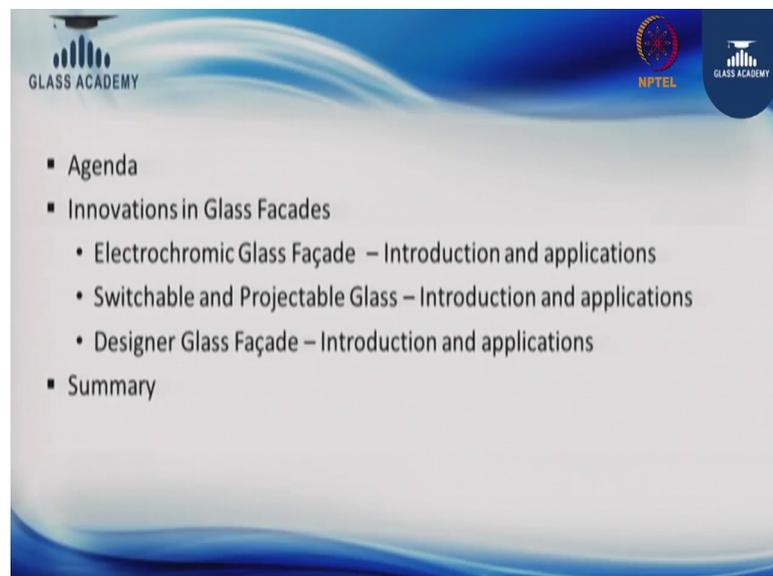


Glass in buildings : Design and Application
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Lecture – 18
Innovations in Glass Future Facades

So, good morning everyone. So, today we will be discussing about innovations in glass and how the overall facades of the future is going to be. So, agenda for the today would be covering the Innovations in the Glass Facades.

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Basically covering the 3 important innovations in the glass industry in terms of the facades, electrochromic glass facades and I will talk about the introduction of the product and the applications for it.

Switchable in the projectable glass some of the introductions and I will talk about some of the applications for the product as well. And the design of facades which is the trend for the today and then we will be talking about introduction and the applications of this product category as well. And then finally, I will summarize in my presentation how these 3 products can be used in this entire glass industry.

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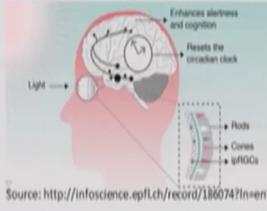


So, just to bring about why the glass you know setting up the context; why the glass is increasingly used in this construction industry; first and the primitive is the natural daylight. So, glass because brings in lot of natural daylight; so, that is the first big reason why the glass is being used in the construction industry.

Second is to have a connection to the outdoors and third is to make the buildings modern. So, these are the 3 basic reasons why generally you would be using the glass in the first place. And I will be actually covering one by one each of them how these can be actually you know explained in each of their reasons. So, let us talk about the first reason natural daylight. So, why this natural daylight matters for health and well being? So, there is a psychological explanation which I am actually going to tell you.

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Why daylight matters for health and well-being
A physiological explanation



• Recent discovery (2002) of new light sensitive cells in the eye (ipRGCs), responsible for « non-visual effects »

• Large impacts on our biological functions:

- Sleep/Wake cycle regulation
- Mood
- Memory
- Alertness
- Cognitive functions
- etc.

• Exposure to natural light is the best trigger of those mechanisms (through **synchronization of internal clock**), inducing positive effects on our health and general well-being

Source: <http://infoscience.epfl.ch/record/186074?ln=en>

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So, there has been a recent discovery in finding out that these new light sensitive cells are responsible for creating non visual effects and it actually have a large impact in terms of the biological function of a human being. So, be it a sleep or a wake cycle, regulation, mood, memory, alertiveness, cognitive functions and there are so many things which actually this non visual effects brings about impact on us.

So, you if you look at the exposure to the natural light is the biggest trigger for all these mechanisms. And it is called that it actually synchronizes the internal clock of a human being which also includes all those positive effects on the health and the general we well being of a human being. So, these are some of the effects which a daylight will actually create you know on a human being.

Now, let us find out some benefits of the views which actually create on a; you know which is which help as a human being when you generally use a glass.

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Key findings (in all sectors)
Views matter much more than we may think!

NPTEL GLASS ACADEMY

- Views to **nature** are usually preferred and particularly beneficial
(restorative effect)
Ulrich (1984; 1981, 2008); Tennesen and Cimprich (1995); Heerwagen & Orians (1986); Tang and Brown (2006); Elzeyadi (2011); Beute (2014); Velarde (2007); Kaplan(1993,2001); Shin (2007); Leather (1998); Human Spaces Report (2015);
- **Views** may be **more valued** than daylight
Farlay & Veitch (2001); Christoffersen (1999); Ne'eman & Hopkinson (1970); Hellinga (2013)
- **Interesting views** may **alleviate** other discomfort issues e.g. **glare**
Tuaycharoen (2005, 2011), Parpairi (1999), Shin (2012), Tregenza (2007)
- **Daylight alone without view content** may not bring benefits
Keep et al (1980), Beute (2014)

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So, views to the nature are usually preferred and particularly beneficial it is an effect which is called a restorative effect which has been studied by a lot of these scientists. And some of this architecture as well which actually proves that views will actually create lot of impact on a human being.

So, views are more valued than natural daylight. So, this is also one of the thing which is which has kind of come up with these kind of studies that; views matters more than as compared to a natural daylight. And some of the interesting views may elevate the other issues some of them can be glare and you know all those issues which actually come up by using the glass. So, those issues are covered with the interesting views.

So daylight alone without a viewing content would not bring the some of the benefits; which is important for a human being. So, if you look at the two important aspects which I have discussed are the views and the daylight. So, all these two points I have a larger impact on the human beings.

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The slide is titled "Why views matter?" with the subtitle "Biological and Psychological explanations". It features four bullet points, each accompanied by a small image:

- Refocus and relax eyes: Accompanied by an image of a person covering their eyes with their hands.
- Satisfy the need for both escape & feeling of safety: Accompanied by two images: one of a person in a white lab coat and another of a person in a red shirt.
- Stay Connected to the world, access to environmental information: Accompanied by an image of a person looking out a window at a cityscape.
- Restorative experience: Accompanied by an image of a person standing on a balcony looking out at a sunset over a body of water.

The slide also includes logos for NPTEL and GLASS ACADEMY in the top right corner and a small number '6' in the bottom left corner.

So, views matter let us talk about some biological and psychological explanations for it that it brings refocus for a human being and relaxes eyes. It satisfies the need of both escape and feeling of safety, it helps you to stay connected to the world and access to the environmental information and it restore the overall experience.

So, if you see views actually matter. So, the most important thing which I am actually trying to say is that views matters for a human being. So, some of the studies which have been done in this green building; if you look at the study which has been done in these green buildings it actually clearly states that these effect are far larger than the tangible effects of having in building which actually allows you to have views and daylight.

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So, if you look at the first impact which is mentioned is the memory and the mental function of students. So, if you look at the universities which are being made a green buildings and which have used daylighting and views their important criteria's. So, they are able to perform 10 to 25 percent better in these green buildings. And these students increases their memory in form of you know being able to perform better in their evaluations.

In terms of the cell processing for call processing for these BPO employees; if you look at these buildings which actually allows if these are not the boxes of insulated material these are glass buildings; so, it actually allows them to process the calls faster. In terms of if you look at the healthcare as an industry; so, it has been actually proven that people who get access to the outside views in hospitals; they are actually curing faster which is almost like their the stage goes 8.5 percent shorter. I am not sure if it is very good for the hospitals as in business per say, but it definitely helps the patients to recover more faster in these kind of buildings which actually allows you to have outside views.

In terms of the day lights if you look at; daylight is actually helping the students to secure high numbers. So, institutions would be very interested in actually providing proper daylight to the students, which actually helps them, scoring higher grades. And if you look at the grades have gone from 5 to 14 percent higher and they learn, their

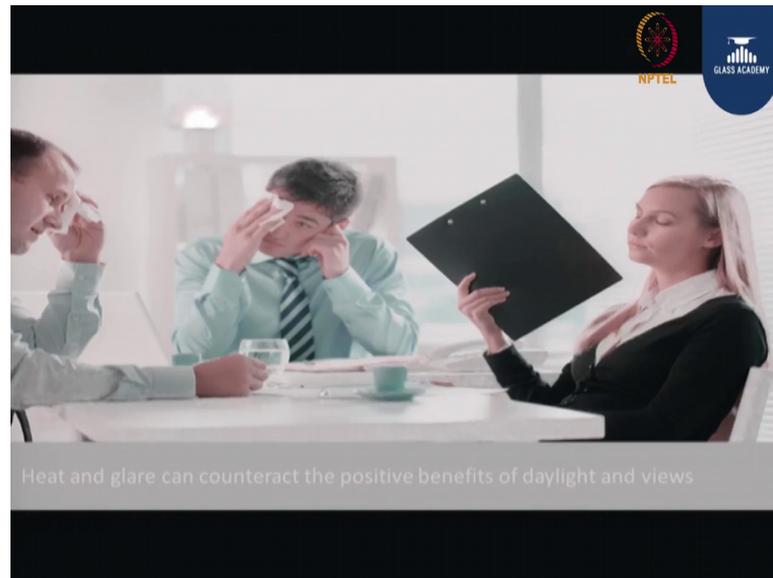
capacity of learning becomes faster more to 20 to 26 percent if they get proper daylight you know in their campuses.

In terms of the workforce, students and you know in terms of the people who are working in the offices; their productivity increases by almost 18 percent which is a large number in terms of the overall productivity of the people. And just to mention you that the absenteeism also goes down when you are actually working in these kind of spaces; which are green spaces, spaces which gets natural daylight throughout the day. So, overall productivity of the people increases by almost 18 percent which has been proved in this study by the world green building council.

So, even if you look at these retail outlets. So, they get increase in their sales; if they are actually allowing you know the people who are coming into their stores, their consumers to have natural daylight to the entire day. In terms of the improvement in the systems overall as intangible movement is that; you get a better efficient daylighting which is almost like 23 percent productivity is increasing increased by that. And then you if you have a better ventilation the productivity overall improvement is almost 11 percent.

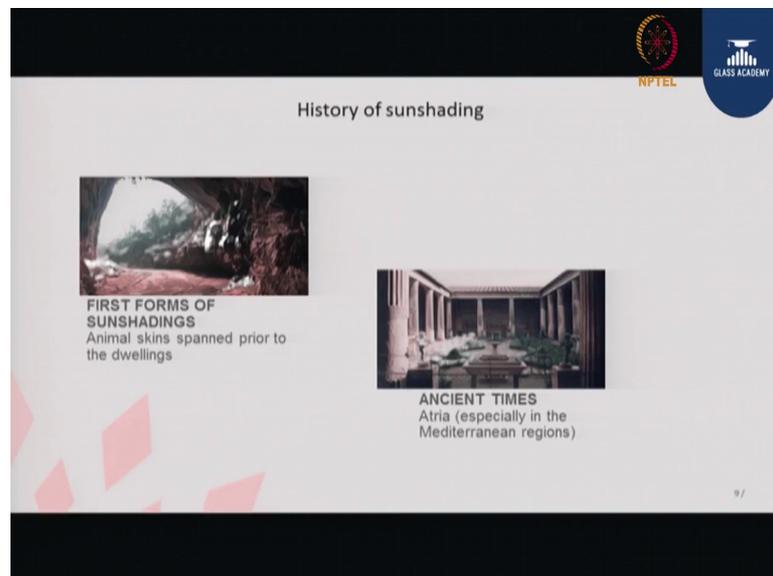
So, if you look at the percentages in terms of the impact of the outer views and the natural daylight is a very high impact in all these kind of buildings. So, if we have talked about lot in terms of you know the better or the you know good impact of natural daylight and views. And by using the glass you get the both of these two important parameters, but that is not only the issue which comes with the glass. So, there are two basic and very challenging parameters which are which are actually related to the glass.

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And which comes with the glass as a as a building material is heat and glare and this heat and glare can counter at the positive benefits of the day lighting and the views.

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So, if you look at in terms of you know let us go back to the solution for it. So, if you look at in the ancient times the first form of sun shading actually started a long time ago with animal skins which are spanned prior to the dwellings. And these were actually to stop the glare which was and glare and the heat which was coming from the sun. So, this

was the first type of sun shading which was actually made available to the human being, to the human race.

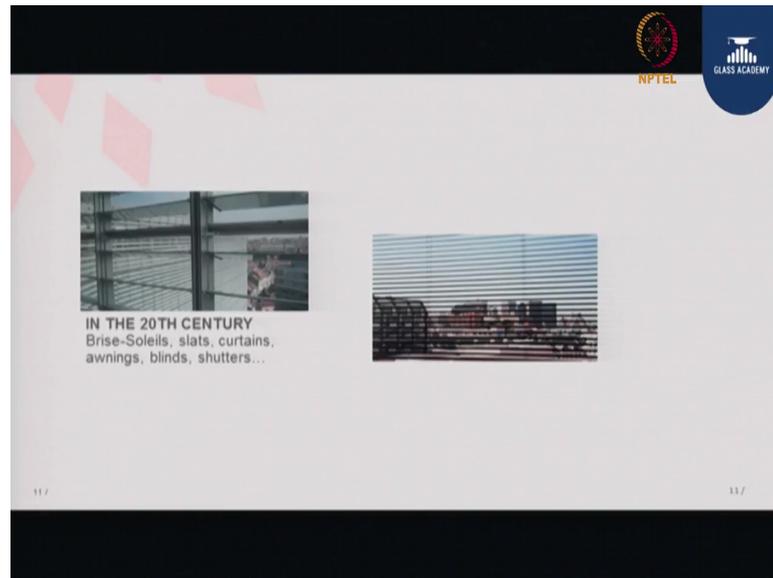
The second which actually came in the existence in the ancient times was Atria, which were especially done in the Mediterranean regions; wherein they were actually using this kind of method to actually provide sun shade to the human beings. So, the history of sun shading is quite old and then we have move ahead in terms of year over year, in terms of the sun shading. So, later then you look at the Celosias in the Arabic regions, the awnings which came in and they provide a very good amount of sun shading to the in to the interiors.

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So, if you look at here many years. So, there has been very large improvement or you know advancement in terms of the newer sun shading options.

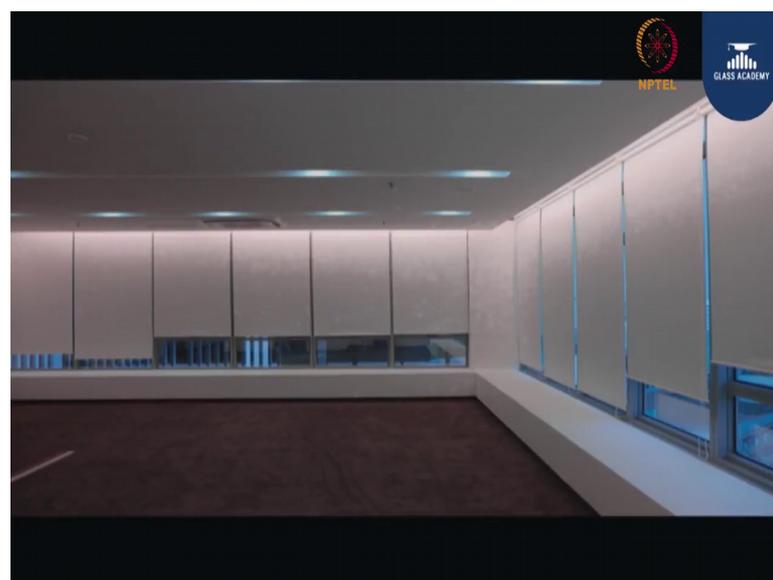
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And in the 20th century we see that now, we have slats, curtains, awnings, blinds, shutters. So, there are a lot of new you know new technology or new products which has helped in terms of giving the sun shading.

Now, when we talk about this 20th, 21st century we are looking forward for these kinds of blinds, rollers, shutters, shading devices. And when we use them; so that is the view what we see from inside.

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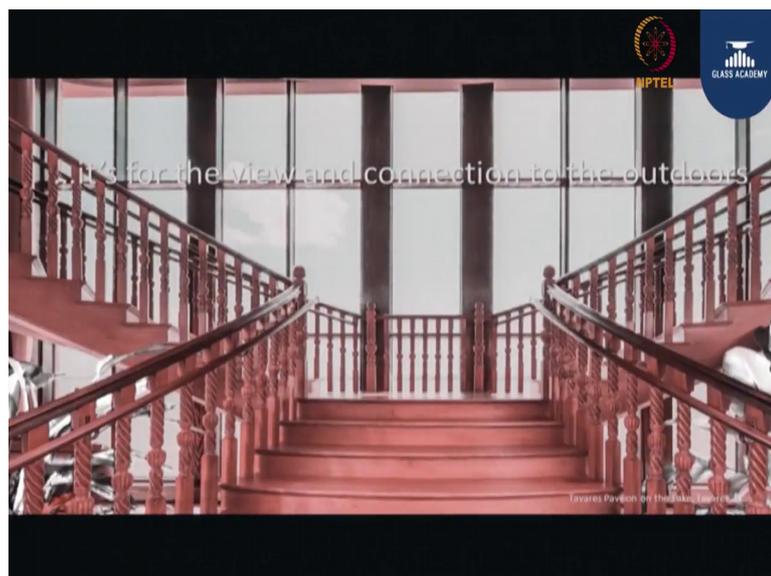
So, imagine if you have used the glass as the first place then you are actually defeating the overall purpose of putting up the blind. And this is the view from inside that when you put on the blind and this is from the outside.

So, the first basic purpose of using the glass at the first place gets defeated by actually putting up the blind in the first place. So, the glass was used to have view to have natural daylight, but it gets defeated then by using the blinds. And this has been a study which has actually proven that once you put up blind or somebody sitting next to the glass puts of the blind in a day; it is going to sustain or it is going to stay for that entire day.

So, this has been proved 90 percent of times people who is setting sitting next to the glass he finds heat and glare and then he actually; so, you know put on the blind and then you are not able to you know then it is not being lifted up through the entire day. So, that is that is the question mark which actually comes in from the designers point of view from the architectural point of view from the construction industry point of view that why your; why you are using the glass at the first place.

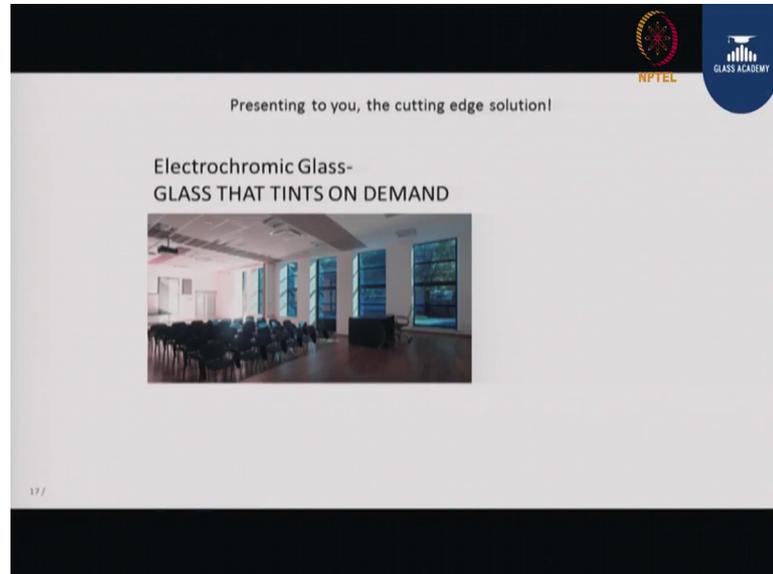
So, there is a reason why the building has been you know why the building is made with windows and for that matter is not to showcase these beautiful blinds which are generally used.

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So, it is actually for viewing and connection to the outdoors. So, we have a solution which is called electrochromic glass.

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So, this is a glass which actually tends to on demand. So, imagine this has a technology; when we look at in terms of the first technology which was there in the market was a was a photochromic lense.

So, this photochromic lense is a passive tinting technology wherein a person who goes outside in the sun. So, this glass gets tainted because of the sun falling on the glass. So, now this is a same process of an active tinting wherein we actually give the current to the glass and then, glass gets tinted based upon this electricity to supply to the glass.

So, this is as a technology is called as a electrochromic glass which actually gets tinted on demand.

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So, if you look at it this is a this is a general office space situation; where the person who is sitting next to the glass, he is not able to you know sit next to the computer. Because there is a lot of glare condition which happens and imagine we have almost like 1.5 lakh lux outside.

And you know that how much we need for working or for studying or you know for being in a living space is not more than 1000 lux. So, imagine that 1 lakh lux or one point 5 lakh lux which is falling directly on the glass and it is allowing even for that matter 25 percent of the light. So, it is actually going to create glare condition and because of this glare condition; people who are sitting next to the glass put on the blind and this is a typical office situation which happens every time.

So, because of this then you know you do not know that why the glass was used in the first place. So, it was used that you get natural daylight and to have the connection to outdoors and this is a typical situation which happens. So, now with this newer technology which is a; which is a very high innovation which has happened is an industry is this electrochromic glass and how it can actually change this entire office space; I would like to showcase it to you.

So, if you see this picture this is a typical scenario; now I will actually put up a electrochromic glass here. And this is how the situation of the office will change and you will have a transparent heat and glare control system.

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Now, if you look at this image this actually clearly tells you how this blinds, moving parts, shadings, roller systems, automated louvers all those things can be actually removed and the glass is going to perform as one material; which is going to do all the functions which is required for controlling heat and glare; most importantly keeping up the daylight and the views. So, this is how this electrochromic glass can actually change the way you look through the glass.

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InPane Zoning

- The ultimate comfort



- No more glare !
- Natural daylight color
- Boundless flexibility

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So, this is a next level technology which is happening in this product itself is the inpane zoning. This is as a technology these are ultimate comfort giving technology because what it does is that you can actually divide a single pane of glass into up to 3 zones which are these light zones.

So, what these light zones can do for you is then imagine that you have a grid of 3.8 meters floor to ceiling height. And then you divide it in a vision panel of 3 meters and then you can have a spandrel panel of for; for example, some point 8 meters; then you can actually divide this entire vision panel up to 3 zones. And let me tell you that it does not have any vertical members in between; it is only the glass, it is a single glass which can be actually divided into 3 parts maximum up to 3 parts and then it helps you in terms of controlling the glare. So, your glare will be controlled completely; you will have a natural daylight throughout the day and you will have a flexibility in terms of controlling each of these zones.

So, if you look at this picture the sun is at the top zone. So, in the top zone it is actually you know it is at the tinted state and then the lowest zones; it is at a more clearer states. So, that is how this glass can be controlled with different tinting zones; I will explain you how this tinting zone is actually being controlled.

So, this is a typical situation wherein you know you understand.

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This is the important slide for this session that how you see that how this glass is being selected particularly. So, the glass is selected on the two basic and important parameters which is the light transmission. So, amount of light which is coming through the glass and the SHGC which is the solar heat gain coefficient which is the heat gain which you are getting from the sun.

So, if you look at these two parameters which are the defining parameters in terms of the selection of the glass. So, if you look at the you know the solutions which are available right now in the construction industry with the glass, you have gone from first generation of coated products to a fifth generation of coated products. So, if you look at the hard coated reflective products which are available right now in the market at quite affordable prices and which were used in affordable housing projects.

So, these have you know light transmissions in the range of these are dark glasses. So, it has a light transmission in the range of 5 to 10 percent with the heat gain of around 15 percent. So, that is the basic solution which is available right now at a very affordable cost. Now, if you look at going towards the high performance buildings you know the buildings which are green compliance; buildings which are green rated buildings which conserve you know large amount of energy. So, from there we can actually go towards the products which are low E products double silver coated products and if you look at this low E 3 which is mentioned in this slide.

So, this has an approximately some 50 to 60 percent of light transmission and has a heat gain of 0.3 to 0.4. So, which is almost like creating a double silver coated glass which has a light transmission ranging from 60 to 50 percent with the heat coming in of around 40 percent. So, that is how the solutions which are available right now low E E 2 which you see in this picture is also a product; wherein you can have a light transmission up to 70 percent with the heat gain of around 0.5. So, the products which are available with us has a selectivity of 2.

So, let me define you what is selectivity; so selectivity is the amount of light which is coming in vis the ratio of the heat which is coming in. So, the products which are available with us right now has a selectivity of around 2 which are fifth generation of the products and with this selectivity of the product; we are able to control the light and the heat by 50-50 ratio.

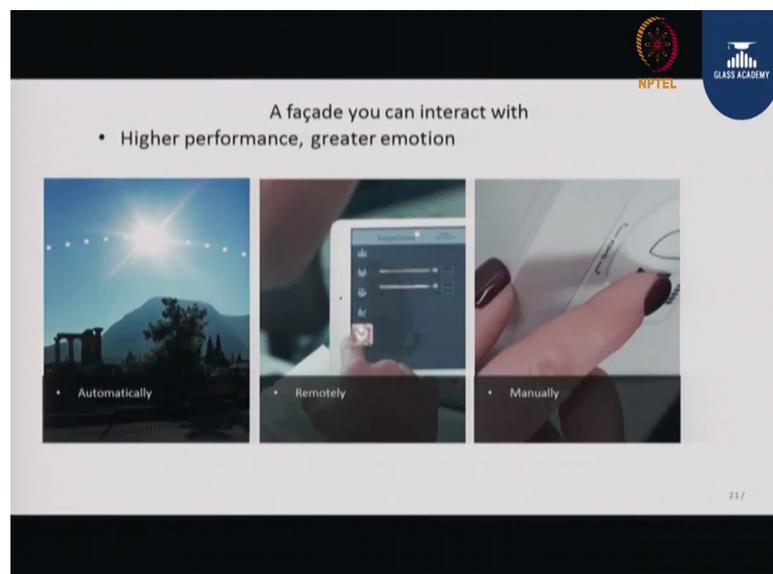
So, imagine you know this is the solution which is available with us and then we are talking about reflective highly reflective glasses which can go up to a heat gain of for an example 0.15 which will become too dark. So, now, I can actually you know we can offer you as a technology which is available; which can give you best of both of the worlds. So, we are talking about a technology which can actually you know create a spectrum of the light transmission against the heat game. So, imagine now this technology or this product can actually give you a light transmission of 60 percent and an SHGC or a heat gain of 40 percent or 0.4.

So, now the magic will start; then you can actually start tinting the product and then the first stage can be tinted up to 18 percent. The second stage can be tended up to 6 percent and the last stage is 1 percent. Imagine 1 percent is a very very you know it is almost like a blackout situation which is being created in the glass and it has an SHGC of 0.09.

So, the SHGC of 0.09 is a is a thing which is almost like you are talking about making a brick wall and then you are still able to see from inside to outside. So, you are not stopping the views and you are still able to conserve the glare part of it and then you are able to see from inside to outside. So, this is a spectrum which a electrochromic glass can offer which is like from light transmission ranging from 60 and going up to 1 percent.

So, let me actually tell you how this will happen in terms of you know when you see those buildings which are actually done with these kind of products.

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So, now we will have you know now this facade is not no longer going to be static; we know that we have seen lot of static facades. And now you will have a solution which will be making all these facades go dynamic. So, now, the facades will have a higher performance and they will be giving you no greater emotions. So, you will have facades which can be actually controlled automatically. So, this system as electrochromic glass can be controlled automatically which already has its inbuilt system and then it also can be integrated to the BMS.

So, you can have the BMS linked with this kind of technology and then both of the you know both the systems can be merged and then the overall building will be performed the way it used the way it should be. So, the way the sun is moving; so, that is how the glass will be getting tinted in the direction of the sun.

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For people who care for...

- ... three unique benefits:

PRESTIGE & INNOVATION	COMFORT & DESIGN	SUSTAINABILITY & SIMPLICITY
		
<ul style="list-style-type: none">• Fascinating technology• Exclusive experience• Differentiation	<ul style="list-style-type: none">• Heat gain control• Free vision... at all times!• Daylight• Glare protection• Silence	<ul style="list-style-type: none">• No blinds, no maintenance• Energy savings up to 40%• Green labels

BREEAM 

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So, so imagine there is nobody will be going through the glass window and then actually you know or putting up the blind or pushing up the roller blinds by manually or by doing it with some servo motors. Now this will be done automatically; so, there is no involvement, no human intervention which is required. And then people will not be able to feel that there is something which is happening to the glass at the first place and they will be feeling more comfortable.

And then to add to you know what you can do next to it, it can be also controlled remotely. You can have your i-phones, your android phones which can be actually linked

up to this facades and then they can control. So, whenever you want to you know; so, imagine if its a corner glazing facade and you have used this kind of technology which is electrochromic glass.

And the sun condition is that the glass is going at 18 percent tinted state, but that may not be enough to do a projection. So, once you want to do a projection you almost want to create a night scene; wherein you do not want to have a large amount of natural daylight which you might require otherwise. So, then you know you get through these kind of technologies and access who control it individually and then control it the way you want; so, you create a manual intervention.

So, by actually controlling remotely or by having a button on the window or next to the window will actually able to do a manual intervention. And as a technology; if you if you do a manual intervention with this product; this is actually going to stay for 2 hours and then it will go back to its original state. So, imagine that this is this is the level of technology which has actually goneead. So, it will again go back to the automated state; so, there is no one which is required to actually reboot the system and restart the system as an you know overall process.

So, now you will have a facade then wherein you can actually do lot of stuff without actually being feeling that you are doing something. So, this is as a technology is a new technology; so as a technology it offers a basic more important 3 benefits to the consumers to the industry per say; so, it is about prestige and innovation. So, the first pillar what is being said as a technology is prestige and innovation because it is a new technology, it is a fascinating technology, it gives an exclusive experience.

So, it gives an experience of not interacting directly and going into the window; it gives you an experience of sitting at the back and then controlling what is happening to the glass. And then maybe you know it gives you an experience of differentiation; so, this is about how this prestige and innovation comes with this kind of technology.

Then there is a there is a bigger pillar of comfort and in terms of the design. So, we talk; we are talking about giving a heat gain control to the user or to be done automatically, it gives free vision. So, that is the more important thing which is which comes with this kind of technology; that you get your vision becomes free from any kind of movement of

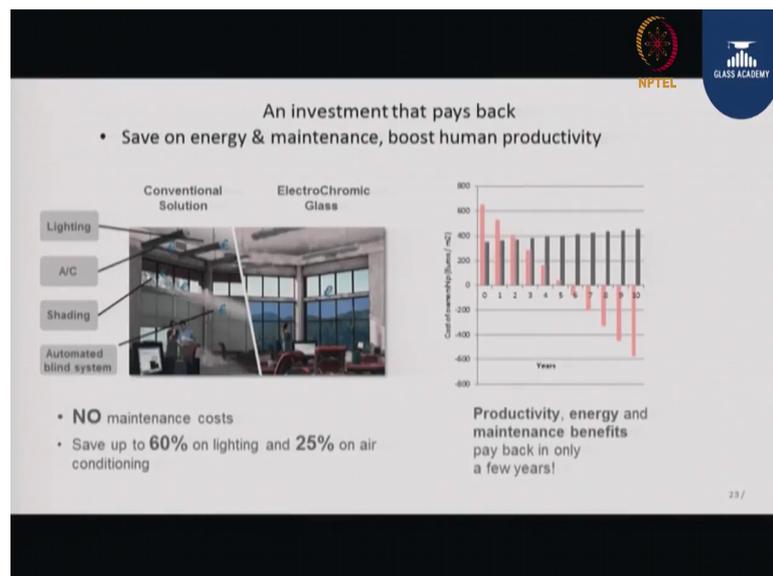
the sun or any kind of problem which are created through the sun of heat and glare. So, you have a free vision throughout the day.

It gives natural daylight you know there is a glare protection which happens and as a product generally from the manufacturers; it come as a laminated product. So, it provides improvement in terms of the acoustic levels of the environment and then it creates a silent situation. It is a simple technology; yes it is a new technology, it is still a simple technology and then there is no maintenance required into this. So, it does not need any blinds; so, there is no maintenance there is no moving parts.

So, so it is like a maintenance free technology it can give you saving up to 40 percent that is how has been calculated throughout the studies. And then it comes and this technology is actually being you know recognized from these institutions like BRIM and USGBC. So, if you actually do these green buildings and if you go through the green building us green building councils website; you will understand that this kind of technology can actually give you up to 13 credits or 13 points by using this technology.

So, let us understand now in terms of how this can be made a case to talk about in terms of the commercials of this kind of technology. Because since it is a new technology; yes we are talking about something very new, but yes it can certainly give you a payback.

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So, you have to actually talk about in terms of how we can compare a bundle costing as compared to you know differential costing for each and every product which we are talking about the entire fenestration.

So, in terms of the conventional solution; we are talking about improving the lighting conditions. Because you are now controlling the glass from outside that how the light transmission is being controlled, then you can actually also you know control in terms of your daylighting cost which is being spent; which is a large amount of money which is which is being spend in the interiors.

We are also talking about improving the air conditioning efficiency of the you know of the overall building. So, you know imagine that we are actually looking at in terms of using a static glass and then you have we have weather is not static you your climate is not static at all. So, then we are talking about actually improving the overall dynamic air conditioning of the building. And we can have savings up to 60 percent in terms of the lighting and 25 percent in terms of the air conditioning.

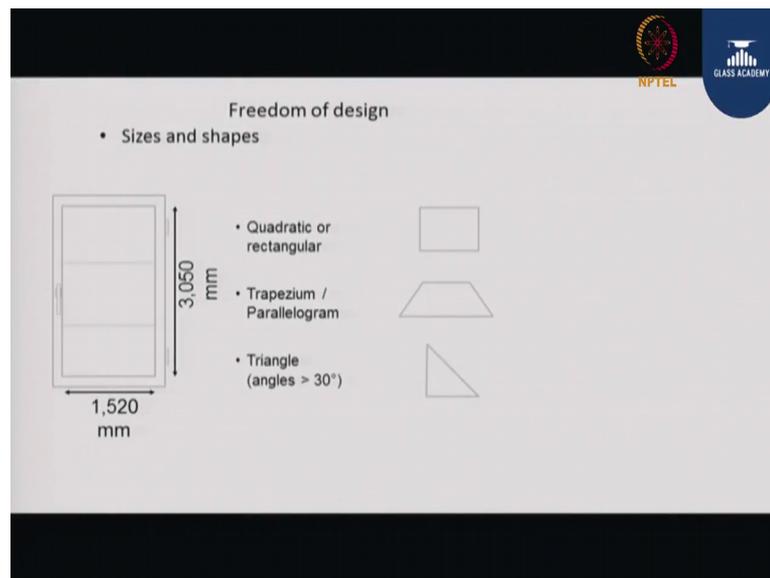
Then we are talking about removing all those shading devices in terms of blinds, in terms of louvers, in terms of internal shading devices, external shading devices; the blind systems which is being generally used these automated line systems everything will be removed and it will be only one glass which will be compared to the other solutions which are there for the fenestration.

So, we are talking about electrochromic glass which is a one cost product and then we are talking about all these differential products which are being used in the entire fenestration. So, a general study which if you see has been conducted and then how we actually look at in terms of the payback. So, we are talking about this payback which is purely tangible.

So, this is not even the non tangible benefits which are being offered by this technology; which is about you know the comfort which somebody will be getting inside, sitting in the building; wherein he do not have to you know hinder his views, he can see throughout the day and he gets the natural daylight throughout the day. So, those are the non tangible benefits which a person is getting and then these are the tangible benefits.

So, these tangible benefits are this productivity improvement, the energy and the maintenance benefits which is being passed on to the occupant and then it gets you a payback within almost like some 4 to 5 years. So, this is the study which has been proved and then it has been you know it has made a large boost on the overall human productivity; if you use this kind of technology.

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So, in terms of the freedom of design this product is available at a dimension of 3 meters by 1.5 meters. So, imagine that you have a floor to floor height 3.8 which I said. So, you have a one vision panel and then you have a spandrel panel which is like less than a meter of a height.

And then you can divide the entire height into one vision and one spandrel panel and then I told you have a technology which can actually divide this one vision panel into inpane zones. So, that also becomes very important factor and then you know you can have one vision glass; without any partitions, without any hindrance of the views. And then you can also do some amount of basic shapes like you know quadratic shape, rectangular, parallelograms and trapeziums and even some amount of triangles you cannot be actually doing with this kind of technology.

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So just to put the things into perspective; how as a product or as a technology; this can be actually put up in the buildings? So, this is one of the project wherein this has been used as a product, this is not a fancy builders or a developers office. So, this is a school Swiss International School in Dubai.

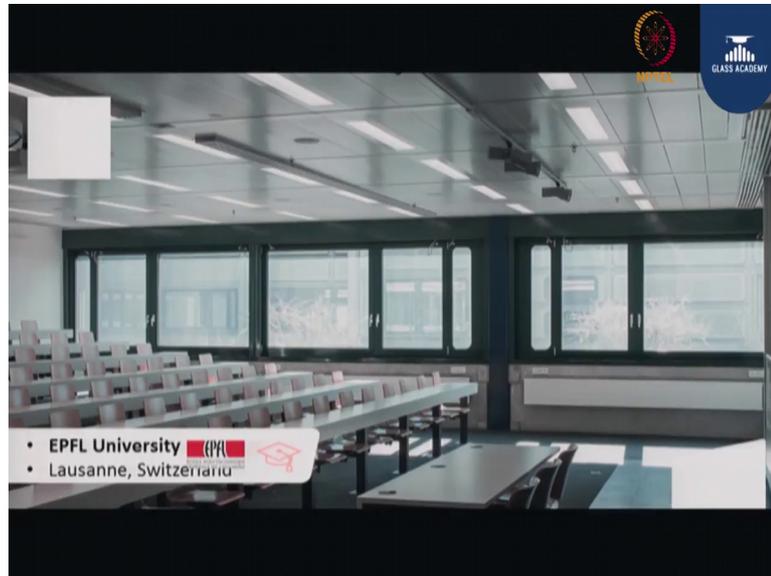
So, the; the agenda of the school was actually to showcase these innovations which are coming up in the industry and to use them to give the experience to the students. So, this photograph of that project and this is the facade. So, in the vision area; so the stage glass has been used in the vision area and in spandrel these are dark glass which is being used, which is a normal static glass.

So, if you see this vision glass; this is on a clear state and in the clear state you can easily see from even from inside from outside to inside. Now this has 3 zones which you cant see now and what I will do is I will show you how this picture actually changes when you introduce these zones in this picture and this is how the facade is going to look from outside for this kind of technology. So, when you tint the first zone; this is going to look like this, you tint the second zone and you tint the third zone.

So, you see this is completely uniform from outside; you know you get a 100 percent privacy from outside and you know you do not find that there is a difference in terms of how the spandrel and the vision is behaving. So, this is you do not see shabby blinds,

different colors chart papers which is being put on the window. So, all those problems are being resolved by actually putting up the glass as is this technology at the first place.

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So, this is the outside view which we are talking about; a more importantly is the view from inside. So, that is what as a technology we it offers giving you a you know vision which is free throughout the day.

So, this is a classroom and we understand that is a classroom with this amount of light which is almost like 60 percent light; it will be very difficult to actually do a projection or do a classroom session. So, there what you do is now you can actually tint the glass and it will actually become up to 1 percent light transmission. The important thing is the students can still see from inside to outside; so that is the beauty of the product. So, this is university project which we have done a PFN University in Switzerland.

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So, this is also a one of a very good application for this kind of technology which is an atrium area application. And I may tell you that these atrium area applications has been generally from an architectural point of view architects would like to make this area very live; very lively in terms of there is a lot of movement of the people they want to see from outside to inside.

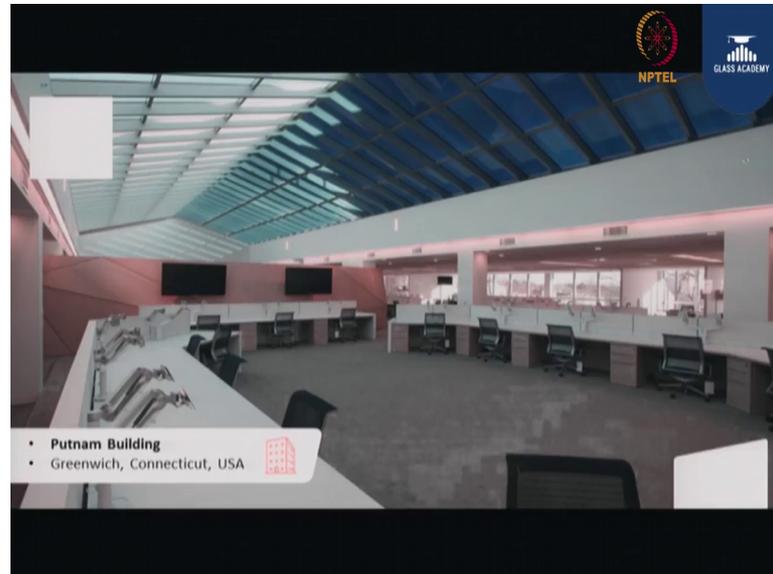
So, to make that connection generally they end up using a clear glass as a product and this area becomes quite a greenhouse. And then because of that you are not able to use this space as a particular space. And then there is lot of air conditioning which we which is being pumped in this kind of application area. So, we have this technology now available with us now it can actually change the way the atrium used to behave earlier.

So if you look at this area of application which is an atrium façade; so, generally you will be using a clear glass and creating a greenhouse effect in this area and then this becomes a non usable area you know for people. So, then now you can actually have a technology of this electrochromic glass which can actually make this area usable. So, if I show you how then you can see now in this picture that how the glass has actually controlled this entire space.

And this space has become a very useful space for anybody to do have cafes here you know you can do even computer screens here. So, this entire space becomes very usable

space for somebody to know work upon and make this as an even earn the revenue out of this atrium area space.

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Ah The other application which can be also think upon in terms of using in this technology which has been a little pain particularly for construction industry has been these skylights. So, generally what you will use in skylight is you know this sheets which are actually giving you diffuse light. And then these becomes little shabby after then years and then it is difficult actually to control because then it; it is a static solution which you end up.

And then the sec next solution is you use glass at a skylight and then glass as a static glass which is used as a skylight; it remains the at the same stage. So, imagine that you have used a glass which has a light transmission of 50 percent. So, it is allowing 50 percent in the day, imagine now the sun is directly falling on the glass and then it clears a it creates a high amount of glare condition and then you cannot sit below the skylight.

So, imagine now if this could have been at a static glass this picture if you see; if you could have been a static glass, it is only going to you can only have vegetables grown below this class, you can you cannot have human beings. So, if you look at this picture; so there are workstations which are 15 not more than 15 feet above the glass and then people are able to work easily. So, you can with this glass; you can actually control the

skylight and with this if I change the picture this is how the sun will be moving on the facade.

So, imagine that now this can this skylight will be completely controlled. And then you do not have to do you know be worried about how the heat will be actually behaving about how the sun is moving on the skylight. So, you will have very high functional skylights with this kind of facade applications.

So, these are some of the applications and the as a product which electrochromic glass can bring into and then there are newer technologies also which are coming up.

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