Glass in buildings Design and Application
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Lecture - 32
Daylighting Controls

Let us have a quick look at Sensors. So, the simplest of the sensors is the illumance sensor.

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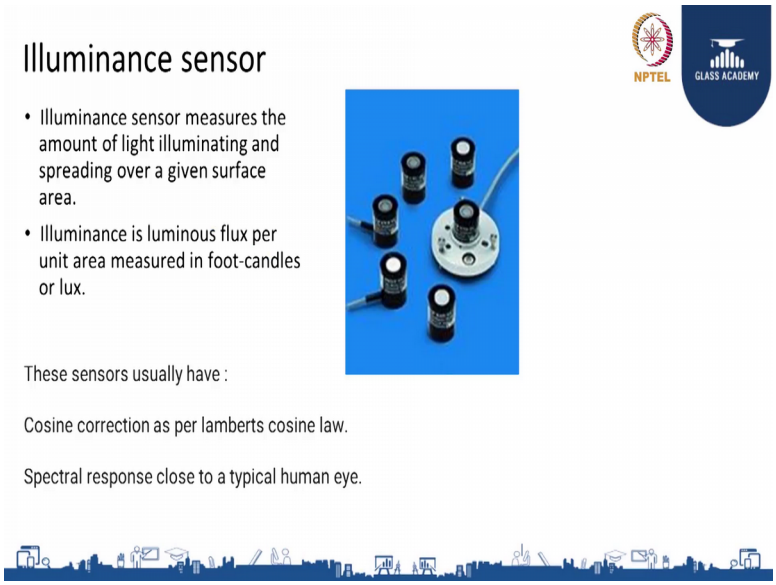

The illuminance sensor measures the amount of light illuminating and spreading over a given surface area. Illuminance is the luminous flux per unit area measured in foot candles or lux. These sensors usually have cosine correction as per Lambert's cosine law. This helps in measuring the low light levels accurately and also accurately measuring the light which is coming at lower angles. These sensors also would have a spectral response close to the typical human eye, because these sensors should report the illuminance value in such a way that this is what the average human eye will see.

So, the values reported by them should correspond to the response that a average human eye will have.

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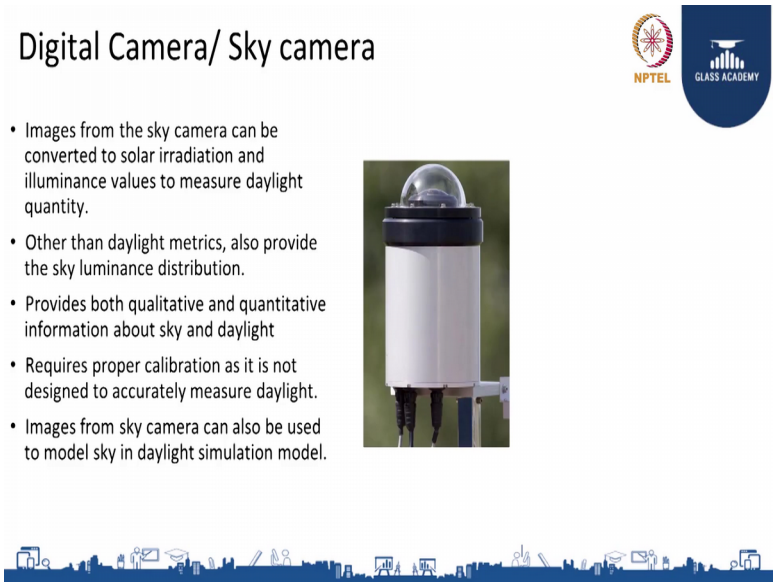

We can also have more complicated sensors like sky camera. So, sky camera can basically look at the whole sky, it can have a 360 degree view angle and it can take pictures of the sky at different exposure levels. Once we know what is the overall condition in the sky we can estimate the light that is entering through the windows into the building, we can estimate if there is a possibility of glare and we can control the shading devices as well as the artificial lighting.

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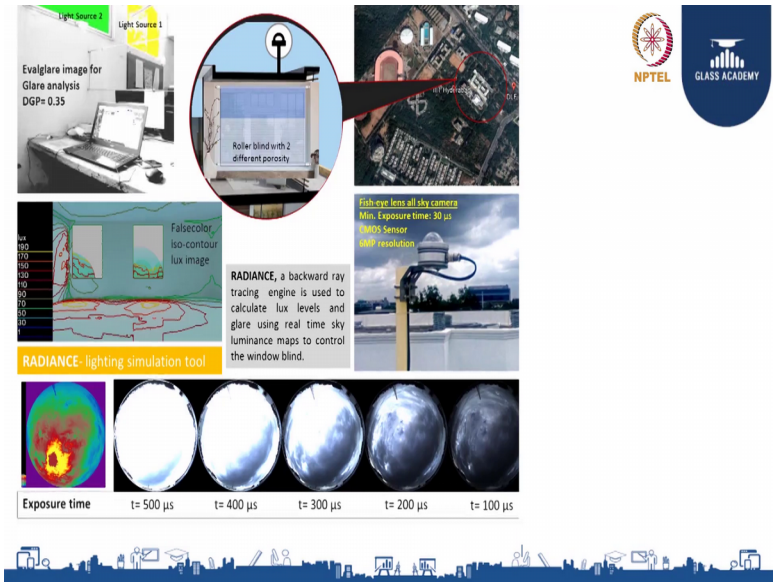

Here is an example how it can be used. So, this is arial view of a campus, we are located a camera here and then this camera takes the pictures of the sky at different exposure times because there is a huge variation in the brightness of the sky. So, we have to take several images at different exposure time and create a high dynamic range image. Based on this image, we understand; what is these sky condition and we can simulate the sky in radiance and also estimate the illuminance level in the building.

Once we can estimate that then we can control the artificial light or the daylight control devices.

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So, let us look at the actuators now.

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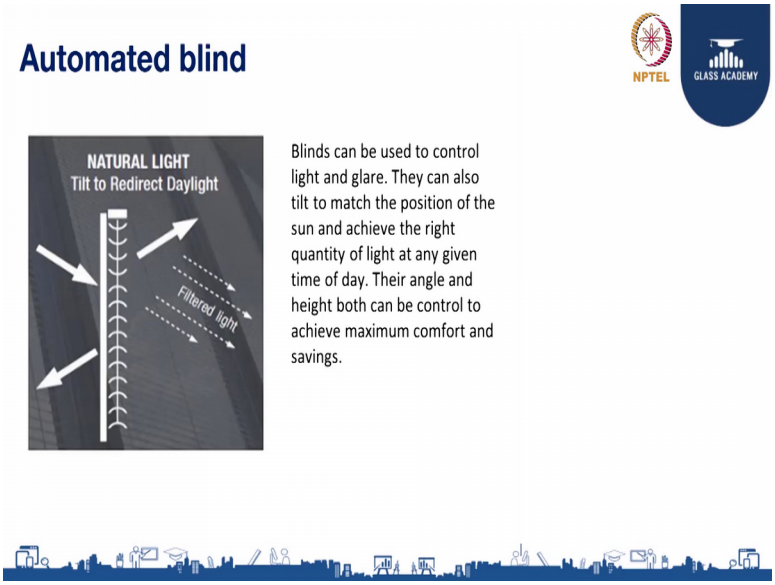

Actuators can be simple like variation blinds. In case of blind, we want to control the light and we also want to use it to control the glare. The tilt of these blind can be controlled in such a way that we are able to redirect the light towards the ceiling and by redirecting as we have seen earlier, we can bring the light deeper into the space. We can close the blind when there is too much of daylight, we can open it when there is less daylight. So, like this we can control the amount of daylight coming from the window.

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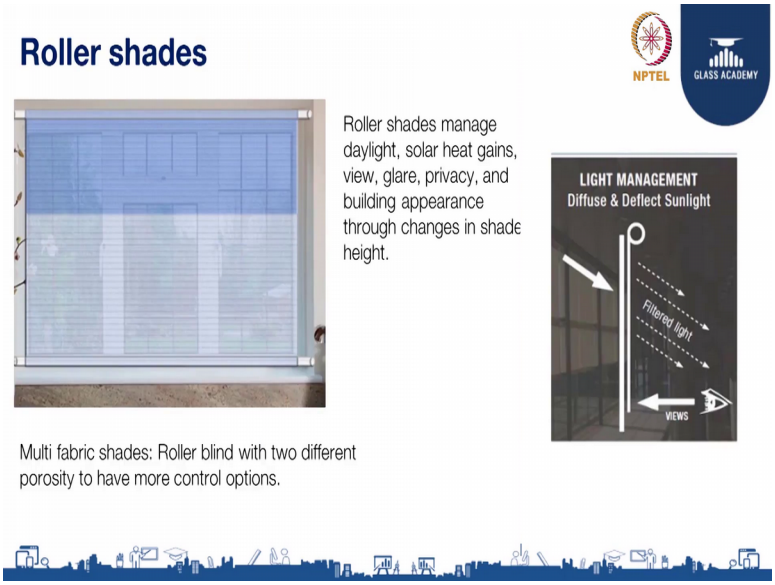

Roller shades are also very commonly used. They control daylight, they also control solar heat gains, they can depending on the time they can provide view or if they are 100 percent opaque, then they can cut the view when they are put down and they can provide privacy, they can protect us from the glare. Sometimes, we can also use multi fabric shades. So, the roller blind can have two different fabrics with different porosity. It helps in controlling the daylight, while maintaining the view outside.

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We can also have awnings which are motorized and whenever the facade is getting too much of sunlight the awnings can prevent the windows and whenever there is no direct sun falling on to the facade. Then it can close and allow more daylight to enter into the space.

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We have already discussed about smart glass. So, we can control the transmitivity of the glass, the visual transmitivity of the glass and we can bring in more light whenever required or we can cut whenever it is in access.

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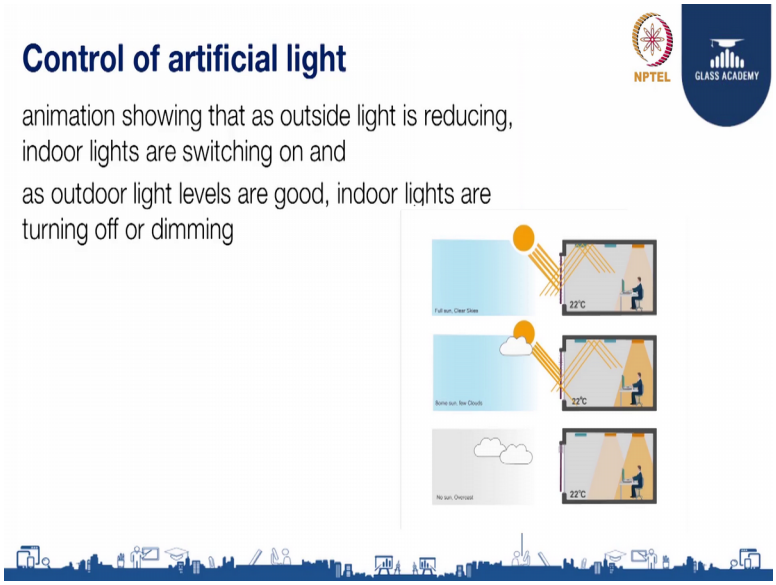

So, let us now look at the control of artificial light. So, we understand that the outdoor daylight conditions would be changing throughout the day and then the artificial light has to respond to it. So, what are the methods by which we can control the artificial light?

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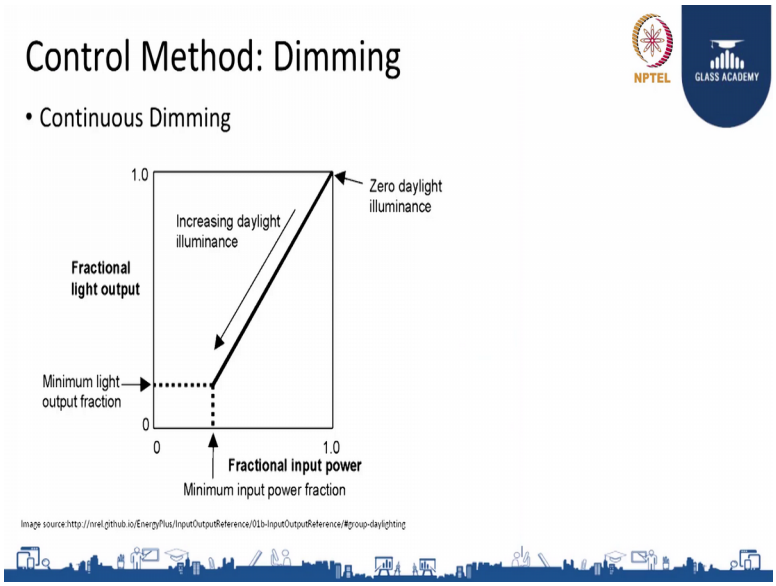

There are they are basically two common methods; one is dimming, in which we dim the light output from the artificial light. In this graph you can see that as the fractional light output reduces, the power consumed by the fixture also reduces. However, you can see that the efficacy of the lamp reduces when we dim it. Meaning, hereby like if I am reducing the lamp output to a 20 percent that does not mean my power consumption will also come down to 20 percent; my power consumption might be 30 percent.

So, I am giving only 20 percent light, but consuming 30 percent power. So, the efficacy has come down. Another way of dimming is step dimming.

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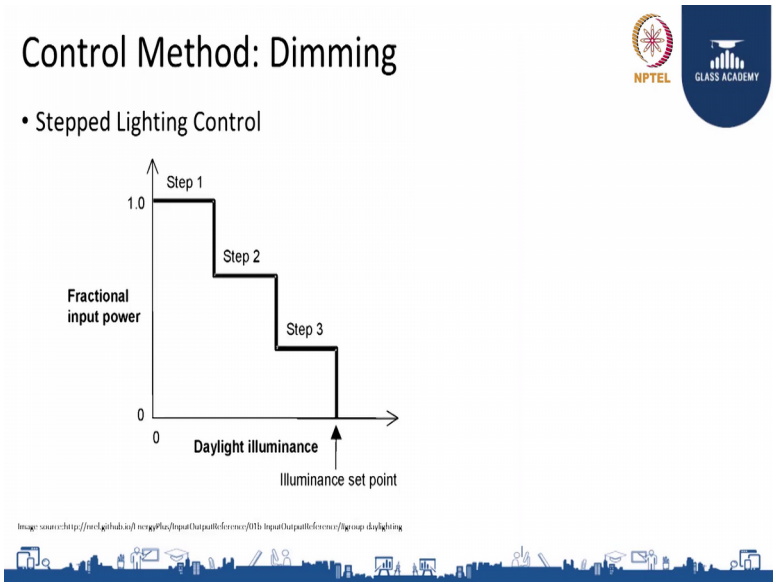

In case of step dimming, we can have multiple lamps in a fixture or multiple fixture and we can switch them on or off to achieve the reduction in the light output. So, say for example, if we have three lamps in a fixture, when all the three are on we get 100 percent light output, when two are on we get 66 percent light output, when only one is on we get 33 percent light output and when all are off we get 0 light output.

So, we can have different steps. This is easier to control and there is no loss of efficacy when we are dimming it, but of course we cannot get continuous dimming, we get it in steps. Let us now look at the control system.

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Control system can be very simple. It can be as simple as a stand alone fixture with a closed loop.

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Here you see a fixture with a sensor, this sensor can estimate the illuminance level and it can also find out if the space is occupied or not. So, if the space is occupied and the illuminance level is less then it can switch on the artificial light and it can dim it till the right level is achieved. If the space is unoccupied, it will switch off the light. In case the

space is occupied and the enough daylight is available then also it will dim or switch off the light.

So, it is a very simple stand alone fixture, we can straight away purchase it from the market and install it. We can also buy or install simple open loop stand alone systems.

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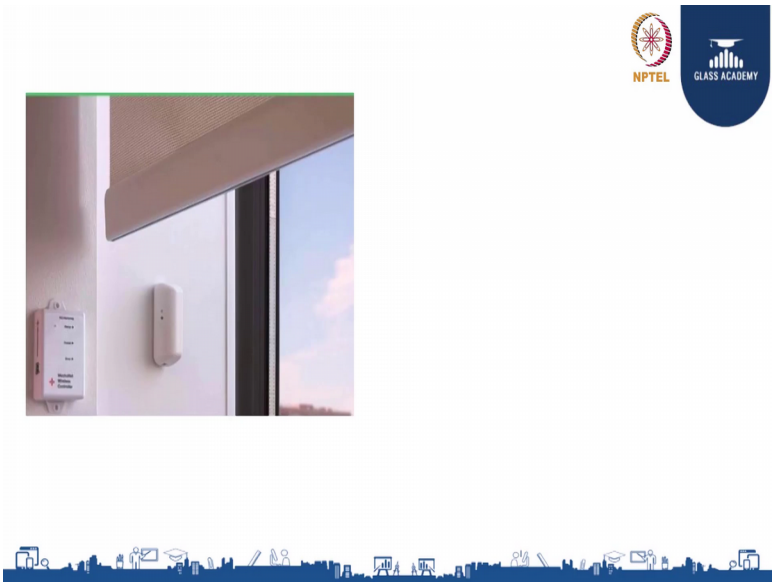

Here you see that there is a sensor which is inside the space, but looking towards the window. If it senses lot of daylight, it will close the shade. If it senses reasonable amount of daylight as per the requirements it will open the shade. So, from these simple stand alone systems, we can go all the way to complicated systems.

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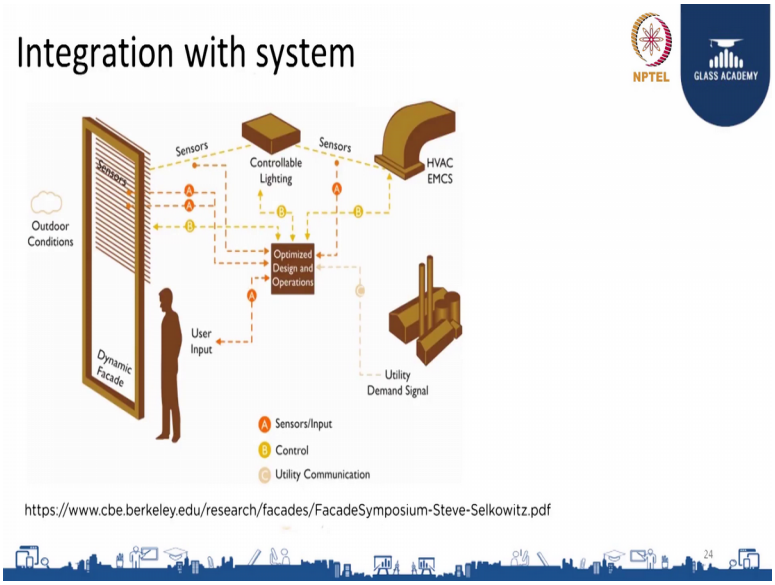

In this system you see that they are several senses; we can be measuring the outdoor conditions, we can be measuring the indoor conditions, we can be measuring the blind position, we can take the user feedback, we can find out whether the space is occupied or not. We can also be talking to the HVAC system to understand whether heating is happening in the building or cooling is happening in the building, we can measure temperatures, we can even get signal from the utility to understand the tariff and if the cost of electricity is very high or low, if there is a demand response even going on.

So, will all these inputs, we might control the artificial light or the daylight devices, and do an overall optimization from the point of view of achieving energy efficiency, and providing comfort to the user.

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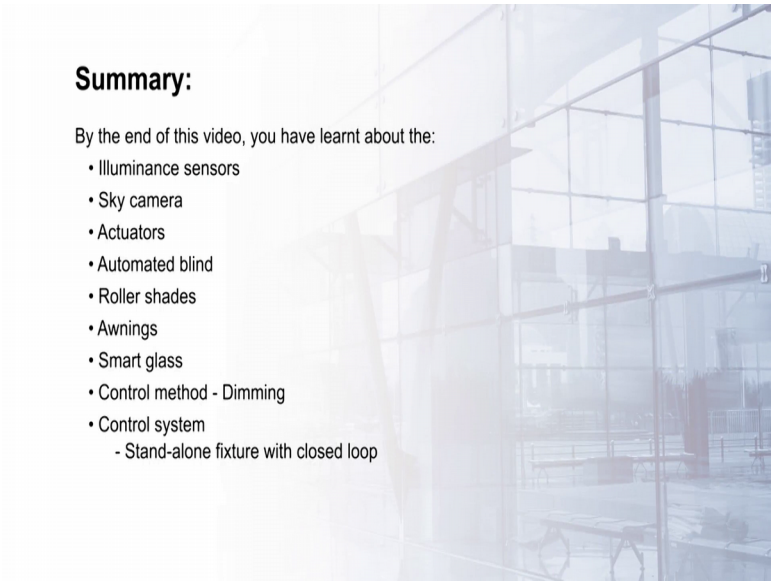

Thank you.