




COMPUTER VISION SYNDROME





Vijay Kumar Yelagondula
 Optometry Faculty,
 Bausch and Lomb School of Optometry
 LV Prasad Eye Institute, Kismatpur Campus
 Don Bosco Nagar PO, Hyderabad - 500 086
 Andhra Pradesh, India, Tel: +91 40 3061 5806
 E-mail: vijaykumar@lvpei.org





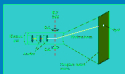




Learning Objectives


- Understanding of processes involved in VDT character generation
- Radiation emission and health effects
- Lighting and ergonomics of VDT station
- Comprehensively able to manage the CVS

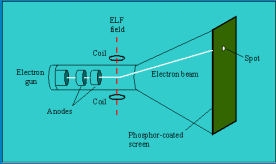
COMPUTER VISION SYNDROME 
VISUAL DISPLAY TERMINALS - VDTs


-  Computers
-  Mobile phones
-  Closed Circuit Television – CCTV
-  Television


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VISUAL DISPLAY TERMINALS - Made of


- Cathode Ray Tube - CRT 
- Liquid Crystal Display - LCD 
- Plasma 
- Light Emitting Diode - LED 

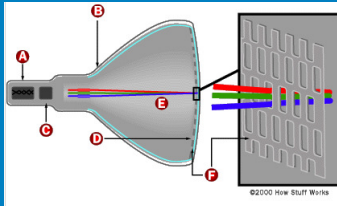
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Cathode Ray Tube







COMPUTER VISION SYNDROME 
Cathode Ray Tube



A Cathode	D Phosphor-coated screen
B Conductive coating	E Electron beams
C Anode	F Shadow mask

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A CRT monitor contains millions of tiny **red, green, and blue** phosphor dots

An electron beam that travels across the screen to create a visible image

Heated filament – electron gun

Naturally pour off a heated cathode into the vacuum(-ve)

Anode is positive, so it attracts the electrons pouring off the cathode

Screen is coated with **phosphor**, -glows when struck by the electron beam

Phosphor glows when exposed to radiation, absorbing UV light and emitting visible/colored light

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Direct the beams of electrons

Steering coils are used to create magnetic fields inside the tube

The fields move the electron beams vertically or horizontally

By applying varying voltages to the steering coils, a beam can be positioned at any point on the screen

Each image is "painted" onto the screen numerous times each second

Phosphor only glows for a very short time – while unchanged pic also need to paint the phosphor

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Three ways to filter the electron beam in order to obtain the correct image on the monitor screen

Shadow mask, Aperture grill and Slot mask

<http://computer.howstuffworks.com/monitor8.htm>

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Shadow-mask

A **shadow mask** is a thin metal screen filled with very small holes

Three electron beams pass through holes to focus -CRT phosphor surface.

Shadow mask helps to control the electron beams – desired colors & image

- by striking the correct phosphor
- Just the right intensity to create the on the display

The unwanted beams are blocked or shadowed



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Aperture-grill

Monitors based on the Trinitron technology,

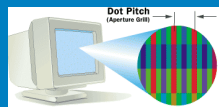
Which was pioneered by Sony, use an **aperture-grill** instead of a shadow-mask type of tube.

The aperture grill consists of tiny vertical wires.

Electron beams pass through the aperture grill to illuminate the phosphor on the faceplate.

Most aperture-grill monitors have a flat faceplate and tend to represent a less distorted image

However, aperture-grill displays are normally more expensive.



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Slot-mask

Slot-mask tube uses a combination of the shadow-mask and aperture-grill technologies

Slot-mask display uses vertically aligned slots

More brightness through increased electron transmissions

Electron beams passes through vertical and round dots of Phosphor

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Dot pitch

Dot pitch is an indicator of the sharpness of the displayed image. It is measured in millimeters (mm), and a smaller number means a sharper image.

Shadow-mask CRT monitor, *distance* between two like-colored phosphors

Aperture-grill monitor is - *horizontal distance* between two like-colored phosphors

Smaller and closer the dots are to one another- realistic & detailed picture appears

The dot pitch translates directly to the resolution on the screen

.25 mm
9,600 pixels/cm² or 10,000 pixels/in²

.51 mm
361 pixels/cm² or 2,256 pixels/in²

.26mm
1,444 pixels/cm² or 9,025 pixels/in²

1 mm
100 pixels/cm² or 625 pixels/in²

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Refresh Rate

Refresh rate is the number of times that the image on the display is drawn each second

If your CRT monitor has a refresh rate of 72 Hertz (Hz), then it cycles through all the pixels from top to bottom 72 times a second.

Refresh rates are very important because they control flicker, and you want the refresh rate as high as possible

Too few cycles per second and you will notice a **flickering**, which can lead to headaches and eye strain

Refresh rate depends on the number of rows it has to scan

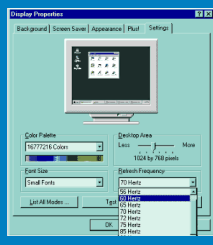
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Refresh rate depends on the number of rows it has to scan,

Tradeoff between flicker and resolution

Recommendations for refresh rate and resolution include

Higher resolution – higher the refresh rate



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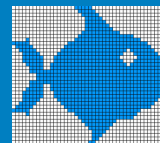
VDT - Characteristics

Character Generation

- Raster

Electron beam scan left to right & top to bottom

RASTER



-Stroke characters

STROKE

-Image is painted by a gun

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VDT - Characteristics

Flicker and Jitter

Flicker - It is the lack of stability in the brightness of the VDT screen image that results from the decay in brightness of the phosphor prior to its being refreshed by the electron beam

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VDT - Characteristics

Flicker and Jitter

Jitter - It is the variation in position of the characters displayed on the VDT screen due to improper or insufficient video deflection voltages

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VDT - Characteristics

Factors affecting flicker

- Size
- Intensity
- Refresh frequency

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VDT - Characteristics

Factors controlling flicker

- General lighting
- Screen lighting
- Medium rate of decay of phosphor
- Electronics with a min. refresh frequency of 65 Hz

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VDT - Characteristics

Color

- Phosphor or
- Combination of Phosphor

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VDT - Characteristics

Color

- Chromatic contrast
- Eye's ability to focus the colors clearly on retina

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VDT - Characteristics

Color & Visual performance accommodation

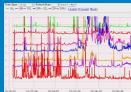
- Distance between VDT & user – 50 to 70 cm
- Presbyopia

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VDT - Characteristics

Radiation – Low Energy X-rays

- CRT
- Electronic circuits



Radiation – Ultra Violet or Visible

- Phosphors

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VDT - Characteristics

Radiation – Electronic circuits

- Radio Frequency - RF

Radiation – AC power circuits (Electro magnetic field)

- Extra Low Frequency – ELF

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Advantages of CRT Monitors

Less expensive

Better color representation

Multiple resolutions

More rugged - harder to damage

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Liquid Crystal Display units

Contradiction – liquid or solid

Liquid crystals are closer to a liquid state than a solid

Fair amount of heat to change solid into a liquid

Very sensitive to temperature

Several phases of crystals- rod shape



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Liquid crystals can be divided into

Thermotropic, lyotropic and metallotropic phases

Thermotropic and lyotropic liquid crystals consist of **organic molecules**

Thermotropic LCs exhibit a phase transition into the liquid-crystal phase as temperature

Lyotropic LCs exhibit phase transitions as a function of both temperature and concentration of the liquid-crystal molecules in a solvent (typically water)

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Metallotropic LCs are composed of both organic and inorganic molecules

Depends not only on temperature and concentration, but also on the inorganic-organic composition ratio

Thermotropic liquid crystals

Nematic phase – regularly arranged - LCDS

Isotropic – randomly arranged

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LCDs uses nematic phase

Affected by **electric current**

Nematic liquid crystal, called **twisted nematics (TN)**, is naturally twisted

Electric current to these liquid crystals will untwist them to varying degrees

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Creating a LCD

LCs

- Light can be polarized
- Liquid crystals can transmit and change polarized light
- The structure of liquid crystals can be changed by electric current
- There are transparent substances that can conduct electricity

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Mirror - A

Glass with polarizing film on bottom side - B

Common electrode plane made of indium-tin oxide on top - C

Above that is the layer of liquid crystal substance - D

Piece of glass with an electrode in the shape of the rectangle on the bottom - E

Polarizing film - F

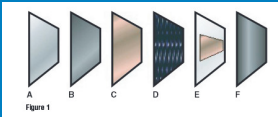




Figure 1


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Backlight



Light guided plate –evens the back light




Light guided plate –with dots



Diffuser over light guided plate – to even the light

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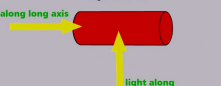
Liquid crystal with two polarized filters

Liquid crystal twist the light to pass through opposite polarized filter

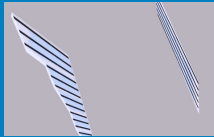
Liquid Crystal
4'-pentyl-4'-cyanobiphenyl

N#CC1=CC=C(C=C1)-C2=CC=C(C=C2)C3H11

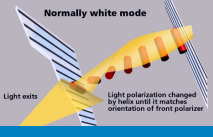
Anisotropic Optical Properties
Light travels at different speeds along different axes



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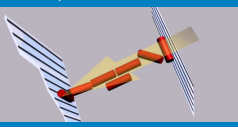
Filters are placed -LCDs sandwiched



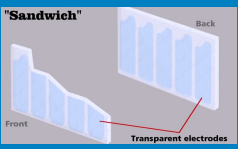
Normally white mode

Light exits

Light polarization changed by twist until it matches orientation of front polarizer



When electric current applied – no light passes




"Sandwich"


Transparent electrodes

By changing in voltage – intensity of display changes

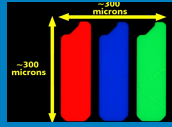
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When zoom in – Pixels (color)



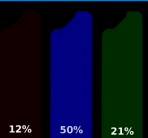
Glass plate under backlight



Sub pixel

~300 microns

~400 microns



To get blue color

12% 50% 21%

Pixels do not overlap – from far they look over lap

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Thin Film Transistors (TFT)

Switch function

TFT Addressing video information

Can Receive Video Info / Unable to receive

Brain blends into fluid image

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Two glass layers called **substrates**

One substrate is given columns and the other is given rows made from a **transparent conductive material**.

Indium-tin oxide

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Seven-Segment Liquid Crystal Display (LCD)

Liquid Crystal Sandwich

Positive Electrodes

Negative Electrodes

Polarizer 1

Polarizer 2

Display

Figure 3

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Passive Matrix

The rows or columns are connected to **integrated circuits**

To turn on a pixel

Integrated circuit sends a charge down the correct column /row

Delivers the voltage to untwist the liquid crystals

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Active Matrix:

To turn on pixel

Row is switched on

Charge is sent down the correct column

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Advantages of LCD Monitors

- Require less power – half of the CRTs
- LCDs also produce less heat
- Smaller and weigh less
- More adjustable
- Less eye strain - Because LCD displays turn each pixel off individually, they do not produce a flicker like CRT displays do

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Radiation

Small amounts of infrared -re-emits it as waste heat

EMF consisting of 50Hz – 60 Hz and higher

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EMF exposure above 2 milligauss (mG) begins to harm biological organisms

EMFs include muscle aches, insomnia, stress and fatigue

Photo aging

EMFs to lymphoma, leukemia, autoimmune system deficiencies, birth defects, tumors, insomnia, heart problems and more

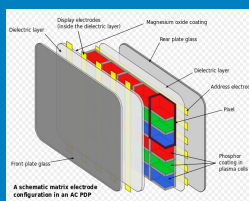
Male infertility

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Plasma work

Flat panel display common to large TV displays 30 inches (76 cm) or larger

Utilizes small cells containing electrically charged ionized gases



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A panel typically comprises millions of tiny cells in between two panels of glass

Cells", hold a mixture of **noble gases** and a minuscule amount of another gas (**mercury vapor**)

Momentarily increasing the energy level of the atom until the excess energy is shed

Mercury sheds the energy as ultraviolet (UV) photons

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UV photons then strike phosphor that is painted on the inside of the cell

Phosphor becomes unstable

Sheds the excess energy as a photon UV and IR light

40% are in the visible light range

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Advantages

Wider viewing angles

Less visible motion blur – high refresh rates

Disadvantage

Phosphors that lost luminosity over time, - gradual decline of absolute image brightness

Black lines between rows of pixels – at shorter viewing distances

Use more electrical power

Does not work as well at high altitudes above 2 km – gases expansion

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Radiation - Plasma

- While plasma monitors do generate a tiny amount of ultraviolet (UV) radiation,
- Plasma TV emits heat by infra-red
- Infrared signals produced by plasma screens have wavelengths between 825 nm and 880 nm
- Can interfere with remote controls (900nm)

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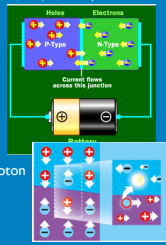
Light Emitting Diode

- Form numbers on digital clocks
- Transmit information from remote controls
- They can form images on a jumbo television screen or illuminate a traffic light
- LEDs are just tiny light bulbs that fit easily into an electrical circuit
- Illuminated solely by the movement of electrons in a semiconductor (ability to conduct electrical current)

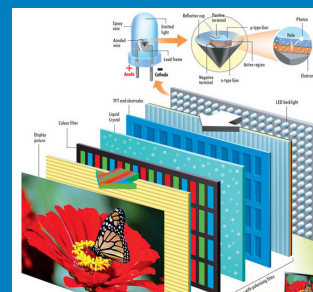


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- Conductor material is typically **aluminum-gallium-arsenide (AlGaAs)**
- Atoms bond perfectly to their neighbors, leaving no free electrons (negatively charged particles) to conduct electric current
- Extra electrons is called N-type material
- Extra holes – P type material
- When an electron meets a hole
- Falls into a lower energy level and releases energy in the form of a photon



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Why VDT and CVS needs eye care practitioner attention

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- Office lighting in the past has been relatively straightforward
- Predominant occupation has been one of reading dark letters (print) on light background (paper)
- With VDT explosion

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VDT Screen & General - Lighting

General lighting characteristics


- Source's spectral composition
- Temporal aspects
- Intensity
- Spatial
- Directional


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VDT Screen & General - Lighting

General lighting levels

- 200 to 500 cd/m²
- 350 cd/m² preferred





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VDT Screen & General - Lighting

VDT screen brightness

- 75 to 150 cd/m²
- Surrounding light not > VDT average brightness
- Surrounding light not < 1/10th of brightness of the visual task






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VDT Screen & General - Lighting

Controlling glare

- Circular polarizer
- Notch or color filters
- Directional or mesh filters
- Neutral density

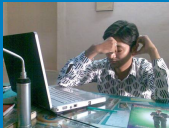




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VDT USER COMPLAINTS

Eye related - More in VDT users

- Eye fatigue & pain
- Eye dryness
- Burning
- Tearing
- Itching
- Blurring



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VDT USER COMPLAINTS

Non-Eye related - More in VDT users

- Nausea
- Head ache
- Musculoskeletal Disorders



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REPORTS & CONTROVERSIES

- Cataracts
- Abortions, Miscarriages
- Birth defects
- Lack of libido

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TYPES OF VDT TASKS – At least five

- Data entry
- Data acquisition
- Interactive communication
- Computer programming
- Word processing

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You are a computer athlete

A dangerous occupation:  This is also dangerous: 

As a typical computer user, you "walk" several miles each day on your fingertips
 $(250 \text{ keystrokes / min}) * (2 \text{ in / keystroke}) * 4 \text{ hours} = 2 \text{ miles}$

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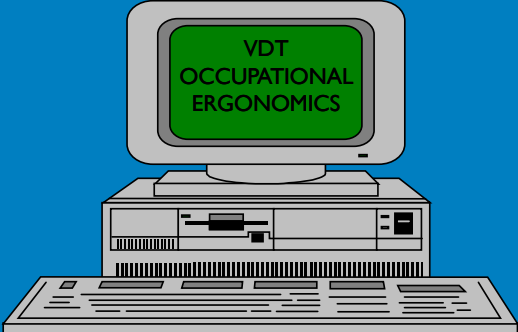
“The complex of eye and vision problems related to near work experienced during computer use.”

Aggravate the symptoms

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Accommodative Disorders	Refractive Errors
Presbyopia	Hyperopia
Binocular Vision Dysfunctions	Astigmatism
Dry Eyes	Myopia

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Repetitive Strain Injury (RSI)

- is pain or nerve problems in upper extremity (hands, arms, or shoulders)
- can also include neck and back
- is a soft tissue disease (muscles and nerves)
- is an overuse syndrome

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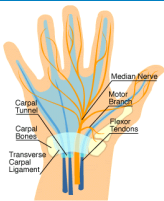
RSI Symptoms:

- burning, numbness, tingling, pins-and-needles
- dull aching OR specific, intense pain

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Carpal tunnel syndrome

- ❖ Carpal Tunnel Syndrome is a specific type of RSI
- ❖ Swelling increases pressure on nerves to fingers
- ❖ Problem is only in wrist
- ❖ Most RSI is more widespread (neck, back, arms, shoulders)



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Cumulative Trauma Disorders (CTD) or as Repetitive Strain Injuries (RSI)

Musculoskeletal disorders such as wrist problems (e.g., Carpal Tunnel Syndrome),


Bursitis, muscle strains (e.g., neck tension syndrome),

Tendon disorders (e.g., de Quervain's disease), and

Tenosynovitis (e.g., trigger finger)

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Bad posture



Slouching

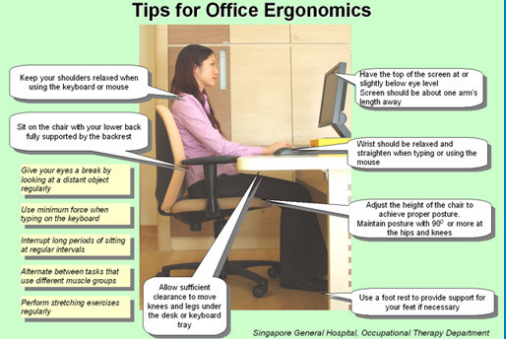
Ulnar deviation
Metacarpophalangeal joints

Dorsiflexion
Extension of the hand at wrist

Pronation

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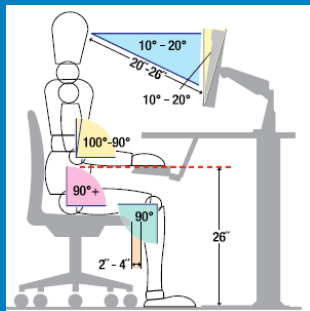
Tips for Office Ergonomics



- Keep your shoulders relaxed when using the keyboard or mouse
- Sit on the chair with your lower back fully supported by the backrest
- Give your eyes a break by looking at a distant object regularly
- Use minimum force when typing on the keyboard
- Interrupt long periods of sitting at regular intervals
- Alternate between tasks that use different muscle groups
- Perform stretching exercises regularly
- Have the top of the screen at or slightly below eye level
Screen should be about one arm's length away
- Wrist should be relaxed and straight when typing or using the mouse
- Adjust the height of the chair to achieve proper posture.
Maintain posture with 90° or more at the hips and knees
- Allow sufficient clearance to move knees and legs under the desk or keyboard tray
- Use a foot rest to provide support for your feet if necessary

Singapore General Hospital, Occupational Therapy Department

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Prevention

- Artificial-tear solutions
- "20-20-20 rule": every 20 minutes, focus the eyes on an object 20 feet away for 20 seconds.
- Proper rest
- Consciously blink

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Prevention

- Often look out the window to a distant object
- Close eyes for 20 seconds, at least every half hour
- Minimize glare
- Update display
- Adjust brightness/contrast

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A group of eye and vision-related problems that result from prolonged computer use

Many individuals experience eye discomfort and [vision problems](#)

When viewing a computer screen for extended periods.

The level of discomfort appears to increase with the amount of computer use


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Why CVS

VDT users rising


Most of them suffer some degree of CVS

In turn loss in productivity

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Symptom complex

- Eyestrain
- Headache
- Focusing difficulties – accommodation inertia
- Eye irritation/ burning
- Double vision
- Neck/back aches

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Aetiology


- Multifactorial
- Prolonged continuous usage
- Blink rate– reduced
- Blink – partial
- Dryness causing to squeeze/arch their foreheads - Causing headache
- Postural problems

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CVS - causes


- Printed versus digital screen
- Printed – black letters on white background
- VDT – letters are not sharp – faded edges
- Contrast is poor
- Accommodation and its reserve
- Eyes moving into RPA (resting point of accommodation)
- Stressful environment – major concern**




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Task demands

- Digital screen compared to printed
- Dynamic characters
- Letters are not sharp/precise
- Level of contrast reduced
- Glare/reflections
- Makes the viewing difficult

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- Bright lighting in the office - Glare
- Ergonomics additive effect
- Lack of /incorrect prescription
- Blink pattern**
- Varying working distances
- External stressors – personal/office

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Symptoms depends

- Level of their visual abilities
- Amount of time spent
- Uncorrected vision problems
- Binocular anomalies
- Aging changes of the eyes, such as presbyopia

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Diagnosis of CVS

Patient history to determine any symptoms the patient is experiencing and the presence of any general health problems, medications taken, or environmental factors that may be contributing to the symptoms related to computer use.

Visual acuity measurements to assess the extent to which vision may be affected.

A **refraction** to determine the appropriate lens power needed to compensate for any refractive errors (nearsightedness, farsightedness or astigmatism).

Testing how the eyes focus, move and work together. In order to obtain a clear, single image of what is being viewed, the eyes must effectively change focus, move and work in unison. This testing will look for problems that keep your eyes from focusing effectively or make it difficult to use both eyes together.

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CVS management

Have a regular eye exam
Uses proper lighting

Half of the light compared with office with printed
Drapes/blinds to reduce exterior light
VDT station side to the window

Minimize glare

Adjust the brightness of the screen

Display monitor quality

Refresh rate – higher better
Resolution – pixel density – higher
Dot pitch- sharpness – lower dot pitch

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Blink often

Exercise – every 30 min – 10 blinks as a exercise
Exercise and stretch eyes

Alternatively focus at far and near – 10-15 sec

Frequent breaks -20/20/20

Every 50 min – change in task for 10 min

Modify workstation

Exercises – neck /arms /legs

Thank you!



LV Prasad Eye Institute

www.lvpei.org

Excellence • Equity • Efficiency