Glass in buildings Design and Application.
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Lecture - 30
Introduction to Daylight Simulation

Welcome to the course on Introduction to Daylight Simulation. In this course I will be talking about or taking you through the whole process of daylight simulation, the input part, the analytical part and the output part.

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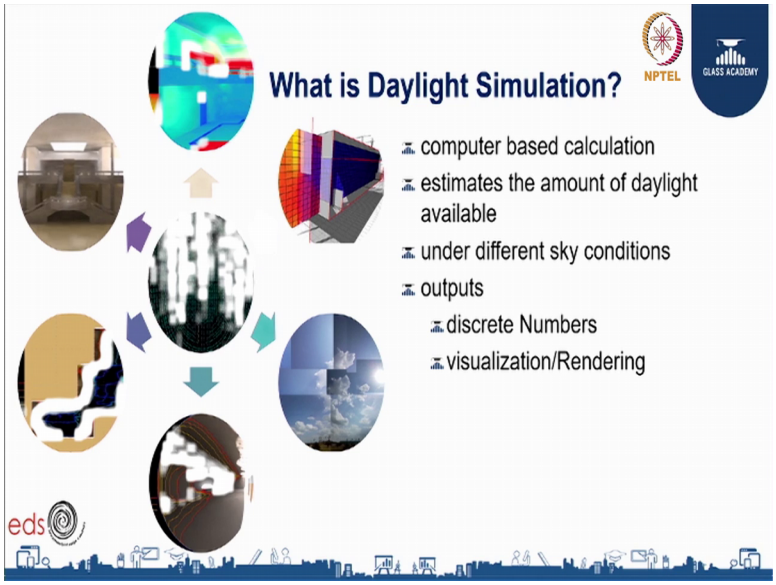

Before we get into the process of daylight simulation let us first understand: what is daylight simulation. It is basically a computer based calculation of the amount of daylight available inside and outside under different sky conditions, simulation output may be discrete numbers; that means, it can be illumination, luminous value or it can be a sensor point or it can be a visualization or photo elastic (Refer Time: 01:14).

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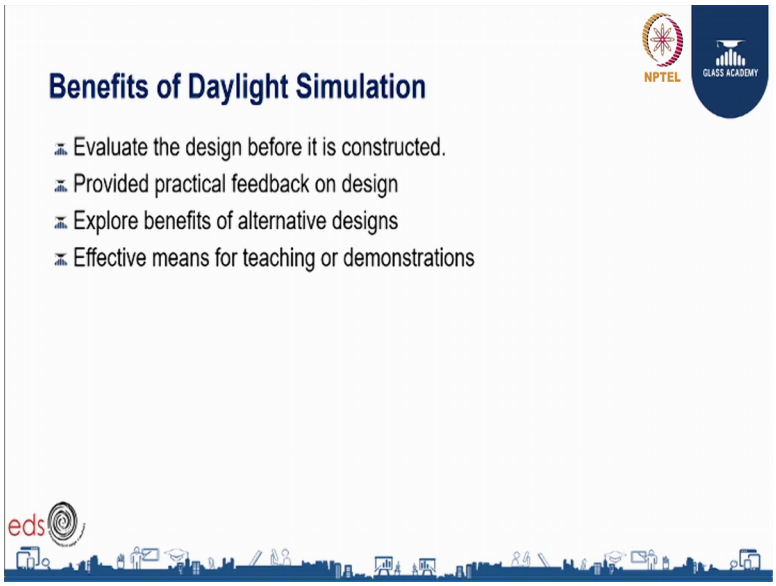

Let us just briefly discuss the benefits of daylight simulation. Simulation helps in checking the brightness and efficiency of the design before the system is actually constructed. It provides the user with practical feedback. It helps in providing the merits of alternatives design without actually physically building the system. It can be an effective means of teaching or demonstrating concept to students.

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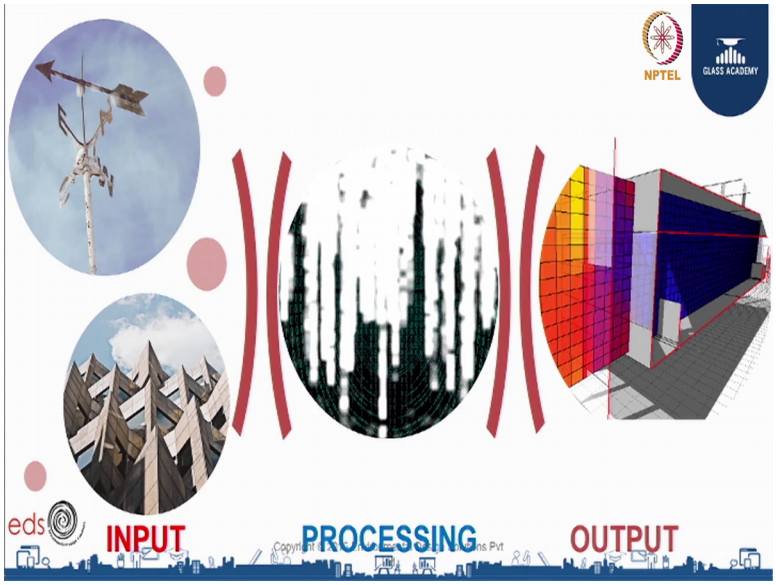

This slide briefly explains you the whole process of daylight modeling; building information such as the geometry and the weather data are feeden into the simulation

engine. The simulation engine processes the information and calculates the illumination values or other parameters and provides the output in terms of luminous quantities such as lux level, illumination value, luminous value. So, now let us just understand this process in detail.

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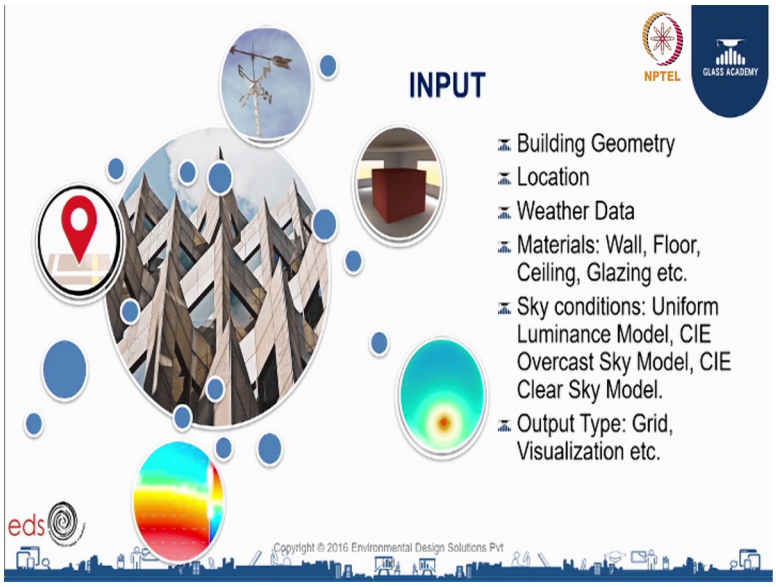

So, now starting with inputs, one of the important or primary input in daylight modeling is the building geometry. Generally, all the simulation tools they provide a modeling module, where you can input the floor, floor plan, the building geometry the building height, you can also give windows parameters exact window location whether shading is there, external shading is there. While creating geometry one has to keep in mind that to keep the model simple, because simulation time is directly proportional to the complexity of the model. So, less surface you will take less time, but if you need more accurate analysis accurate output, then you have to model a detailed you have to put in detail geometry.

The second, the next input that is important is the location of the building. Location is important to for the simulation tool to generate the solar profile for that project, for the location of that. It is very useful in point for point in time analysis. When you are doing point in time analysis only latitude and longitude can help you, with that however, if you intent to do an annual simulation then you have to take a weather file into consideration. After creating a geometry, one has to provide material information in terms of the color

of the material or affectless of the material, what kind of material is whether it is a fabric material, whether its metal, whether its glass, whether it is the smooth the texture is smooth or rough, because all these parameters impact the simulation output.

For point in analysis one as to give sky conditions sky models. So, there are 3 sky models are available, first is called uniform illuminance sky model. So, there are 3 types of sky model first is uniform luminous model, the second is cii overcast sky and the third one is CIE sky, clear sky model the last input is to specify the kind of output that you are expecting. So, it the output can be a detailed grid output where you need lux (Refer Time: 04:54) luminous value for each point or it can be an visualization over a photo elastic. Now, let us see the type of output that we expect or once the simulation engine process the input, it generates the output in form of photo elastic visualization.

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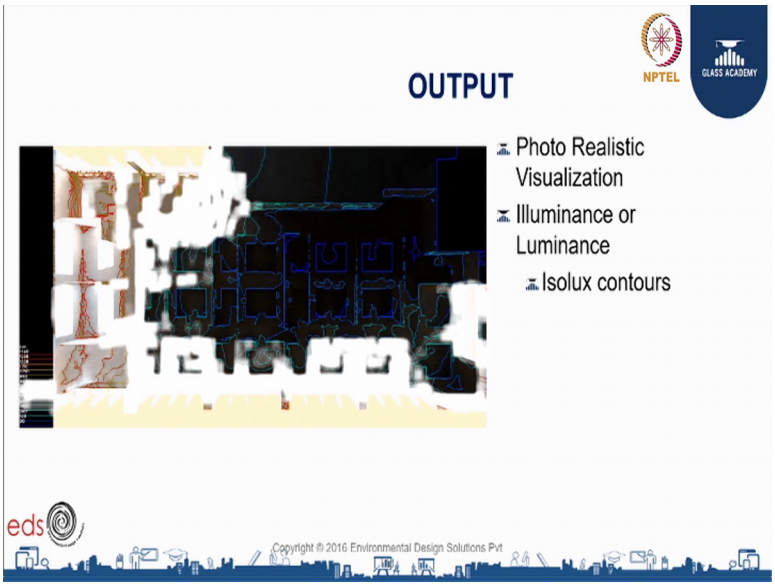

It can be discrete values such as luminous Isolux contours.

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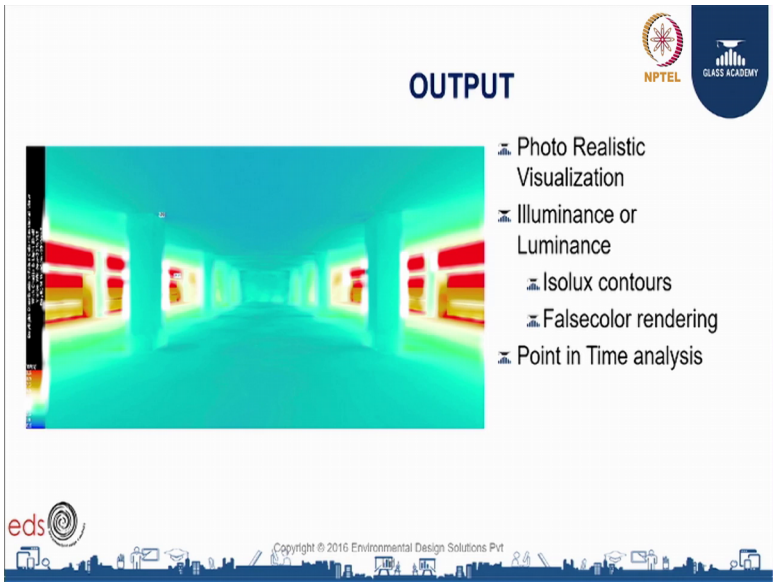

Or false color rendering the above outputs that that you have seen are generally point in time and for annual simulation were the values are average out or normalized the annual simulation output can be represented by a chart or graphically.

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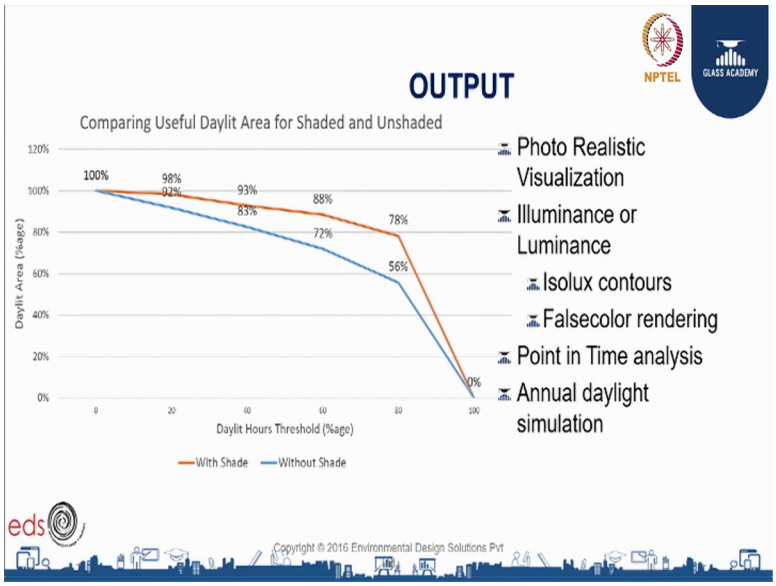

So, in this chart you can see it has calculated the useful daylight area or shaded and unshaded throughout the year how many percentage of the area you are getting that. Now, let us just in this section I will take you through different applications of simulations with some real life projects in case studies.

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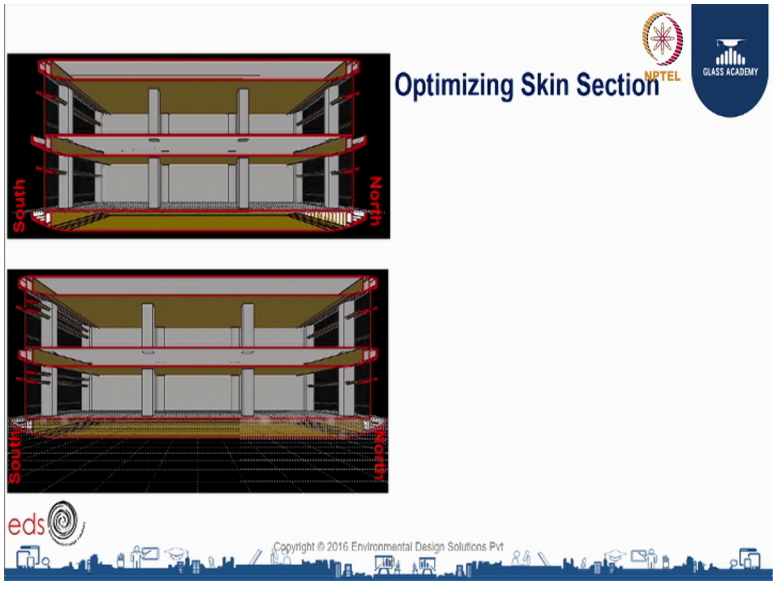

First application of simulation is optimizing skin section. Daylight simulation can help the design team in optimizing skin section in terms of window height, view window or daylight to window configuration, shading and interior light shelves. In this example we

compare two sections the smaller part planter or ion the lower sections was sorry in this example we compare two section of a building, the second section had smaller planter or no planter on both sides and addition light shelves on the outside.

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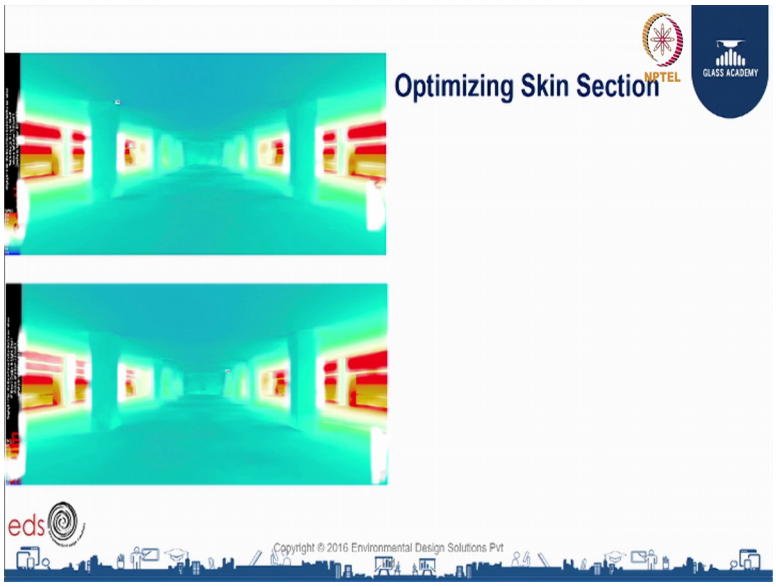

Both the sections are simulated for point in time and small color images where generated.

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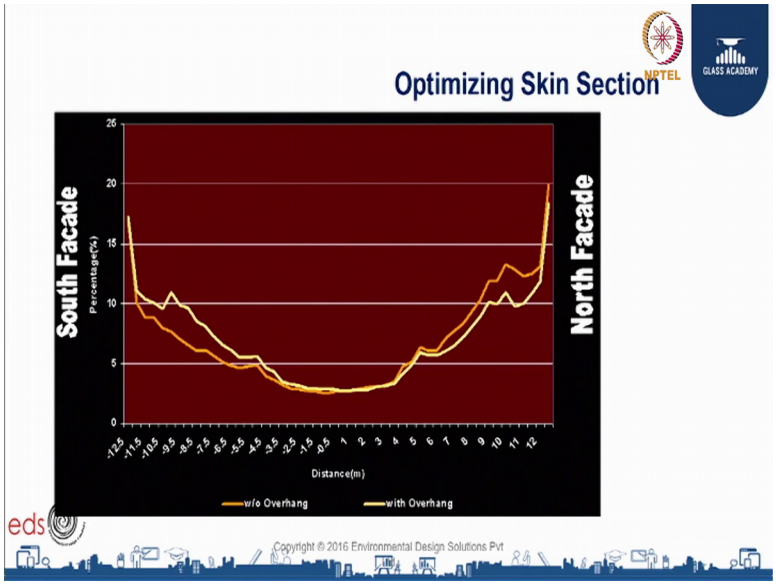

The lux values at worked at levels for a typical section of the was taken out and was dotted. Just to see just to see how what are the lux value, lux distribution. We observed

that we observed that on the north facade the section without any shading was working better than the section with shading because the section with shading was not actually blocking the diffuse light. Whereas, if you see the south facade south facade the section with shading was or very interior lights was performing better in terms of daylight distribution, because it was redirecting the direct light into the office space. So, there was a distinct output in terms of distribution on the north and the south facade.

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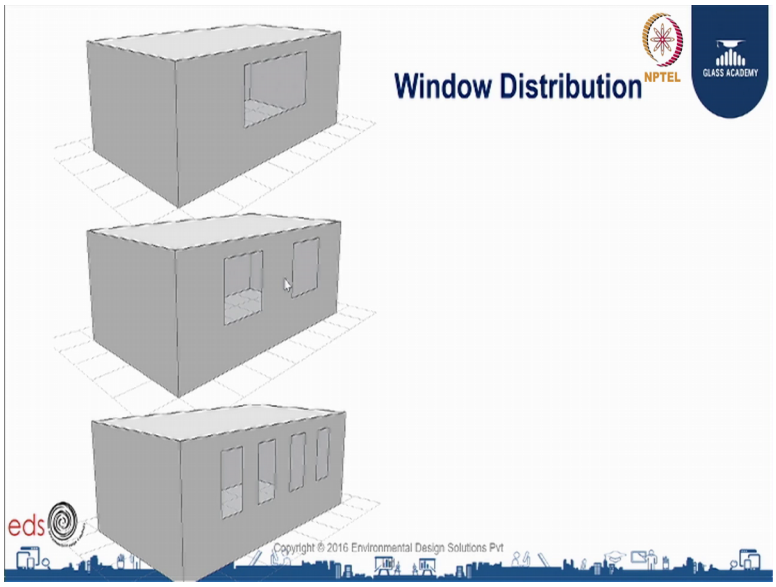

Next example is on window distribution in this as you all know uniformity is a very important aspect in what you call it as a good daylighting and so, in this example we took the base case which has got a single big window at the center of the facade. Then we modified that configuration into two windows and four windows just keep in mind we have we kept the overall window area same as the base case.

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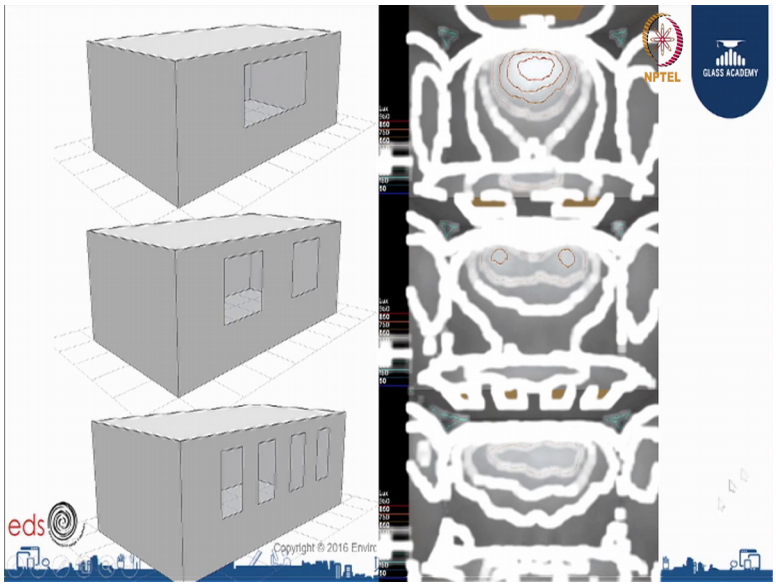

Then we simulated for each case. So, you can clearly see that in the first case which has got a bigger window at the center, there is a higher lux level at the center of the room and a you can say low lux level at the corner of the room. So, this basically results in a very bad uniformity ratio, which is which is not a good for a good daylighting design.

So, when we simulated the second case which has got two windows, we saw a improvement in the uniformity ratio and the fourth the third case where there 4 windows, we got a very uniform daylighting distribution into the office into the space. So, this simulation actually had in finalizing.

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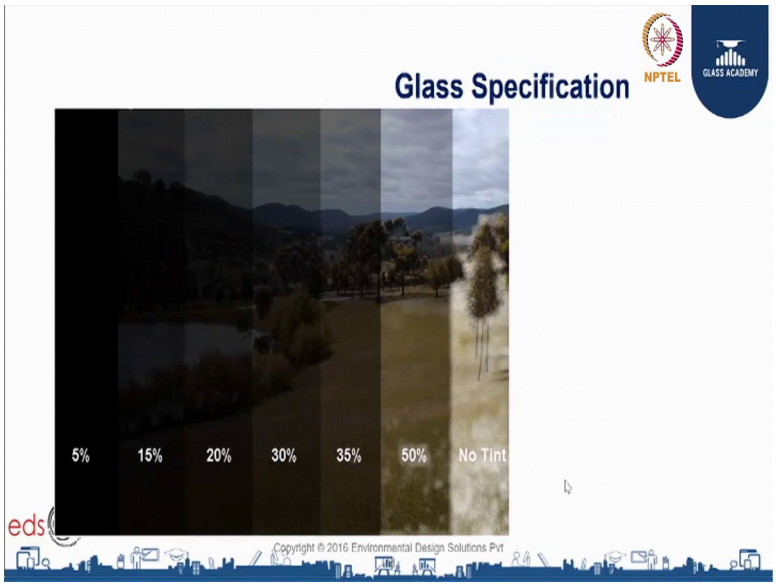

Next part is how to the next application of daylight simulation is in selecting the light glass specification for the space. In this image you can see a what we are trying to say is that different in how you will see the glass or outside world from in the from inside the office space. So, we have got 5 percent glass which is a dark, then 15 percent is light and then 20 and this is how it moves.

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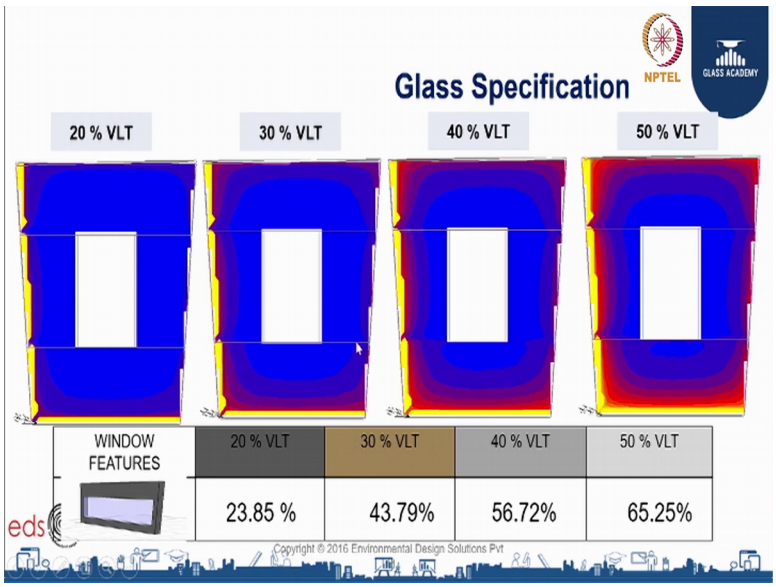

So, with no tint you have a clear view to outside. So, in this case there is a rectangular almost more or less rectangular space office space where I call inside. So, there is a core

inside the post design was simulated for different glass reality that is for 20 percent, 30 percent 40 percent then 50 percent. And the areas that were getting average lux level above 300 lux were taken out that input was taken out from the simulation tool. So, what we observed that, 20 percent with 20 percent reality this office space only 23 percent of the office space was getting, lux level above 300 lux than when we move to 30 percent it increased to 43 40 percent it moved to 56 and with 50 percent we were at 65 percent area as getting lux level more than 300 lux.

As per different rating system and international standard, any the area between 50 to 75 percent is considered as a good or well day lit office space anyways we should target maximum day lit area, but anything between 50 75 is considered as a good day lit space.

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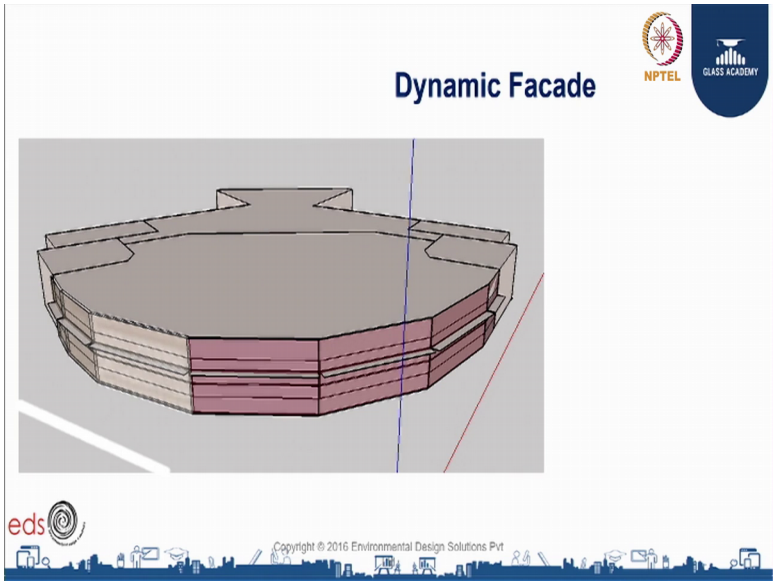

The second the fourth application is on the dynamic facade simulating and modeling the dynamic façade. Dynamic facade can be a movable sense or it can be photometric class which changes the tent depending on the outside solaridation. So, in this example the red highlighted face are west facing facade and the green where north facing facade. So, this office space had got a curved façade, where you know each face was pointing towards a different direction.

So, the west facade enjoyed a glare free daylight during first half of the day, but in the evening or after 3 pm they were getting direct sun coming in and glare issues where

there. So, we valuated different we evaluated photometric glass option for this office space.

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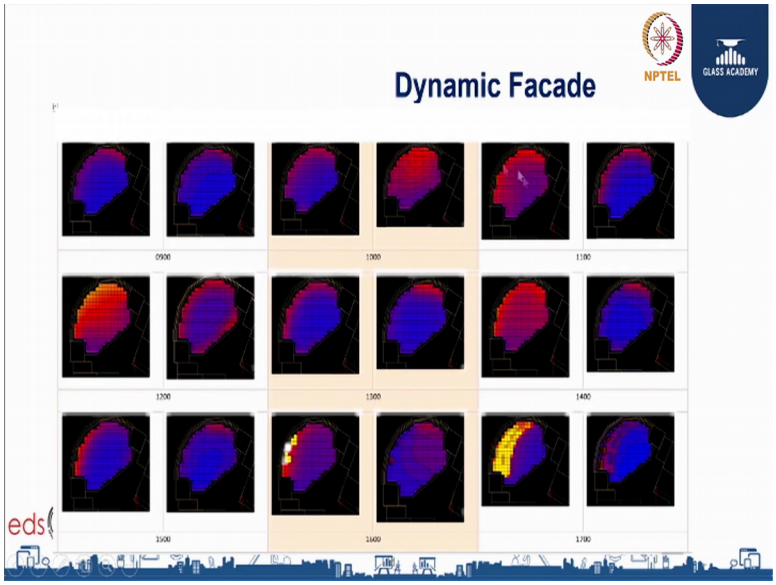

And so, what we did was we took the base glass which are which is the results are highlighted on the on the left side, and the dynamic glass was simulated at the same time. So, we simulated it for every hour on a peak day and tried to find out the lux level and the glare part. So, over here the glare was considered anything above thousand lux was considered as to much of light which may result in glare issue.

So, the space was modeled for 9 11 till 5 pm and one can clearly see. So, if you see the yellow and the orange part are the areas where you are getting lux level more than 1000 lux right. So, you can clearly see after 3 pm this is the vase case and this is the dynamic glass you are after 3 pm you are you are this office space is getting direct sun, and as in the 4 pm you get more patches of a high level of lux level and that 5 pm it will almost like covering around 25 percent of the area as getting more than thousand lux. Whereas, if you see the dynamic glass performance it is more or less giving you and uniform a lux level that is within 1000 lux.

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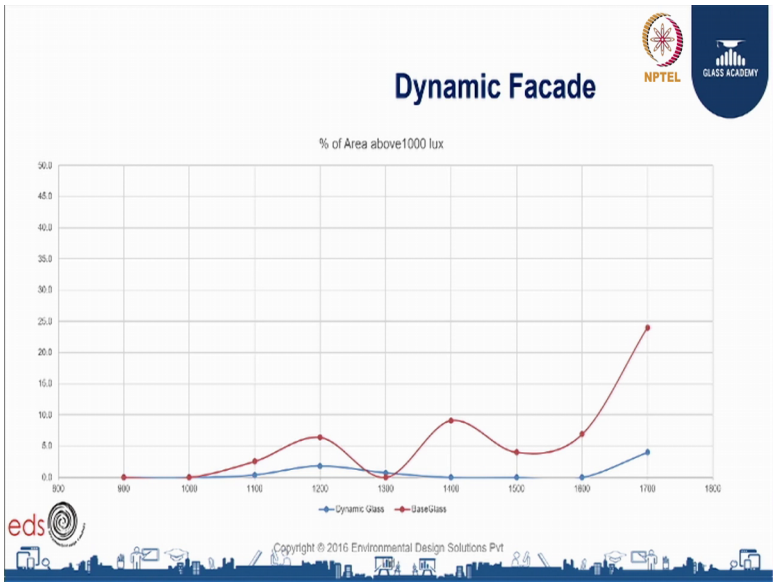

The same was kind of plotted to see the impact on this plot on x axis are the number of rs from 9 am to 7 pm, and on y axis is the percentage of the area that is getting lux level more than 1000 lux. So, our intention our requirement is to keep to have this area minimum, we have minimum area within 1000 lux. So, this is the plot for the base glass which is a the normal glass. So, you can see in the morning there is no issue, but in the evening there is a after 3 pm, there is a increase in the in the in the percentage of area that is getting more than 1000 lux.

So, at seven at five pm it is almost like 24 percent 25 percent and at 4 pm it is somewhere around between 8 to 10 percent. And, if I now just see the dynamic glass which is shown in the blue graph, you see that the dynamic glass is able to tent able to change the tent of itself depending on the solaridation and also during the second part of the day also it is still within 5 percent range. So, there are some of the tools now I will be discussing or giving you an overview of the various tools that are available for daylight modeling.

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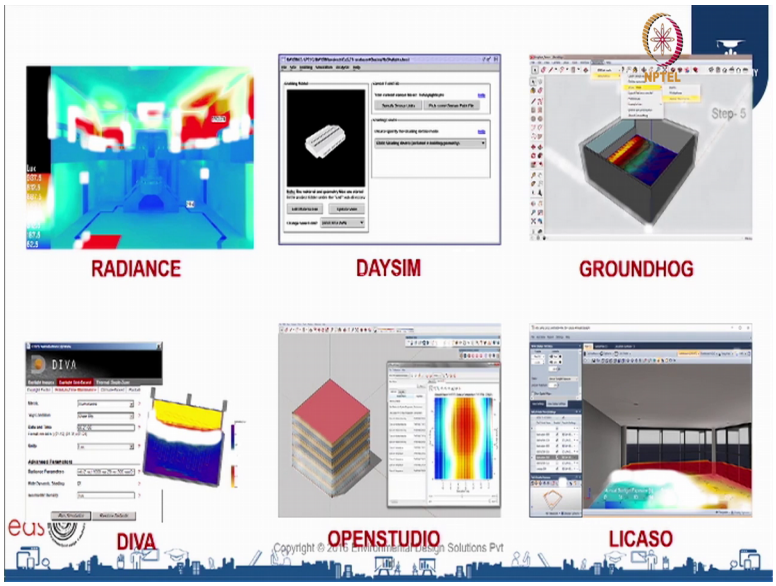

The first tool that I would like to discuss is radiance, it is a validated suite of tools of performing lighting simulation it was originally written by gradward, it includes a (Refer Time: 14:49) as well as many other tools for measuring the simulated light levels. One study found that radiance is the most useful software package for architecture lighting design and the same study also noted that radiance often serves as a underlying simulation in general for many of the other packages. So, all the other packages that I will be discussing they have at their backend, radiance simulation engine running doing the calculation.

The second tool that I would like to brief you about is DAYSIM. DAYSIM again is a validated radiance based lighting simulation tool. So, DAYSIM is basically for doing the annual simulation again it uses radiance at its backend for its calculation for all simulation process, it uses radiance. The benefit of DAYSIM is one is it takes it helps you in annual simulation, the other one is it also helps you in modeling the dynamic facade you can put in sensor, you can put in conditions and it changes the values for every hour of the glass of the position of the shade venation blinds and other switchable blazings and combination thereof.

The second the third tool is the groundhog; ground hog is a plugin in catch up which basically takes DAYSIM and radiance as a backend. So, it uses it takes the modeling module of sketch up to build the geometry, and the rest of the things are done again in

radiance. The next tool is diva device rhinoceros based tool, it helps in parametric because rhinoceros and grass hoppers has a roy come plug in where you can do parametric modeling you can put in algorithms you can put in logic. So, it (Refer Time: 16:55) clubs with rhinoceros and grass hopper on that front. Openstudio openstudio is basically a thermal rigid modeling tool, it has a converter inbuilt where you can export the 3 D model into radiance format, and it also fire ups radiance engine radiance simulation engines to do the calculation and then it also imports that the result into the its result viewer.

So, openstudio is another free tool, where you can use it use to do daylight simulation. The next is licaso, licaso is a annual daylight simulation software based on agi 32 and (Refer Time: 17:42) tools, it takes into count the electrical lighting system and controls and occupancy in photo sense.

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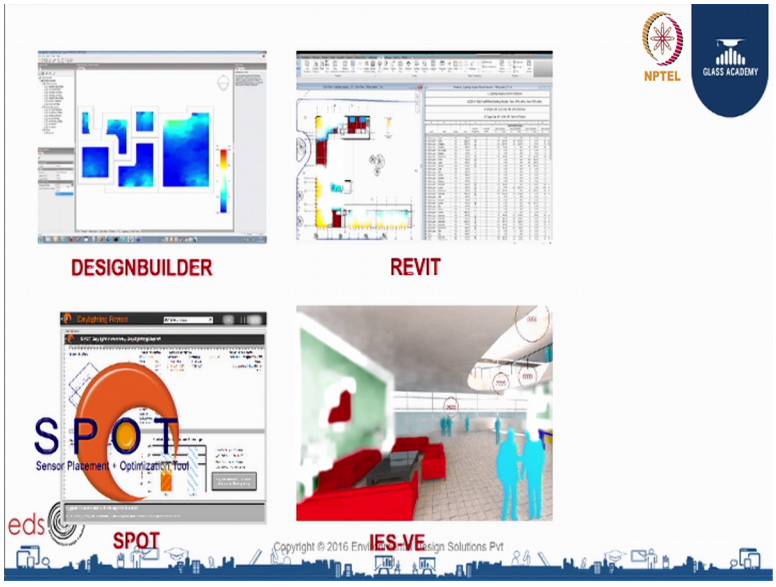

There are besides this it is design builder, it provides advanced it a advanced modeling tool and it has an easy to use interface. You have spots, spots stand for sensor placement and optimization tool it is software for daylighting design and again analysis software then we have Autodesk Revit which is a building information modeling tool beam tool, it has a plug in called light analysis revit plug in which uses AutoCAD 360 cloud computing to give you results and then we have got IESVE integrated environment software virtual environment it also has a plug in for daylight modeling and simulation.

Overtime the advancement of technology and computing power, the daylighting design of building has changed from purely (Refer Time:18:47) that is the daylight factor to a complicated performance matrix such as you known useful daylight illuminance, special daylight automony, which takes into count annual hourly simulation. So, the later part the later part of special daylight autonomy, where you have to do annual simulation is very complicated and is consist of large amount of data generated.

So, you can you can imagine for every there are 100 sensor points or grid points, for every hour it calculates the output for those 100 points multiplied by you know 4000 points if I take the daylight task. So, they have become really complicated and it takes time to generate that. To solve this the latest technology of cloud computing is also coming into daylight simulation, where we use where the uses multiple computer servers which are located all over the world use their computing power to give you output in less time. So, that so, that you can take the call you can take the decision in that.

So, cloud is comprised of numerous servers in data sensors and they are similar to what we use as internal document storage. So, a in daylight modeling there are two service provider which are giving cloud computing.

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One is Sefaira which is again is a cloud based. So, it takes into count the revi model sketch up model and it does the calculation and the other one tool is light stanza, it takes sketch up and again Revit as a input model and the user can do different kinds of analysis

from UDI to special daylight autonomy in this. Now, just to end this course just as a advice I would say that simulation is a powerful tool but the integrity of the output is depended on the integrity of the input.

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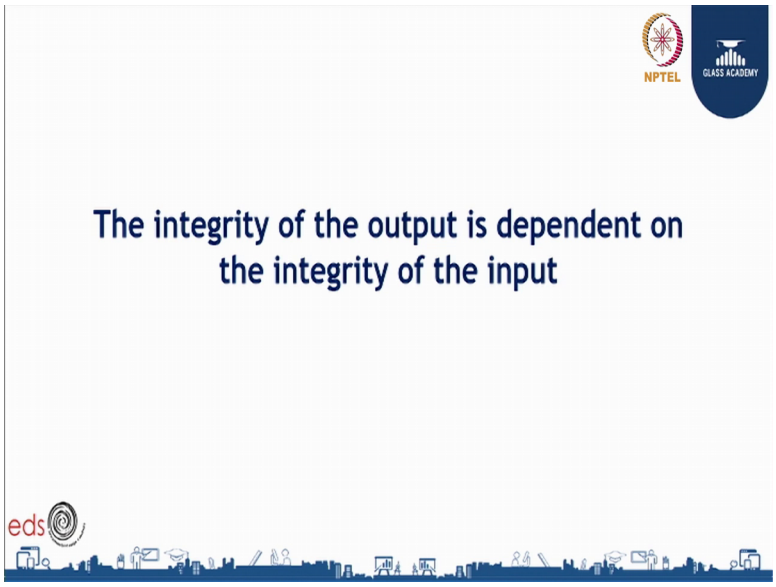

So, you can definitely use simulation to (Refer Time: 20:53), but be sure on the kind of inputs, that you are inputting into the software because that will drive your output.

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Thank you.