Course Name: Architectural Approaches to Decarbonization of Buildings

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Week: 10

Lecture 4

Dynamic Envelope - Case Studies Part 2

Hello all so we will further continue about dynamic envelopes because dynamic envelopes help in conserving operational energy and let us look at some more case studies, some more examples of how dynamic facades have been used in architecture. Here today we will see the hyper filter skyscraper which is a project and it I know it had a honorable mention in the 2014 skyscraper competition. We all know skyscrapers are energy intensive buildings. They can be energy intensive buildings unless strategies are taken to control its energy use. So the hyperfilter skyscraper It recognizes not only the temperature aspect or not only the daylighting aspect, but it looks at environmental pollution, indoor environmental quality and environmental pollution as a threat to mankind. Under today's levels of pollution, that all the cities are extremely polluted, fogged, smogged, etc.

There are harmful substances which spread into hundreds of kilometers and an entire region can become like a very polluted place. Now this hyperfilter skyscraper is conceived to inhale the pollutants and other harmful gases in the city and give out or release concentrated oxygen. So the skin of the project is made out of long pipe filters that ensure the cleaning process. While clean air is released into the atmosphere or pumped out.

All the harmful substances are stored for use in a chemical factory. So the hyperfilter skyscraper is conceptualized or designed to actually inhale carbon dioxide and other harmful gases in cities and exhale concentrated oxygen. Now the skin of this building is made up of long pipe filters which ensure the cleaning process. While clean air is given out into the outside, all the harmful substances are gathered inside the building. Those harmful substances are carefully stored in a particular place and given out to the chemical factories.

So it is like a biomimetic structure and it has a particular structure, design component which takes in the outside impure air. So this is how it looks. The inhaled harmful

substances are divided into their various components and then segregated. So it is conceived, it is conceived because it's an unbuilt project. It is conceived to have tubes like these and holes here which inhale.

So this inhales the So, the other longer tubes function more like a celia I guess and then this is supposed to inhale the bad and harmful gases and store those the byproducts of it and at the same time it is supposed to pump out concentrated oxygen to reduce the impact of air. So, So the external skin has pipe filters and it keeps the temperature balance throughout the building. So it is conceived to be located in big cities in between the skyscrapers on some very busy traffic road or factory areas where the structure soaks up the carbon dioxide and other harmful gases. The hyperfilter skyscraper looks at the threat to the human being due to environmental pollution and it tries to merge carbon capture technology with the building's design. Now in today's condition of cities becoming very polluted with harmful substances spreading over hundreds of kilometers, this seems to be a good solution if it is implemented further.

Hence we need this kind of building like an air scrubbing building in the heart of the city in an urban core. This building or this concept is conceived to have holes for inhaling the polluted air. So, the polluted air is inhaled inside. And there are a series of, if you see, there are a series of filtering mechanisms through which Now the harmful gases is stored. So it's more like a reservoir.

So it acts like a reservoir for harmful gases. However, the facade is designed in a very interesting way and that is why I have included this as one of the case studies to make you all think and trigger of all the ways to reduce your operational energy. Is air pollution, considering air pollution part of reducing operational energy? Yes, because we already know that some of the cities today use air filters because the air outside is so polluted and you need operational energy for that. So there you can also think of various such concept options which right now this one is only at a conceptual stage. The next one is the Al Bahar Towers.

Al Bahar Towers is designed as a responsive facade. It is developed in the Emirates of Abu Dhabi and it has 29 storeys. It gets its inspiration from Mashrabiya shading system, which was, the kinetic facade is developed by a computational design method. Whereas the Mashrabiya are vernacular architectural elements. They are basically a type of balcony in the form of a small, lattice opening encasing the second or higher floors of the building and they overlook onto an internal courtyard.

Using a parametric description for the geometry of the actuated facade panels, this was simulated to operate as a response to solar exposure and the changing incident angles

during different parts of the year as well as during different parts of the day. Distinguishing aspect of these towers is that the skin is protective and it has about 2000 umbrella type of glass elements. that will automatically either open or close you can see what happens when it is closed and you can see how what how it looks when it is open so when the umbrella type of a system is open it looks like this when it is closed it begins to looks like this and you can see that this is more done through origami it is origami inspired or paper cutting inspired outer facade. So this system has a umbrella like element that will automatically open or close based on the outdoor sunlight which you want to either allow or prevent from getting inside. So it's an intelligent facade and it is dynamically controlled by a building management system.

So the adjustable shades help reduce interior heat gain which are caused by sunlight and you are able to cut out these by minimum 50 percent. This makes the towers eco-friendly and they are they are designed in such a way that the building is protected by another layer of a facade which will guard or control the ingress of solar radiation or day lighting inside the building. So, these are the details of how it was conceived. You can see how these are, how these elements operate with a mechanical motor behind it with a polypropylene flap like this which closes itself. So this umbrella will close itself or open itself with the motorized.

So here are the motorized systems which will enable the opening. So this is how it will flap out or flap in to prevent solar radiation from, solar radiation as well as lighting to enter Or prevent the light from or solar radiation from entering inside. So the outdoor skin operates like a curtain wall. And it operates like a curtain wall to either close or partially open or completely open the facade. the completely open the curtain wall which is behind and each of the triangle is coated with fiberglass and it is programmed to respond to the movement of the sun throughout the year and throughout the day in such a way that solar gain is minimized glare is minimized So what will happen in the evening all the screens will open up.

So they will fold at night and you will be able to see more of the glass facade. But as the sun comes out in the morning it will start to gradually close itself and prevent the solar radiation from hitting the building. what happens is because of this the building has optimal performance of the outside shades and the series of folding and unfolding of these 1, 2, 3 happens throughout the day and this will result in the shades successful ability to filter or cut out light and architects can also choose the nature of glass behind this system and that will further reduce the need for artificial lighting. And allow the natural lighting to be used to the maximum. So, it is an exemplary building because of which lot of operating energy and savings and operational carbon emission is cut out.

So, because of this screen, it is estimated that more than 50% solar radiation is cut out and the building's need for energy draining air conditioner is reduced by a minimum of 50%. Also the shade has the ability to filter the light and this has also allowed for further more energy savings by means of reduction in artificial lighting. And the last case study we will see for today is the Council House 2. So this Council House 2 again is a Comparing to a building with a 6 green star rating, this building has 64% lower emissions as compared to another building which does not have a dynamic facade. So it is expected that this building will reduce its electricity consumption by a minimum of 85%.

And it will definitely contribute itself towards a sustainable environment by reducing its operating emissions. So it is also known as CH2 and it is located in Melbourne. This building has facade, a facade which has a panel like this similar to what we have seen in the earlier case studies where this panel will hinge itself along this end and either open itself or close itself allowing for control over the amount of solar radiation that falls on its surface as well as day lighting that falls on this on its surface. So this building gives complete control to the ones inside and all of these are done using computer monitors and this building consumes a lot less energy. It also houses solar panels and which provide about 60% of hot water.

It is considered that this building will significantly lower carbon emissions. The cogeneration plant which this building has also produces a lot of hot water. There are several advantages of kinetic buildings that allow architects to develop realistic solution for dynamic human and environmental conditions. The first is, as a conclusion, the first thing that dynamic facades do is it creates an optimal indoor climate. With the help of a kinetic facade, you can allow the building to take in as much solar radiation or wind or light as much as needed and cut out what is not needed.

So this movable facade will enable the building and it will empower the building to control the ingress of elements which will otherwise increase the load on air conditioning. Besides it creates smart building envelopes. For example, one can integrate these elements on the facade with solar PV or some other mechanism which can even tap the solar energy. Also, there is provision because of its smartness to have a control on daylighting and it empowers the user to no, operate or handle it with ultimate smartness. Whether daylighting is needed or not, the occupant inside has the power to operate this facade.

And therefore, kinetic facades, even though their initial embodied energy may be slightly higher, they will definitely operate on a long run be productive by having a reduced operational energy throughout the lifespan of the building in addition to empowering the user with whatever is needed. The user is empowered to control it in terms of day

lighting, solar radiation and probably wind. So, we will stop this class today and we will stop the class with the envelope systems and we will move on to an interesting topic in the next class. Thank you.