Ergonomics for Beginners Industrial Design Perspective

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Visual Issues

Module No. # 06

Lecture No. # 28

Visual Performance

Welcome to this twenty-eighth session of ergonomics for beginners industrial design prospective.

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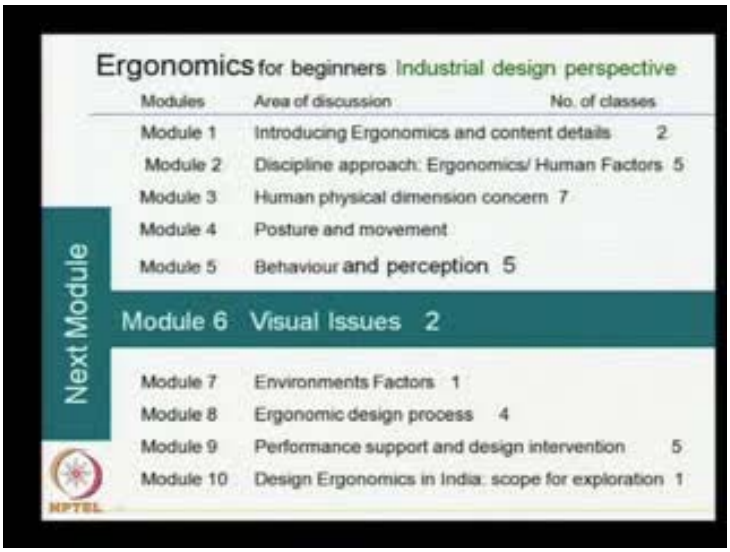

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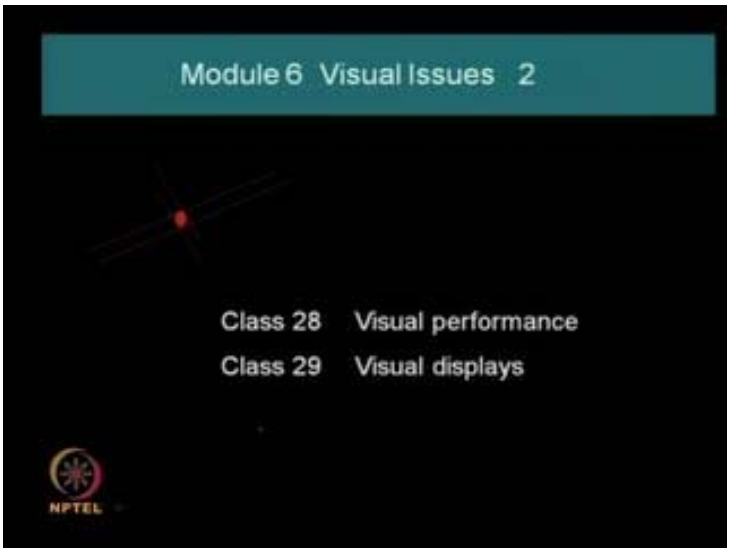

Today, we are starting the module number 6 - visual issue - and there will be two lectures and within that the today's class number 28 and 29 - class number 28 is that visual performance and 29 is that visual displays related material.

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Today's session, class number 28 is visual performance and basic design issues; in this, we will discuss the basic visual performance aspects.

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Now, the visual perception - if we see this figure here with this vehicle park, here this structure says that it is a barrier; when we see from this angle, a person can cross this, so that much space and etcetera is provided here. When we appreciate a visual object, we do not appreciate in the same way. Individual variations in the interpretation of sensed data can be critical in certain situations; people differ in experience, attitude and preconceived ideas.

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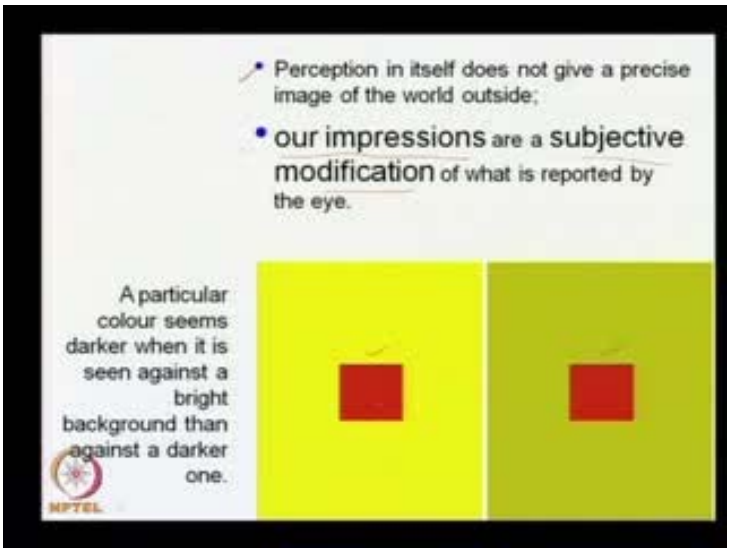

These are the basic issues of visual performance. Now, we will discuss some of the basic principles that assist us in recognizing object and act upon it. Accordingly, the perception in itself does not give a precise image of the world outside; our impressions are a subjective modification of what is reported by the eye; means, whatever we see visual input goes through eyes, the brain processes it and accordingly we perceive.

In this figure, a particular color seems darker when it is seen against a bright background than against a darker one. With the same redness seen in different backgrounds, the perception of the richness of red color varies; means, it says that the impression and the way I am looking at it, others may feel it different, but there is some similarities of thoughts and some similarity in perception will be there; if we can recognize these similarities and patterns and we apply in design, there will be a mass appeal to that.

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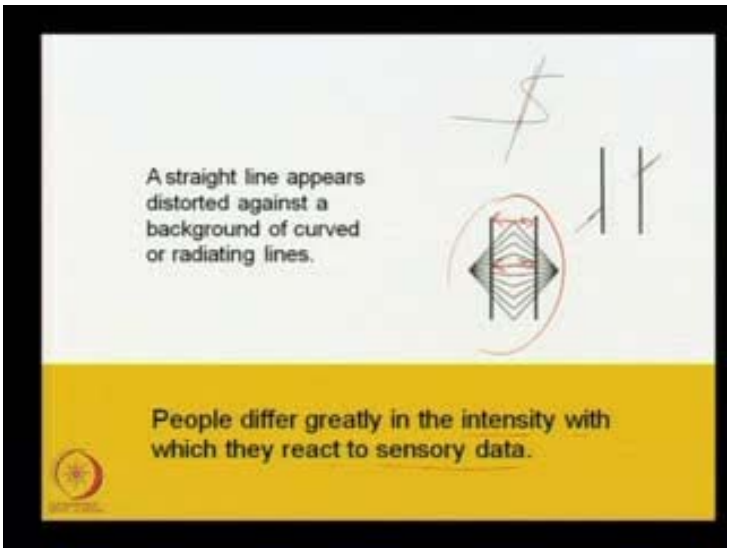

A straight line appears distorted against a background of curved or radiating lines; like here, this line when it cuts these 2 parallel lines, it does not give you a straight line appearance. In this case, the 2 parallel lines are intersected with some radiating lines, it appears closer in this region (Refer Slide Time: 04:54) and distant in this region (Refer Slide Time: 04:54), but it is not actually true. So, these are the perception and so called illusion and etcetera; it can be used appropriately in some design to convey some specific message.

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People differ greatly in the intensity with which they react to sensory data. So, the visual system controls most of - about 90 percent - all our activities in everyday life; it is especially important in a great many jobs that we perform. The eye is a receptor organ for light rays, and the essential process of vision is nervous functions of the brain.

So, whatever input is entering and how we are reacting? The judgment process is influenced by many other issues and factors that is the past experience and other situation awareness, etcetera. Eyes become sometimes an important sources of fatigue like when numerous nervous functions of stimuli-reaction nature that are under stress during seeing are considered like that way.

If in a dim light condition, if we wish to read something, that sensory input goes to our mind through eyes and to concentrate on those object the eye muscles action increases - the activity increases - and that leads to a fatigue condition not only to the eyes to the whole body itself.

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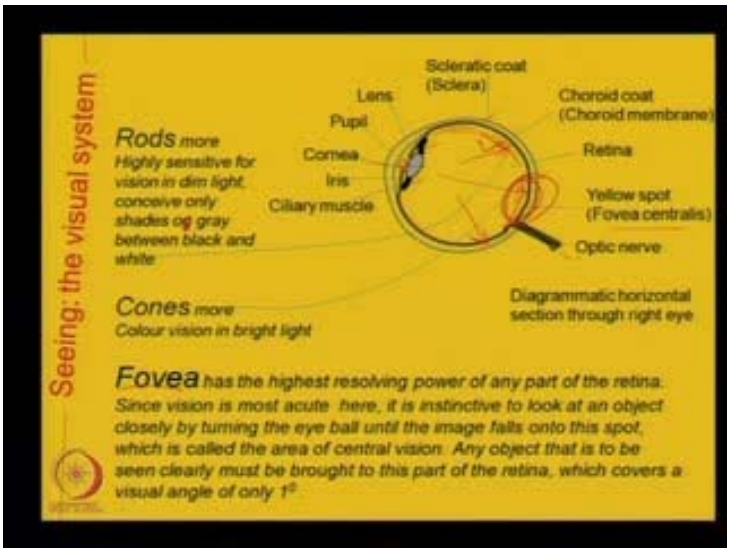

Then, while discussing all these aspects, we must see something about the eye structure and how it functions; like seeing the visual system, like that eye is more or less oval shape to circular shape matter, where it is filled up with some specific liquid and outer cover – now, if we see this figure in that outer cover is there, that is called scleratic coat or sclera; this inner coat is called cornea; and the inner side of the eye, the inner lining is the retina and retina is lying on a choroid coat that is choroid membrane.

Now, this retina contains rods and cones; these are the light sensitive cells and with this light after it is sensitized, it sends some electrical impulse through the optic nerve to the brain.

Now, here the light rays enters that whole area, we see a lens is there, this lens is organic lens and it is tied with the eye body with a ciliary muscle and then this lens is covered by both sides of the eyes with iris muscles; so, the iris contracts, expands, and relaxes; so a hole in between is that the pupil, it dilates or first squeezes and thus the light enters this pupil through which it enters into the lens to the retina and we see the rods and cones cells in this retina just approximately opposite to the lens position, there is a pupil and there is a yellow spot called fovea. Now, we see that there are 2 types of light sensitive cells; that are the rods which are highly sensitive for vision in dim light, conceive only shades of gray between black and white and they are more concentrated away from the center, that is periphery region and just towards the central region; cones are more and they are mostly used for color vision in bright light.

Now, the thing is that, when a bright light comes the pupil squeezes, so an image is formed, light falls near the fovea area where cones are there and with a specific light it can recognize the color also; but these rods cells which are spreaded in the other sides, in this area when the dim light comes we require more light to stimulate these cells, so the pupil size increases this lens it flattens. So, the light goes to the periphery area instead of concentrating on the fovea side, so as they are not getting much light and therefore they can recognize the light condition but not color as much. So, we say that, grayness or shades of colors are being sensed by these rods cells; so, these are the basic principle.

So, if we try to understand what is the fovea function? Specifically, the fovea has the highest resolving power of any part of the retina since vision is more acute here. It is instinctive to look at an object closely by turning the eye ball until the image falls on to this part, so what happen? To focus or to fix our eye on a specific area of interest object either our eye ball moves accordingly to focus on that or to assist that head also assisted this squeeze, which is called the area of central vision; in this, any object that is to be seen clearly must be brought to this part of the retina which covers a visual angle of only 1 degree, means, the rays of light if it is within or around 1 degree then a good vision is possible and so it is called the visual acuity.

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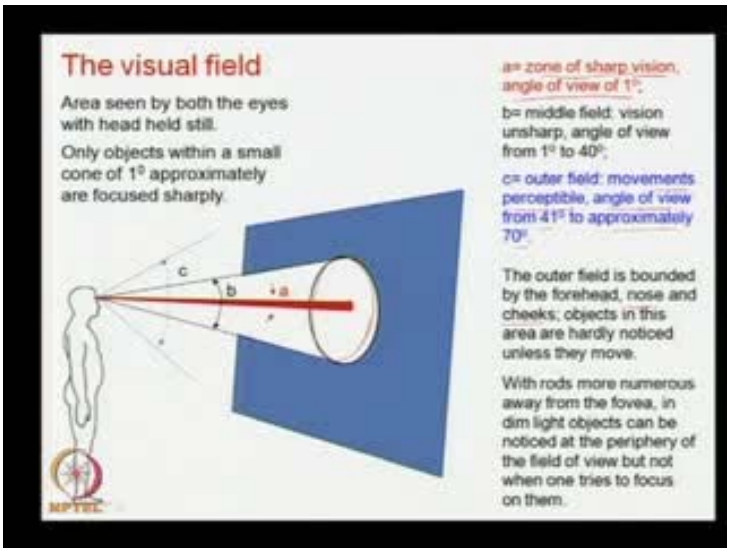

With these it can be said that, while talking about this visual field one thing is that how we see a red object when there is a good amount of light is there, because what has happened? The light falls on that object, some portion of light energy etcetera is being absorbed by the material and rest are reflected to our eyes; so, what has happened? The red rays are reflected to my eyes, so I can see it as red.

Now, if the incoming light itself is less and after absorption of all other relative red light components, then the red components when it is coming to me, its quantity is also less; so this light cannot go directly to the fovea point, so to accommodate that less light for our vision purpose our pupil dilates, so these less red light or something it goes to the periphery part of the retina, then this color will appear towards grayish.

So, this is the basic matter, if we consider now how in design we can apply these issues - physical scientific phenomena people have studied it. Now, a designer's requirement is that, if we want to create an ambiance where all these illusions and specific concentration for vision and somewhere to create a different ambience is necessary, the play of light intensity is required and accordingly some design can be conceived.

Now, the visual field in this slide - if we see the visual field the area seen by both the eyes with head held still, that is the visual field, means, with head still up whatever area I can see through my eyes, this is a visual field area. Therefore, both eyes will be in visual field and somewhere in the periphery side it will be circular type and here it will be the

cut kind of thing for this nose and etcetera. So, both the fields will overlap and will give you a total visual field. Now, here in this case, if we see a single eye only object within a small cone of 1 degree approximately are focused sharply, that is the visual acuity. Now, in this figure, if we see the red portion corresponding to the eye a, this a angle here is the zone of sharp vision angle of viewing is of 1 degree, so it will be viewing zone; then the b portion, middle field of vision will be un-sharp, angle of view form 1 degree to 40 degree this region.

Now, the c position - the c angle here is the outer field view movements perceptible, one can perceive the movement angle of view form 41 degree to approximately 70 degree, these come under this outer field; the outer field is bounded by the forehead, nose and cheeks; object in this area are hardly noticed unless they move.

So, this information if we use in our design practice then obviously our attention will be done accordingly with rods more numerous away from the fovea rod cells, in dim light objects can be noticed at the periphery of the field of view, but not when one tries to focus on them, so the periphery area and focus area we need to consider with this.

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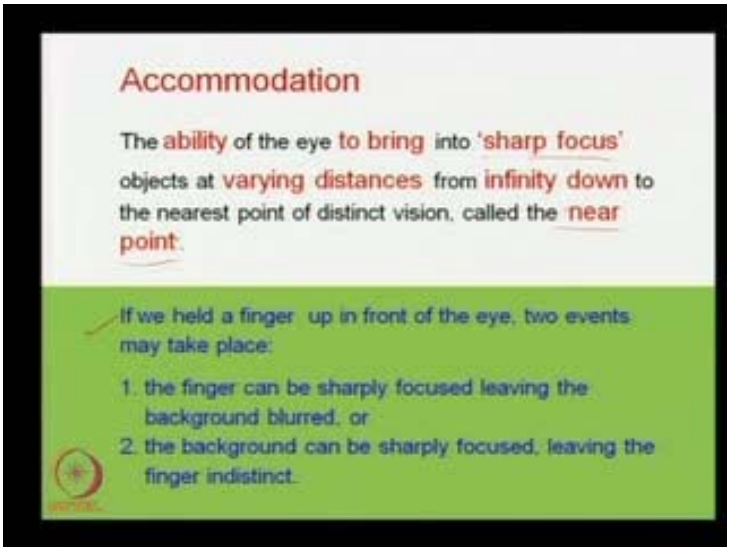

Now, another issue is that accommodation - the accommodation is the ability of the eye to bring into ‘sharp focus’ objects at varying distances from infinity down to the nearest point of the distinct vision, called the near vision.

So, infinity vision is towards far distance and near point is close. Now, if we explain, if we held a finger up in front of the eye, two events may take place: now, if we put a finger in front of our eyes, then either this finger can be seen sharply if we focus on this and the background will be blurred; if we focus on the background, then this finger will not be seen sharply at least 2 or something it will be appearing. So, these are the cases when eye focus is on distant object then inner vision is not sharp; if we focus on closer point then outer side will be blur. So, these issue this optical illusion we can create to some ambiance with the specific designs. So the finger can be sharply focused leaving the background blurred or background can be sharply focused leaving the finger indistinct.

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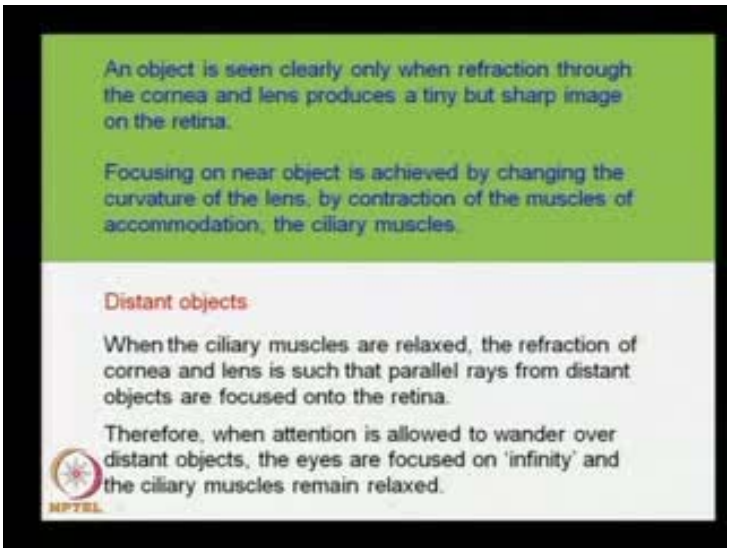

An object is seen clearly only when refraction through the cornea and lens produces a tiny but sharp image on the retina; so, the main object we want to concentrate should be more lighted. Focusing on near object is achieved by changing the curvature of the lens, by contraction of the muscles of accommodation that is the ciliary muscles; those muscles are holding the lens.

Now, the distant objects - if we focus on distant object - when the ciliary muscles are relaxed then lens will be flatten, if the ciliary muscles are relaxed then muscles will be in the lens will be flatten the refraction of cornea lens is such that parallel rays form distant

objects are focused on to the retina. Therefore, when attention is allowed to wander over distant objects, the eyes are focused on ‘infinity’ and the ciliary muscles remain relaxed.

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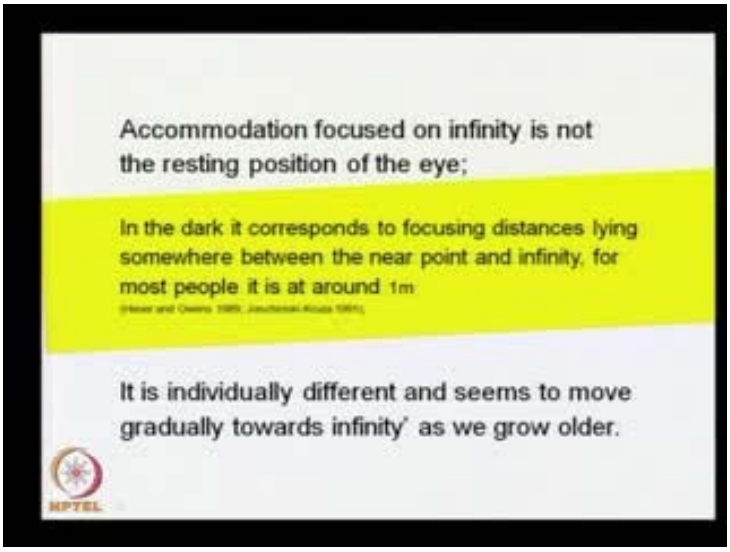

So, if we want to give a person relax feeling with some visual treatment, and then this principle can apply in design. Accommodation focused on infinity is not the resting position of the eye; when you are focusing always on infinity, it is not the resting position for eye. It is studied that, in the dark it corresponds to focusing distances lying somewhere between the near point and infinity, for most of the people it is around 1 meter from the eye position and that also corresponds with our reach value or the arm reach value.

It is individually different and seems to move gradually towards infinity as we grow older; because when we grow older the elasticity of lens reduces and also ciliary muscles becomes fatigue and becomes less functioning, so the close vision where more refraction power of lens is required - it is not available - so when the age increases we tend to see clear little far distant then the closer one.

Now, if we want to design something that the elderly people would like to use or the main target group to be addressed, then this has to be considered. Now, mostly it is seen that, if we want to see this finger and concentrate on it and try to bring it closer, so still you can focus on this finger, when it comes very close to around 10 to 15 centimeter then it becomes blur, to focus on that either you need to go back with your head or it is not

possible to bring close. So, this vision is almost we can say that, it is the minimum near vision point.

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So, with this we can say, near vision - the lens is continuously adopting its focal length so that sharp images are always projected onto the retina. The accommodated lens does not hold still but is in constant motion. When we are concentrating on one point or one object, our eye is not focused, our lens is not in the same position, like that so it is always in a constant motion - it is always adapting these things in a motion.

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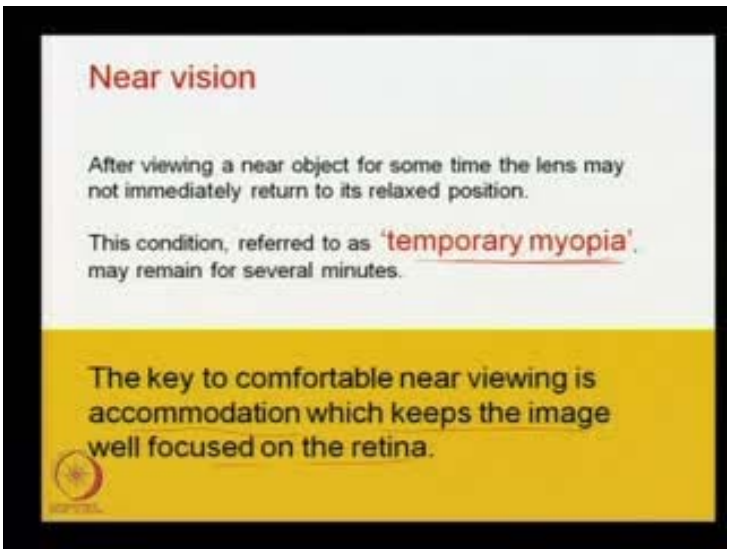

Near vision: After viewing a near object for some time then the lens may not immediately return to a relaxed position. When you are concentrating on some specific work we are doing and then suddenly if we want to see a distance, then our eye cannot focus immediately, it needs some time; when we are seeing a distant object for a longer time, suddenly if I have to focus on a very close one, then it also needs some time.

So, this time gap we have to use, we have to provide; this condition, referred to as 'temporary myopia', may remain for several minutes in some cases. The key to comfortable near viewing is accommodation which keeps the image well focused on the retina. In this case, if the object of vision that we want to see, if it is vibrating or the visual object is fixed but the person position is vibrating or both in the same direction or opposite direction vibration this affects, so this is always better; if we want to concentrate on a specific subject, this vibration thing should as much as possible be avoided.

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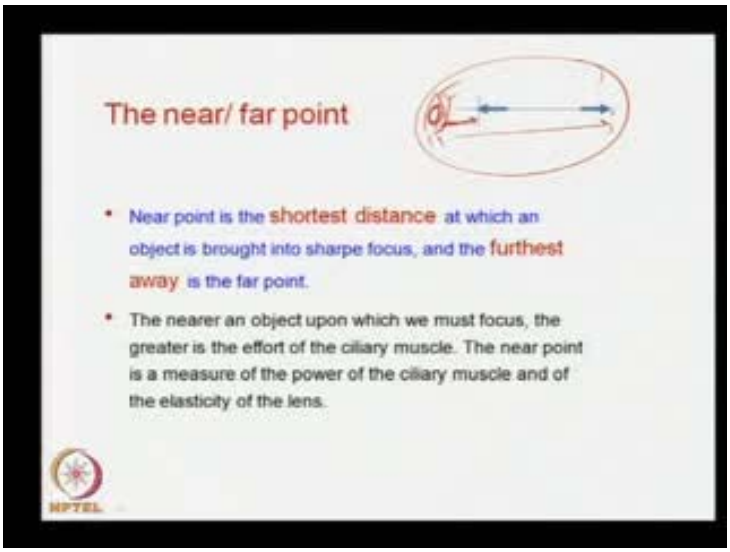

Now, the near and far point of this field, so this is the eye, so close vision and this is the far vision. Near point is the shortest distance from the eye at which an object is brought into sharp focus, and the farthest away is the far point we can concentrate.

The nearer an object upon which we must focus, the greater is the effort of the ciliary muscles; ciliary muscles that holds the lens. The near point is a measure of the power of

the ciliary muscle and of the elasticity of the lens that reduces when age increases; specifically this is the case of elderly requirement.

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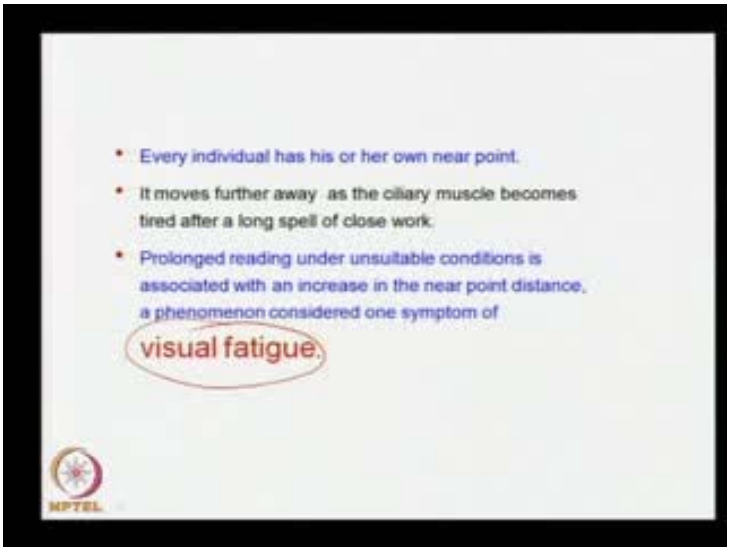

Every individual has his or her own near point relatively. It moves farther away as the ciliary muscles becomes tired after a long spell of close work. Prolonged reading under unsuitable condition is associated with an increase in the near point distance, a phenomenon considered one symptom of visual fatigue. If we want to perform some visual task, errors are there and these errors are the measure of visual fatigue, how many errors we are making and how much error we are making.

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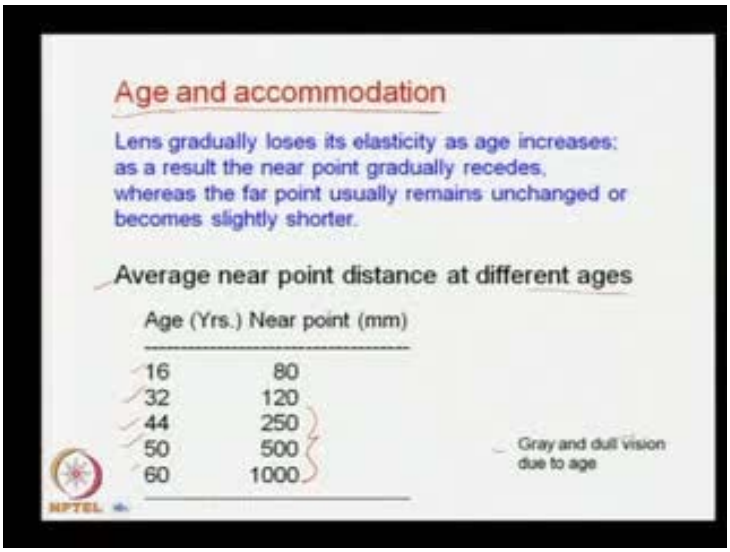

Now, the age and accommodation relevance - the lens gradually loses its elasticity as age increases; as a result the near point gradually recedes, whereas the far point usually remains unchanged or become slightly shorter. So, for the aged people - for the near vision - the rectification by wearing glasses are there.

Now, average near point distance at different ages: In a specific group this may also vary with different conditions and etcetera, but as an example we are saying here that roughly at around age of 16 years the near point may be 8 centimeter or 80 millimeter, may be at around 32 years age around 120 increases, at around 44 around 25 centimeter that is 250 millimeter, at around age of 50 around 50 centimeter that is 500 millimeter, beyond that if it is very close without any specks, it is very difficult to focus on that something like this and around 60 years age it is around 1 meter below, 1 meter will be difficult to focus for the near point.

So, for this area we need to rectify this problem with wearing glasses; just now we said that gray and dull vision due to age when light is not being focused on the Fovea, and then it goes the periphery side of the eyes, so the things will appear as gray and dull. So, to these are called dull vision due to age.

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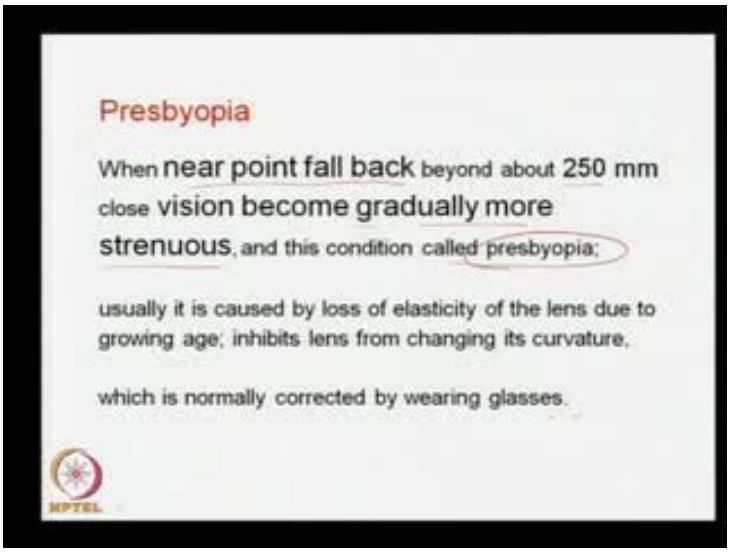

Now another aspect in this vision is that presbyopia: when near points falls back beyond about 250 millimeter close vision becomes gradually more strenuous, if we want to focus without glass, it becomes more strenuous and this condition is called presbyopia. Usually it is caused by loss of elasticity of the lens due to growing age; inhibits lens from changing its curvature, so these are the problems which is normally corrected by wearing glasses. Now, how we can use this in our design? That is our own intelligence we have to use how much how whether glasses will be worn or some other additional systems should be provided on the visual object itself, that is our own decision to be made.

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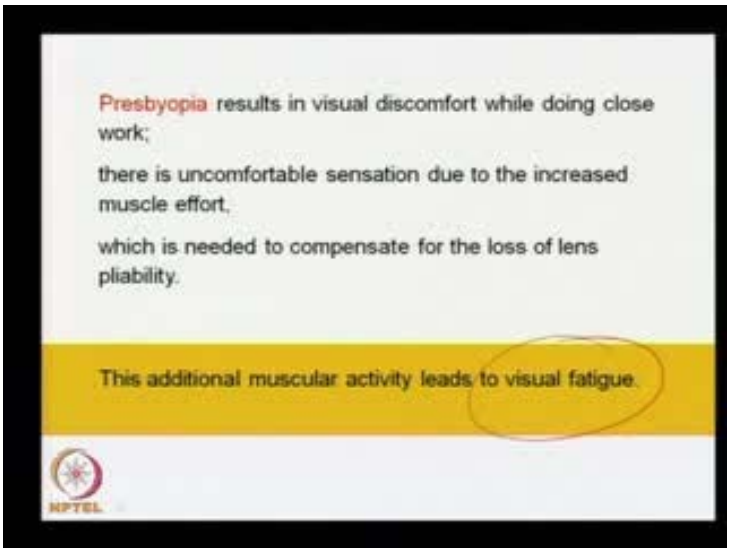

Presbyopia results in visual discomfort while doing close work; there is uncomfortable sensation due to the increased ciliary muscle effort or other muscle effort, which is needed to compensate for the loss of lens pliability. This additional muscular activity leads to visual fatigue. We need to consider these aspects in creating any visual atmosphere.

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Then, speed and accuracy of accommodation: Illumination plays a critical factor in accommodation that we have just discussed; if less light is there then the vision is blurred. When the light is poor the far point moves nearer, we cannot concentrate on the far distance and the near point recedes, while both speed and precision of accommodation are reduced.

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The better the luminance contrast of visual target against the background, such as letters in a printed text, the faster, easier and more precise the accommodation. The speed and the precision of accommodation decreases with age; and show a marked decrease from about the age of 40 in general, for this purpose people say that after 40 years you need to wear some kind of glasses. Now, in this slide we are showing that the same visual object, before reading is placed here with different light conditions, it differs in perception, differs in easiness of reading.

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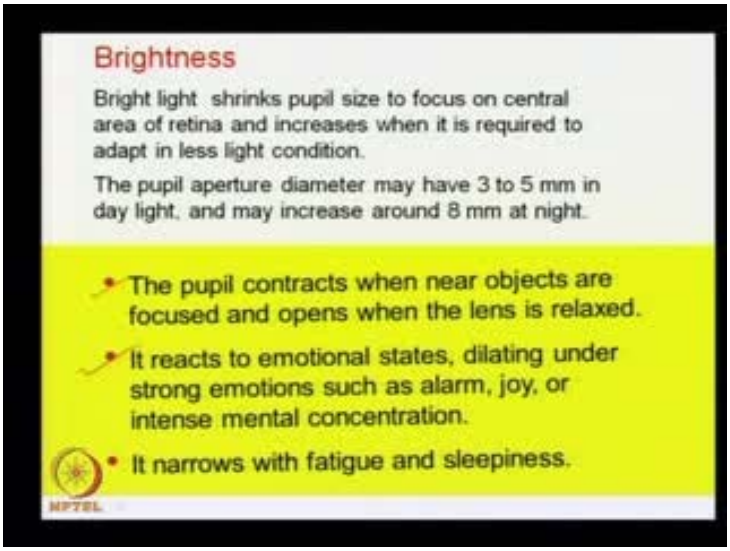

The brightness: The bright light shrinks pupil size to focus on central area of retina and increases when it is required to adapt in less light conditions. The pupil aperture diameter may have 3 to 5 millimeter in day light, and may increase around 8 millimeter at night.

The pupil contract when near objects is focused and opens when the lens is relaxed. It reacts to emotional states, dilating under strong emotions such as alarm, joy, or intense mental concentration it dilates and some time it shrinks also in sorrow. Normally, it shrinks, it narrows with fatigue and sleepiness; but still another condition we can say that when you are tired and sleepiness, if at that time more light intensity sources are around then it is irritating; so for that purpose if we are together with some people, some one feels fatigue and some feels energetic at that moment; but those who are feeling fatigue they need to sleep, those who are more active they need to read something. Suppose in that case, a focusing light arrangement would be better, if they require they can switch on that light to focus on their required objects whereas others may sleep, they will not be disturbed. Now, how best we can create this situation, that is our design requirement and intelligence accordingly we can use need to use it.

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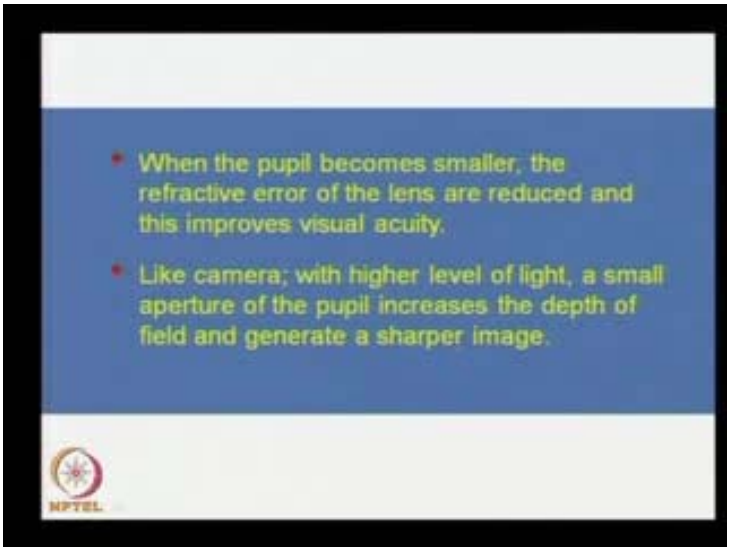

When the pupil becomes smaller, the refractive error of the lens is reduced and this improves visual acuity. Like camera; with higher level of light, a small aperture of the pupil increases the depth of field and generates a sharper image.

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In this slide we are showing that, this film was shot inside a car, where the outer side is too much illuminated and inners is relatively less, so what has happen? When a camera is used, it sees whatever the slide is presented here, the camera image it shows like this way, but our eye does look at it in a different way; even in this context our eye also can identify each and every points of this phase and etcetera, so this is a special accommodation that camera cannot do perhaps.

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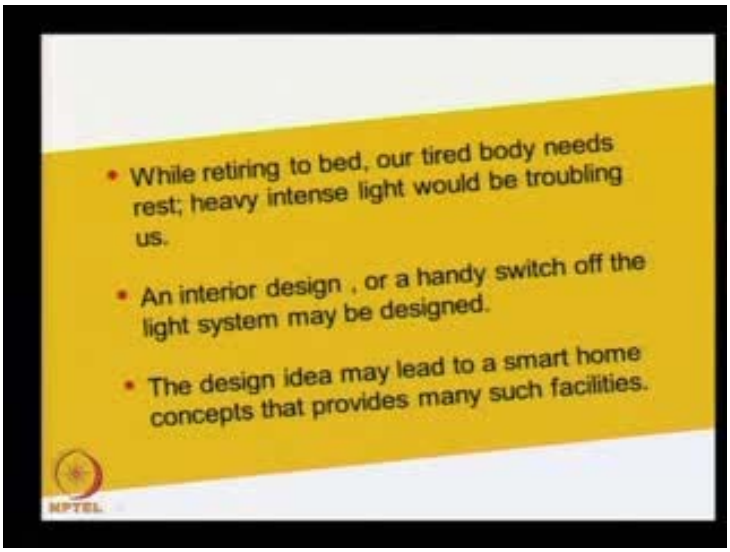

In this case, less light condition and little focus light is added here to see that camera focus is this, but human eye can also see little different more clearly, but there we need to provide some more time to accommodate this; as for example, while retiring to bed, our tired body needs rest; heavy intense light would be troubling us. An interior design, or a handy switch off the light system may be designed, means, for the light is there, if I am feeling sleepy, so with the eye matter and eye fatigue etcetera or body also needs rest, at that time to go up to that switch point that is on the wall to go and switch off it would be better, if we can have a switch nearby, so that simply you can switch off that one. The design idea may lead to a smart home concept that provides many such facilities.

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In this case, camera sees this field, some lights are there at late evening time, the people are seen walking but their clothing colors and etcetera are not visible properly; but if we give some more time to observe, not in this slide because it is already taken, but in the real situation if we allow a person to observe for a little longer time, then some details can be seen.

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In this case, wherever light falls that is the intensity of light is coming to you, one can recognize the colors but others not; so depending on to create the visual affect, specific light application it requires, this is called adaptation.

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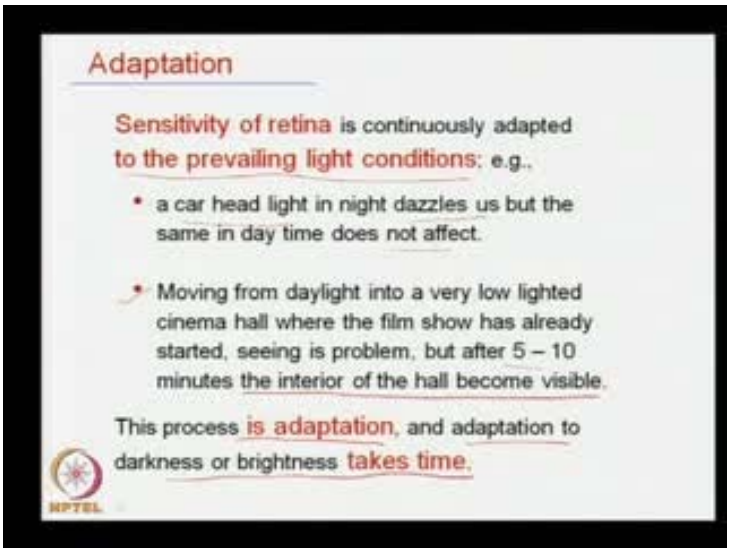

Adaptation is the sensitivity of retina, sensitivity of retina is continuously adapted to the prevailing light conditions: as for example, we have shown earlier and now a car head light in night dazzles us but the same light if it is on in day time does not affect to us. Moving from day light into a very low lighted cinema hall where the film show has already started, if we want to enter seeing is problem, if we want to see or identify our seats in this dark condition, it is difficult therefore we need some once assistance to identify our specific seats.

But after 5-10 minutes though the light condition remains same the interior of the hall becomes visible. So, this is the adaptation, so if we give some more time then we can see that details.

So, if we do not give this much time and if we wish the person should react or act accordingly, it would not succeed; so, this process is adaptation and adaptation to darkness or brightness takes time. In that case, if a person has to enter into a dark place, so in between either there will be another space where an in between lights is there or some gradual decrease or increase of light condition should be maintained and some time may be given.

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So, with these we may create an special exhibition hall kind of thing that appearance, where people need to concentrate on some specific object whereas the total light condition may differ; in this case, a vehicle light is coming in this dark place, only this much is visible nothing else; but in this condition if we stand for some more time then we may see some other details here also.

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Adaptation to darkness: This sensitivity is much higher in darkness than in daylight. Darkness adaptation is relatively faster in the first 5 minutes and then gradually slower

afterwards. Around 80 percent adaptation takes about 25 minutes and for full adaptation it requires as much as 1 hour. Sufficient time must be allowed to adaptation to darkness; at least 30 minutes is needed to acquire good night vision. Low light restaurants activities may be cited as example that requires appropriate design application. Normally, what happens? When you enter to a little low light restaurant everything may be very good in order, but at that time, when the menu card the waiter brings to you, it is very difficult to read those menu cards, so in that case either allow some more time to adapt your eyes or there may be another thing that a specialized or localized lighting system can be provided.

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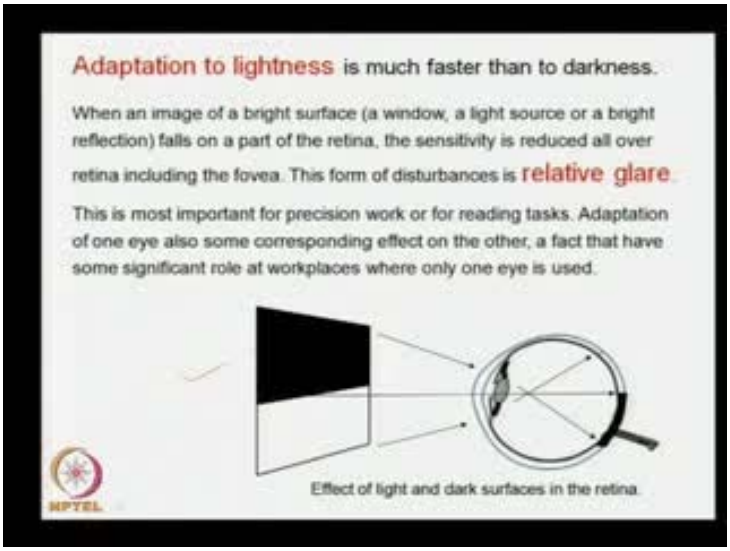

The adaptation to lightness is much faster than to darkness. When an image of a bright surface – window, a light source or a bright reflection - falls on a part of the retina, the sensitivity is reduced all over retina including the fovea. This form of disturbances is relative glare. This is most important for precision work or for reading tasks. Adaptation of one eye also has some corresponding effect on the other, a fact that have some significant role at workplaces where only one eye is used. In this case, it can say that effect of light and dark surface in the retina in this figure explains this.

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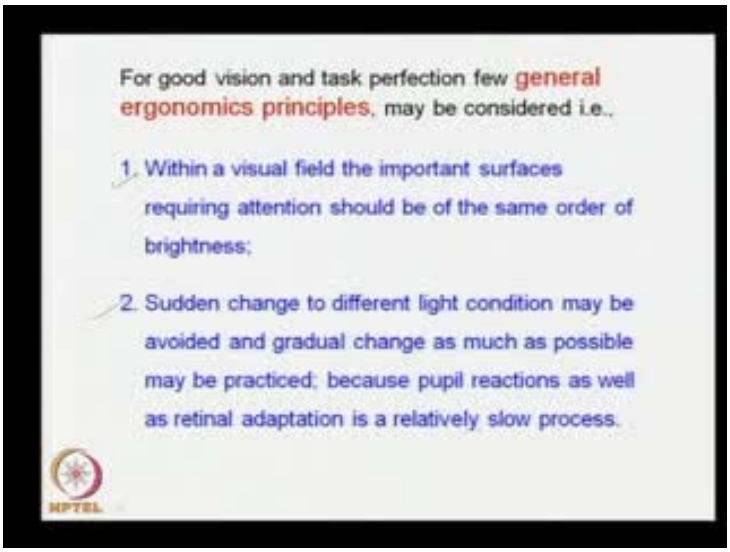

For good vision and task perfection few general ergonomics principles, may be considered as for example, number 1, within a visual field of important surface requiring attention should be of the same order of brightness; number 2, sudden change to different light conditions may be avoided and gradual change as much as possible may be practiced; because pupil reactions as well as retinal adaptation is a relatively slow process.

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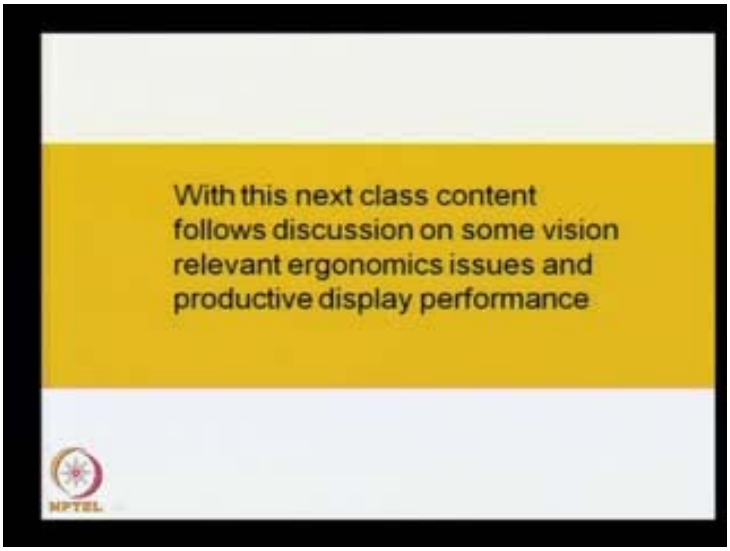

So, with this the next class content follows discussion on some vision relevant ergonomics issues and productive display performance, means, with today's basic principles of whatever we discussed related to the vision. Next class we will try to see its other application areas in design.

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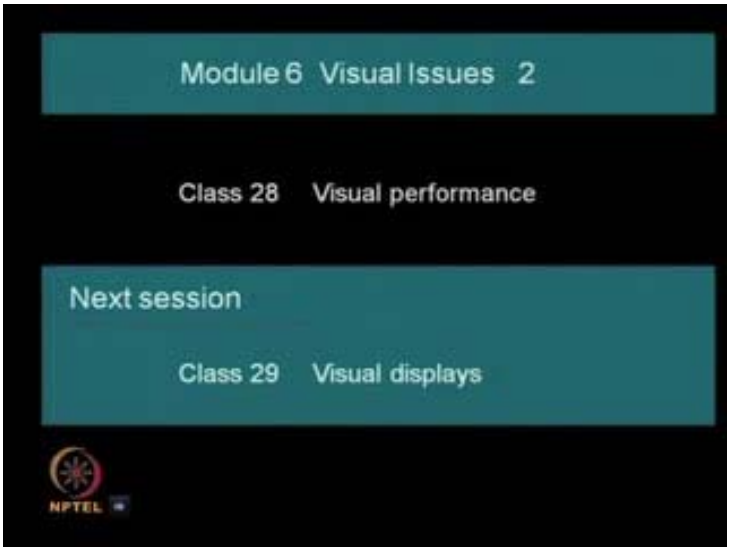

So, with this we are completing today's session. Next session will be class number 29 - the visual displays.

Thank you very much.