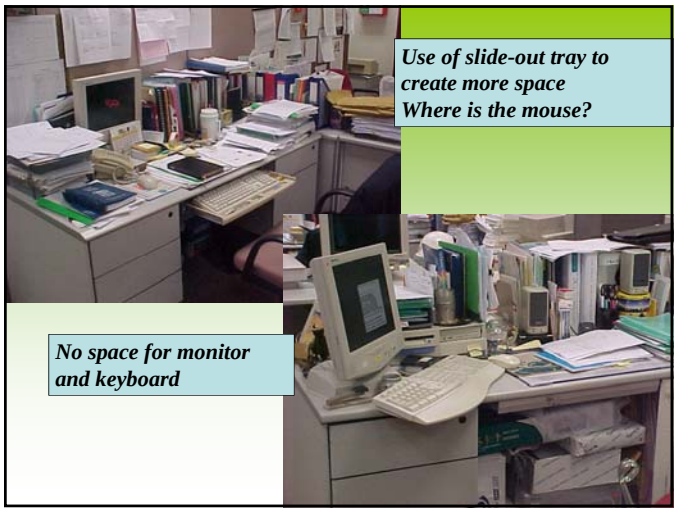
- **Computer screen and keyboard directly in front : Head facing front**
- **Head and neck upright, not leaning forward**
- **Shoulders kept back (not rounded) and relaxed**
- **Back (curve of spine) supported on backrest of chair**
- **Back and hips at 90 degrees**
- **Elbows at about 90 degrees**
- **Wrist and forearm in a straight line, forearm supported**
- **Knees at 90 degrees, adequate space behind legs**
- **Feet resting on floor, or footrest**

Keyboard Issues

- Keyboard height
- Use of keyboard tray
- Positive slope vs Negative slope (Hedge et al, 1999)
- Keyboard design: angled, split, different arrangement of keys (vs QWERTY)
- Subjective Variables:
- Objective variables:
- Which ones produced more favourable results?

Studies on keyboard design and performance **(Hedge, Zecevic, Swanson**





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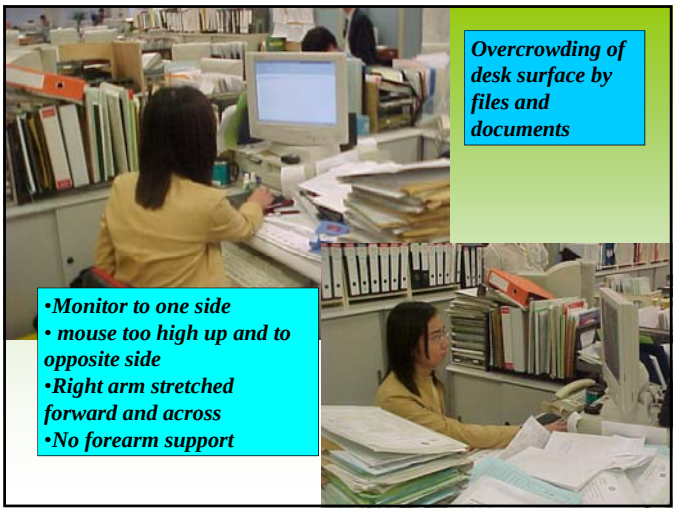
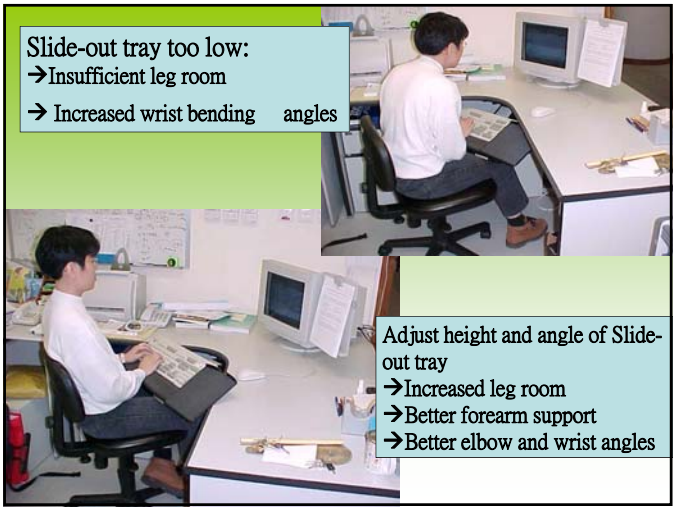


Overcrowding of desk surface by files and documents

•Monitor to one side
• mouse too high up and to opposite side
•Right arm stretched forward and across
•No forearm support

Keyboard too far forward - arms stretched out

Slide-out tray too low:
→Insufficient leg room
→ Increased wrist bending angles



Adjust height and angle of Slide-out tray
→Increased leg room
→Better forearm support
→Better elbow and wrist angles

Speed and Force of Keyboard Operation

- Rempel et al: inserted loadcells under individual keys (1-2), studied keystroke force & acceleration, related to keyboard design (<10N each)
- Sommerich, Armstrong: studied keystroke forces and measured emg in forearm muscles
- Fernstrom et al: Compared emg in forearm muscles with 6 kinds of typewriters, keyboards
- Thatcher & Brochy: measured pain and no of keystrokes per hour in data entry clerks (>11000per hr increased risk of pain in more than 1 area)

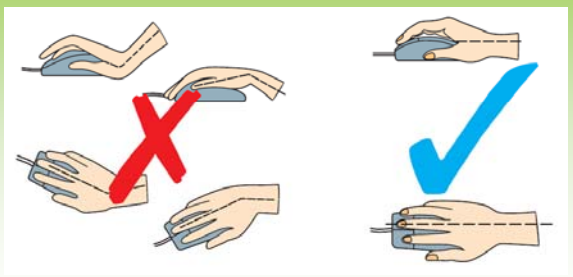
Mouse Issues

- Incidence of discomfort/CTD
- Position of mouse,
- Mouse design: pencil and tablet, trackball,

***Issues to be explored**:*

- Force, speed and frequency
- Muscle activities: forearm extensors and flexors

Mouse use



Studies on Mouse Use

- Increased incidence of UE problems due to mouse use
- Development of technology - editing, programming, drafting, graphic designs
- ?Problem of mouse position(joint angles), force, speed, repetition, muscle fatigue
- Karlqvist et al: examined different mouse positions - measured movts and emg- close to body is best
- Cook et al (2000): no correlation between hours of mouse use and pain, but found relationship between arm abduction and pain (survey)
- Size of mouse, type of design – trackball, pen, etc

The study of Anthropometrics

- Measurements of human dimensions
- Widespread applications from building design, clothing to furniture design
- Ergonomics – include product design and usability
- Usability, comfort, safety are also elements in ergonomics
- Matching the human body to the task/product

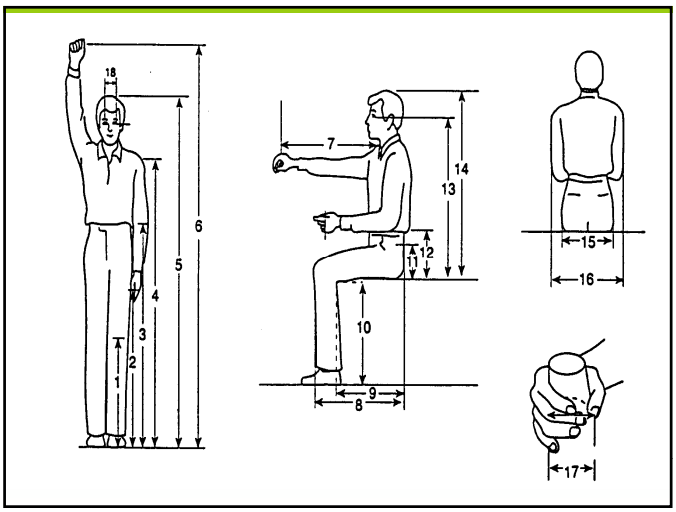
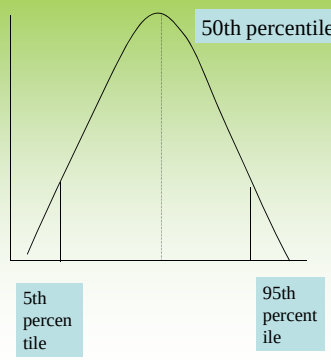


Table 3.2 US civilian body dimensions (in cm with bare feet; add 3 cm to correct for shoes) of industrial relevance. Adapted from McConville et al. *(1981)*:

	Female			Male		
	5th	50th	95th	5th	50th	95th
Standing						
1. Tibial height	38.1	42.0	46.0	41.0	45.6	50.2
2. Knuckle height	64.3	70.2	75.9	69.8	75.4	80.4
3. Elbow height	93.6	101.9	108.8	100.0	109.9	119.0
4. Shoulder (acromion) height	121.1	131.1	141.9	132.3	142.8	152.4
5. Stature	149.5	160.5	171.3	161.8	173.6	184.4
6. Functional overhead reach	185.0	199.2	213.4	195.6	209.6	223.6
Sitting						
7. Functional forward reach	64.0	71.0	79.0	76.3	82.5	88.3
8. Buttock-knee depth	51.8	56.9	62.5	54.0	59.4	64.2
9. Buttock-popliteal depth	43.0	48.1	53.5	44.2	49.5	54.8
10. Popliteal height	35.5	39.8	44.3	39.2	44.2	48.8
11. Thigh clearance	10.6	13.7	17.5	11.4	14.4	17.7
12. Sitting elbow height	18.1	23.3	28.1	19.0	24.3	29.4
13. Sitting eye height	67.5	73.7	78.5	72.6	78.6	84.4
14. Sitting height	78.2	85.0	90.7	84.2	90.6	96.7
15. Hip breadth	31.2	36.4	43.7	30.8	35.4	40.6
16. Elbow-to-elbow breadth	31.5	38.4	49.1	35.0	41.7	50.6
Other dimensions						
17. Grip breadth, inside diameter	4.0	4.3	4.6	4.2	4.8	5.2
18. Interpupillary distance	5.1	5.8	6.5	5.5	6.2	6.8

1 in. = 2.54 cm.

Normal distribution of anthropometric data (e.g.height)



Matching anthropometic factors with Chair Dimensions

- Popliteal height→height of seatpan
- Thigh length → Depth of seatpan
- Height of trunk →height of backrest
- Width (buttocks, trunk) →Width of seatpan and backrest
- *What is the matching factor for armrest height?*
- *What other measurements do you need?*

Making Recommendations for a Group of Workers

- Based on anthropometric data
- 5th, 50th and 95th percentiles
- ***Let the small person reach and let the large person fit***
- Reach dimensions 5th percentile
- Clearance dimensions 95th percentile
- e.g. Seat height: range = 5th-95th, or aim for 50th percentile
- Seat pan width, depth: 5th? 95th?

Consideration of Body Sizes (Anthropometry)

- Most furniture are made to fit medium size persons
- Recommending chair dimensions - which end of the normal distribution do you use?
- If some components do not fit, can try adjusting that component first, and check your sitting posture
- If still don fit, try adding some accessories, e.g. back support, foot rest etc

TABLE 2
SUMMARY OF CHAIR REQUIREMENTS

Parameter	Requirement
1. SEAT	
Compressed height above floor—	
for keying tasks	380 mm to 480 mm (adjustable)
for combined keying/writing tasks	380 mm to 510 mm (adjustable)
for high counter work stations	540 mm to 730 mm
Usable depth	330 mm to 480 mm (adjustable)
Maximum pan depth	430 mm
Minimum seat width	450 mm
Tilt	Fixed horizontal or adjustable between 10 forward and 5 backward
Cushioning —	
type	Flexible, cellular polyurethane, AS 2281, Type BH5
thickness	50 mm approx.
Covering fabric	Should be woollen
Swivel action	Central vertical axis
2. BACK SUPPORT	
Width (maximum)	360 mm
Height (maximum)	430 mm
Height of centre of convex area above compressed seat	220 mm to 250 mm (adjustable)
Forward position (maximum)	330 mm from seat reference point
Rearward position (maximum)	480 mm from seat reference point
Cushioning	Flexible, cellular polyurethane, AS 2281 Type AH2
Covering fabric	Should be woollen
3. BASE	
Style	5-star
Diameter (minimum)	580 mm
4. ARM RESTS (where supplied)	
Height above compressed seat (maximum)	210 mm
Length (maximum)	200 mm
Distance from front edge of seat (minimum)	110 mm
Distance between inside edges (minimum)	480 mm

AS3590.2-1990, p.14)

Environmental Issues

- Lighting
- Temperature
- Noise
- Space
- Office organisation
- Work organisation

Lighting in Offices

- Uniform illumination
- Reduce visual strain and discomfort
- Reduce Musculo-skeletal strain
- Improve accuracy and efficiency
- Normal desk work: 300 and 500 lux
- Not < 200 lux (W/m2)
- Use daylight bulbs or fluorescent for colour recognition tasks

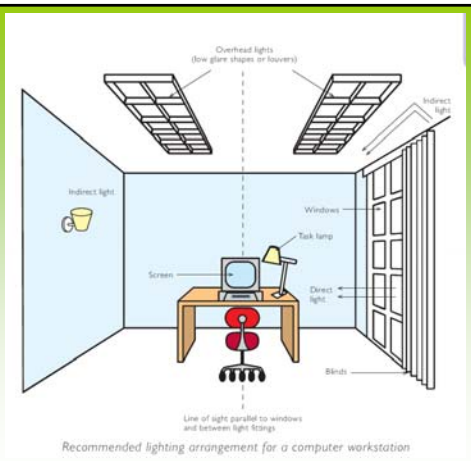
Lighting in Offices

individual lamp in dark environment gives maximum concentration but prolonged work under such illumination will lead to visual fatigue

ideally the changes between task illuminance and illuminance of immediate surroundings should be gradual thereby avoiding harsh contrasts

Reflection and Glare

- If lights are too bright, glare will result
- Align workstation at right angle to windows and light sources
- Avoid the use of well-polished surfaces
- Reducing the contrast between the work area and its surrounding



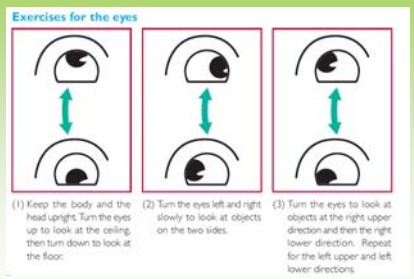
Recommended lighting arrangement for a computer workstation

Effects of lighting from unshielded and shielded window

ISO9241 recommendations on Environmenta Requirements

	Min	Max	Preferred
Lighting	**200lux**	**700lux**	**500lux (natural, indirect)**
Flicker		**Perceptible but not distracting**	
Sound &Noise	**30dB(A)**	**60dB(A)**	**40dB(A)**
Vibrations		**Perceptible but not distracting**	
EM fields	**-1kV/m**	**+1kV/m**	
Temp Humidity	**68^0 40%**	**72^0 70%**	**70^0 60%**

Exercises for eyes

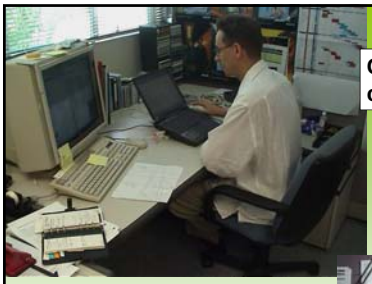


Use of Laptop Computers

- Straker et al (1997):compared posture between laptop and desktop
- Villaneuva et al (1998):examined 5 types of PC-FPD
- Szeto et al: Compared posture (using Fastrak) between standard, notebook and sub-notebook
- Saito et al(2000): Ergonomic guidelines for using notebook personal computers

Laptop Issues

- Posture and discomfort in using laptop
- placement and workstation settings
- Use of laptop as primary instument
- laptop vs desktop - replace or combine
- which type of laptop
- carrying of laptop
- Visual aspects, typing performance



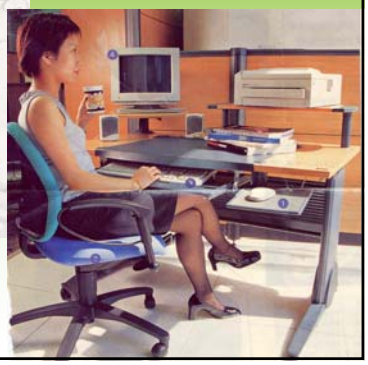
Concurrent/alternate use of laptop and desktop

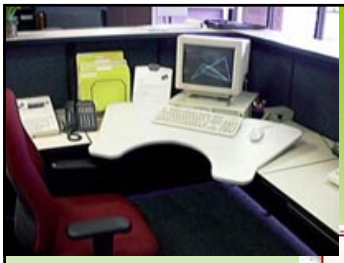
Use of laptop deck under desktop screen

Accessories

- Wrist pad
- Mouse pad
- Document holder
- keyboard tray, arm supports (troughs)
- footrest
- back support

Different types of accessory items for different problems – may not work for all individuals





Different types of desk top covers to provide more forearm support

Organisation of work

- Task rotation / Job rotation
- Introduce mini breaks
- software programmes incorporated in computer
- *e.g. "Coffee Break 3.2.1", "GymBreak", "Ergo Minder"*
- Appropriate rest pauses may actually increase productivity

"Pause Gymnastics"

- Scandinavian concept, to introduce a set of exercises, during a working day, in order to alleviate the effects of fixed work postures and repetitive movements
- Rhythmic, free or set movements, may be done with music
- May be modified for different group of workers depending on what they need

Sunderlin and Hagberg (1989)

- Effects of different pause types(15-20sec): pause with gymnastic movts, passive pause with rest and diverting pause (every 6 minutes in 3x30min work periods)
- Some reduction in muscle activity during work
- Subjective preference - more for active pauses and diverting pauses, rather than passive pauses

A review of physical exercises recommended for VDT workers (Lee et al, 1992)

- Reviewed previous studies (papers) that have instructions of exercises for VDT workers
- Identified 4 main components essential in such an exercise programme:

1. **Stretching of chronically shortened/tensioned muscles to increase flexibility**
2. **Mobilisation of the spine to counteract sustained posture**
3. **Strengthening or contraction of weakened muscles**
4. **Improvement of venous return from lower limbs**

Current and future issues in computer use

- Increasing use of laptops
- Multiple screens and/or computers
- Increased speed and functions of computers
- Smaller and more portable models of computers - more eyestrain and poorer posture
- Advancing technology - less incentive to move, tendency to sit for even longer periods
- Education of workers most important and need to emphasise mini-breaks and exercise

➔Even longer hours of static posture, lack of exercise →Neck, back, shoulders problems

➔ Use of mouse or other input devices →right arm, wrist, fingers problems

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Home computer workstations

- One computer shared by the whole family
- To whom should it fit?
- More than one computer
- Lack of space or proper furniture
- Personal habits – posture and work organisation
- Environmental factors
- Children – computer game addiction

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Selecting the *RIGHT* input device

- Find mouse that fits the size of your hand
- Light-weight and easy to operate
- Keep wrist and fingers relaxed!!!
- Keep forearm supported
- Keep it *close* to you!
- Take frequent breaks!
- Change hand!

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Definitions of terms

- **Standards**:Based on research evidence or consensus, usually quantitative, useful reference usually established by prof. assoc. or national bodies, may result in some penalty under the law
- **Specifications**:clear quantitative statement, e.g. work surface height should be 35"±5"
- **Guidelines**: can be quantitative or qualitative, provides information to assist users or designers, no penalty involved, suggested info., may form basis for standard

Ergonomic Guidelines

- **Qualitative/descriptive - emphasis on principles and concepts**
- **Quantitative - e.g. NIOSH lifting limits**
- **Limitations - variations due to work tasks and anthropometry**
- **Research: Musculoskeletal loads - described in terms of %MVC - more useful in assessing muscle effort in certain jobs, but not very practical for individual workers**

Example of a set of qualitative (descriptive) guidelines

1. **Avoid forward inclination of the head and neck**
2. **Avoid forward inclination of the trunk**
3. **Avoid requiring the upper limbs to be used in a raised position**
4. **Avoid twisted or asymmetrical postures**
5. **Where possible, keep joints within the middle 1/3 of their range of motion**
6. **Provide an adequate backrest in all seats - and design the seat and workstation in such a way that the backrest can be used to full advantage**
7. **Where muscular forces must be exerted, the limbs should be in the position of greatest strength - unless by doing so one of the forgoing principles is violated** ***(Pheasant, 1986)***

Recommendations for VDU workstation

(Quantitative)

Range of measurements, or exact measurement

- e.g. Seat height 400-530mm, or 450mm

Range of angles, distances

- e.g. Elbow at 90-100 degrees

"A Picture Speaks A Thousand Words"

Ergonomic Standards and Guidelines

- ISO 9241: International standards on office type tasks and environments
- 17 parts: VDU requirements, keyboard, workstation layout and postural requirements, environmental requirements, visual display requirements
- Many countries have their own standards: US, Canada, Australia,UK
- **http://www.system-concepts.com/stds/status.html**

Websites on Hong Kong DSE (Occupational Health & Safety) Regulation

- Occupational Safety & Health Branch, Labour Department, Hong Kong Government. A Health Guide on working with Display Screen Equipment. http://www.labour.gov.hk/eng/public/pub5.htm
- Occupational Safety & Health Council, Hong Kong. On-line Risk Assessment for Display Screen Equipment. http://online.oshc.org.hk/assessment/DSEe/index.asp