1. **Glare and Visual Performance**  
   DEA 3500 Human Factors: Ambient Environment

2. **Glare**  
   - Glare is produced by brightness (luminance) in the visual field that is sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort or impair visual performance.

3. **Ergonomic Lighting Issues**  
   - Computer Vision Syndrome  
   - Glare and Visibility  
   - Color balance  
   - Ambient lighting systems  
   - Two-component lighting systems  
   - Contrast Management  
   - Personal control

4. **Computer Vision Syndrome**

5. **Cornell/Xerox: Lighting Changes**

6. **Visual Problems of Computer Users**  
   - Computer Vision Syndrome  
   - Eyestrain, tired eyes, eye fatigue  
   - Blurred vision, difficulty focusing  
   - Double vision, afterimages  
   - Tearing, itching, burning, sore, dry, gritty eyes  
   - **CAUSES**  
     - VDT effects on vision  
     - Inappropriate visual correction  
     - Inappropriate lighting and layout  
     - Glare

7. **Computer Use and Eye Symptoms**

8. **Video Display Terminal (VDT) Effects on Vision**  
   - Innate tendency to move the eyes to a bright light source (phototropism), such as specular glare in the VDT screen, may cause eyestrain.  
   - Reading rate for text from a VDT screen is up to 30% slower than that for an equivalent printed page.  
   - Blink rate falls from an average of ~22 blinks per minute when relaxed to ~7 blinks per minute when viewing a VDT. Also, ocular area can increase.  
   - Two hour of VDT work is sufficient to produce reduced visual acuity and eye vergence ability.  
   - VDT work produces 1.8 times more focusing abnormalities than paper work.
Resting Points of Accommodation and Vergence

- In the dark, the resting point of accommodation (RPA) is the default accommodation distance of the eyes (~30" or 75 cm).
- In the dark, the resting point of vergence (RPV) is the default convergence distance of the eyes (~32" or 80 cm).
- Computer screens often placed too close to user.

Viewing Angle and the Resting Point of Vergence

- Looking down at 45° also exposes > 40% less of the eyeball’s surface than looking straight ahead (Rupp, 1987)

Vision Correction and Age

- About 30% of young workers are myopic (short-sighted).
- The focusing ability of the eye deteriorates with age, especially over age 40 years. Without prescription spectacles the near point increases from about 20 cm to 70 cm.
- One in six people in the US visit an optometrist because of VDT problems; around 10 million eye examinations each year.

Aging US Population

- In 1997 there were ~34 million people > 65 years. This will increase some 15% to over 39 million by 2010, and over 100% to over 69 million by 2030.

Age and Lighting

- The need for more light for visibility increases exponentially after age 40 years.

Glare

Types of Glare
- direct glare - bright light in the field of view
- reflected glare - bright light reflected from a surface
  - specular (smooth, polished surfaces)
  - spread (pebbled, brushed surfaces)
  - diffuse (flat-painted, matte surfaces)
  - compound
- discomfort - produces discomfort, does not impair vision
- disability - reduces visual performance
- blinding - temporary blindness

Sources of Glare

- Overhead lights
- Task lights
- Windows
- Reflective sources (clothing, paper)
- Computer screen
- Computer screen

Direct glare

- A bright light light source in the field of view, at a level sufficiently greater than retinal adaptation, can cause direct glare.

Effects of Direct Glare on Visual Performance

Direct Glare

- Direct glare can result from many bright light sources - sunlight, ceiling light
20 VDT Screen Glare
- Specular glare on the computer screen increases the time to read relatively easy text passages from the screen (Dugas-Garcia & Wierwille, 1985).

21 Specular Glare
- Specular glare refers to the presence of bright, reflected light sources, typically reflections from ceiling luminaires.

22 Specular Glare
- Reflected (specular) glare can also occur with indirect lighting.

23 Specular Glare on Worksurfaces
- Reflected glare from overhead lights affects task visibility on office surfaces.

24 Glare and Visual Discomfort
- Reports of visual discomfort from specular glare occur long before any measurable performance decrements are demonstrable (Dugas-Garcia & Wierwille, 1985).
- Veiling glare from high ambient illuminance "washes out" screen contrast.

25 Direct and Reflected Glare
- Offices often have multiple glare sources that must be considered.

26 Testing for Veiling Reflections

27 Reducing Veiling Glare
- Though often not aesthetically pleasing, screen hoods and anti-glare filters can be effective in reducing veiling glare.

28 Testing for Discomfort Glare

29 Testing for Reflected Glare

30 Screen Color and Reflected Glare
- Changing the background luminance of the computer screen to a positive polarity (white with black text) can help to reduce some forms of reflected glare.

31 Reflected Glare
- With a bright glare source, changing the background luminance of the computer screen has only a minimal impact.

32 Minimizing Screen Glare
- Install different office lighting (e.g. indirect uplighting, two-component lighting).
- Use a flat-panel display (LCD, plasma).
- Cover the front of the VDT screen with a mesh or optical glass glare filter.
- Cover the top and sides of the screen with an opaque hood.
- Wear "VDT glasses".
- Relocate or reorient the computer screen.
- Wear darker clothing, remove reflection sources.

33 ipad vs E-Ink
iPad Glare Filter