HOW TO MAXIMIZE DAYLIGHT IN COMMERCIAL BUILDING WITHOUT INCREASING HEAT GAIN

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ABSTRACT

To reduce heat in commercial buildings in daylight, you can use shades, blinds, and curtains. On hot days, draw the curtains or shades to keep the sun out. Well-designed sun control and shading devices can dramatically reduce building peak heat gain and cooling requirements and improve the natural lighting quality of building interiors. Depending on the amount and location of fenestration, reductions in annual cooling energy consumption of 5% to 15% have been reported. Horizontal slat-type blinds can also be adjusted to block and reflect direct sunlight onto a light-colored ceiling. When completely closed and lowered on a sunny window, highly reflective blinds can reduce heat gain. External blinds can be installed to more effectively prevent heat from coming into your house. Honeycomb blinds consist of little cells that retain pockets of air.

In addition to the most common ways to reduce heat impact, such as shading devices and green roofs, there are also new ways to reduce heat impact such as tensile structures, brise soleil, mashrabiya, and sunbreak.Working with qualified engineers and installers can help to ensure that the best possible choices are made for the building.

Keywords Reduce heat impact, Energy savings, Shading devices, Accessories, Skylights

1. INTRODUCTION

There are several ways to maximize daylight in commercial buildings without increasing heat gain. One way is to use window treatments, such as shades or blinds, to shade a window or diffuse direct sunlight, minimizing heat gain. Another way is to use high-performance glazing systems that admit more light and less heat than typical windows. This can be achieved through spectrally-selective films. Increasing the glazing area is another method to maximize daylight within a space. Another way is to use skylights, it can reduce the need for heating during colder months and contribute to the heat gain of a space. However, during hot weather, skylights can also be a source of unwanted heat gain in a home and offices. To prevent unwanted solar heat gain, you can install the skylight in the shade of deciduous (leaf-shedding) trees or add a movable window covering on the inside or outside of the skylight. Exterior shades will be more effective than interior shades at reducing heat gain in summer. However, three glass characteristics need to be understood in order to optimize a fenestration system: U-value represents the rate of heat transfer due to temperature difference through a particular glazing material. It is measured in watts per square meter per degree Celsius (W/m²K). The lower the U-value, the better the insulation provided by the glazing material. Solar heat gain coefficient (SHGC) represents the fraction of solar radiation admitted through a window. It ranges from 0 to 1 and is expressed as a decimal. The lower the SHGC, the less solar heat is transmitted through the window. Visible transmittance (VT) represents the amount of visible light transmitted through a window. It ranges from 0 to 1 and is expressed as a decimal. The higher the VT, the more visible light is transmitted through the window. There are some new ways to maximize daylight in commercial buildings without increasing heat gain.

1.1 TENSILE STRUCTURE

Recent advances in the industry have made tensile fabric architecture and building facades more versatile and functional than ever before.

Tensile membrane building facades are an alternative to traditional metal mesh facade screens that use fabrics or membranes under tension to cover the exterior of buildings. They are cost-effective and address common design challenges such as energy efficiency, acoustics, security, and aesthetics when designing new buildings or planning renovations.

FIG-1

FIG-2

EFFICIENCY - Energy-efficient building facades are becoming more and more important to architects as energy efficiency continues to dominate discussions in almost every industry. Building facades made of tensile membranes are the ideal solution to the problem of lowering solar heat gain while retaining optimal visual light transmittance. They also contribute significantly to reducing the urban heat island effect in metropolitan areas and commercial centers where there is a greater proportion of concrete than of greenery.

LESS WEIGHT - Because they are less than 5% the weight of metal screens, architectural fabric mesh facades are a fantastic substitute for metal screens or other metal wire facade solutions. This lessens the load on already-existing structures, necessitating less structural support and enabling the use of greater fields of mesh facade architectural panels.

COST SAVINGS - Fabric mesh facades are lighter than metal mesh facades. This means that they require fewer support structures and mesh facade connection details. Fabric mesh facades are a great value engineering substitute for metal mesh facade cladding since they take less time to install and cost less to labor.

MAINTENANCE AND DURABILITY - Metal mesh facades run the risk of rusting and discoloring the ground beneath and around them. Tensile membrane facades avoid this from taking place. The majority of fabric mesh materials contain a coating to prevent fading and give an extra degree of security. The same cleaning procedure applies to metal mesh. Fabric mesh facades promote rain access since water cleans the fabric and does not harm it. With some fabric meshes, a lifespan of up to 20 years is anticipated.

MORE DESIGN FLEXIBILITY - The majority of tensile fabric mesh can be printed with patterns, artwork, images, or branding in order to add particular hues. It can also be printed with different metal wire mesh colors in gray, bronze, copper, and bronze to provide the look of a metal mesh facade for a fraction of the price. The metal mesh facing cladding prevents this.

CASE STUDY

MLC BURWOOD,AUSTRALIA

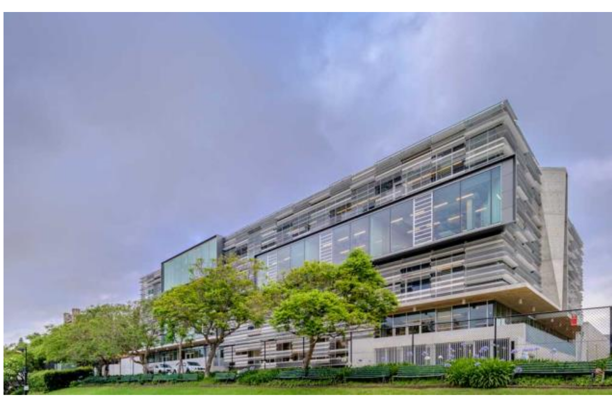

FIG-3

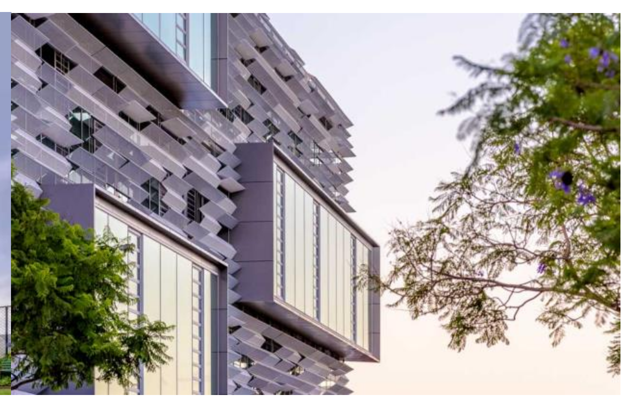

FIG-4

In order to create a second skin facade made of perforated aluminum panels fastened to tensioned cables, Locker Webforge, a partner of Ronstan Tensile Architecture, was contacted by the MLC Burwood school. Ronstan was requested to handle the structural design and installation. The facade would increase the building's modern look while simultaneously increasing its sustainability and energy efficiency.

With reducing the need for mechanical ventilation, the Locker Webforge AtmosphereTM perforated panel facade system offers an energy-efficient way to maintain a suitable interior temperature. While the perforations keep the building's interior feeling open and airy, the panels offer shade. Locker's Atmosphere can cut the amount of solar energy that enters a building by up to 78%, which lowers the amount of energy needed to run HVAC systems to maintain comfort levels.

At MLC, the panels were fully built on the school's tennis court area, saving laborious and time-consuming raised work platforms and scaffolding installation. The finished panels were then attached to the pre-installed brackets and lifted into place in stacks by a crane, which resulted in a substantially quicker facade installation and lower site costs.

FIG-5

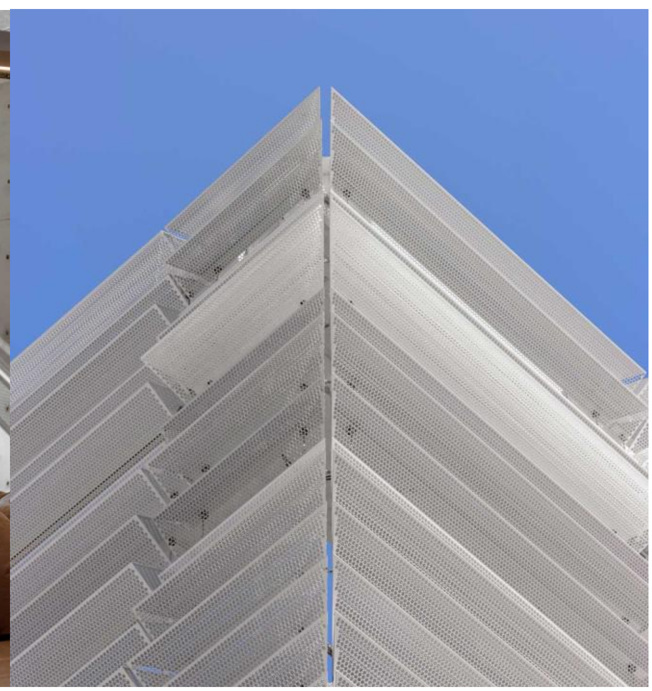

FIG-6

1.2 MASHRABIYA

Mashrabiya is a type of balcony or window that is usually found in traditional Islamic architecture. It is made of small pieces of wood or metal that are arranged in a pattern to create a screen. This screen provides shade and privacy while still allowing air to flow through. It is usually found on the upper floors of buildings and overlooks an internal courtyard.

CONCEPT

The mashrabiya is a wooden lattice screen made of incredibly tiny circular wooden balusters. The Arabic word for "drink" is the source of the name "mashrabiya." The mashrabiya was initially used as a "drinking area" because its open lattice and shade offered a steady flow of air that cooled the water within porous clay pots as they sweated. As depicted in Figure 7, the mashrabiya serves a variety of purposes, including restricting the passage of light, regulating air movement, lowering the air's temperature, raising its humidity, and ensuring a high degree of seclusion.

FIG- 7

According to Köppen's classification of climates, Egypt has a hot, dry, arid climate. Because of the high levels of direct solar radiation and the clear sky, it necessitates special façade treatments to minimize heat input while maximizing daylighting. If appropriately built, double-skin façades (like Mashrabiyas) are one of the building's facade treatments that can enhance the inside environment while using less energy (Poirazis, 2006). A hybrid solution using a shade screen as the outer face and a high performance curtain wall system as the internal layer of the façade has evolved from the traditional double façade kinds of buffer, twin face, and extractair, where the exterior layer is glazed, for hot, arid climates (Boake, 2014), as shown in figure 8.

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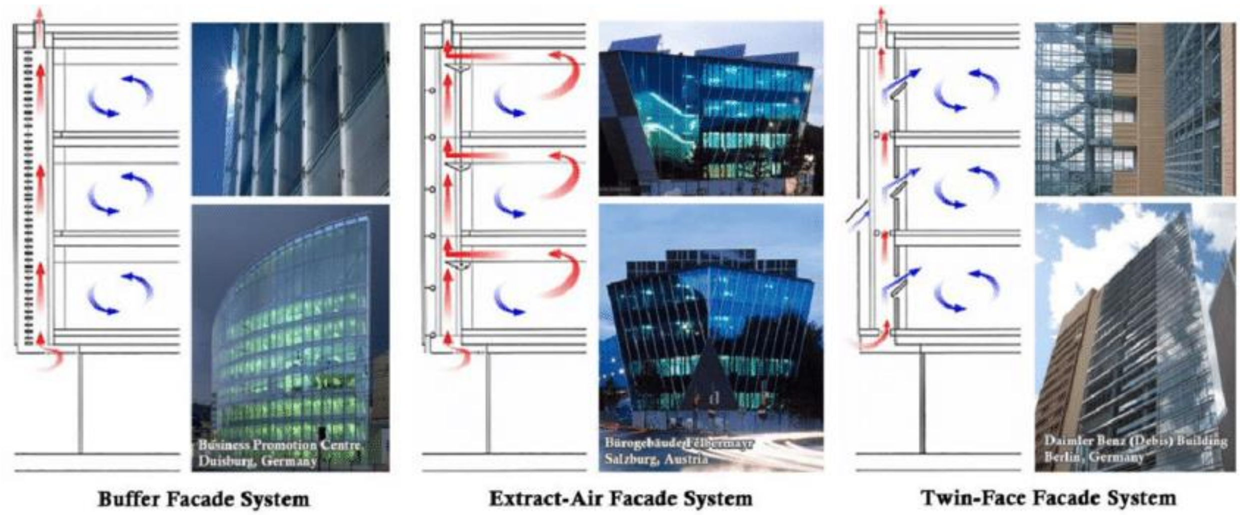


FIG-8

BENEFITS

- It is a type of window that is usually found in traditional Islamic architecture.
- It provides shade and privacy while still allowing air to flow through.
- It is usually found on the upper floors of buildings and overlooks an internal courtyard.
- Mashrabiya also provides both light and shade which helps with a cooling effect with hot temperatures.
- It is used as an oriental ornament that provides local identity to buildings.

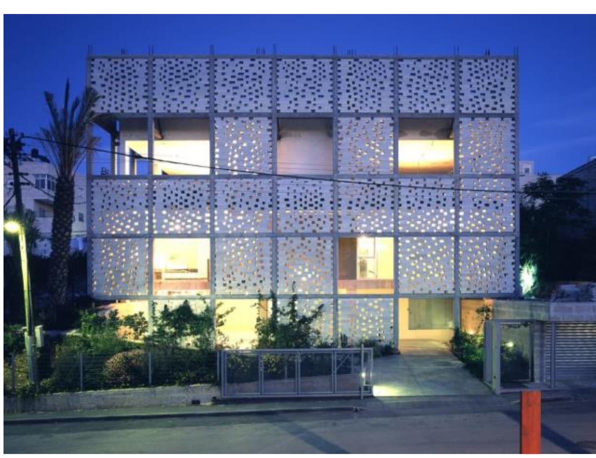


FIG-9

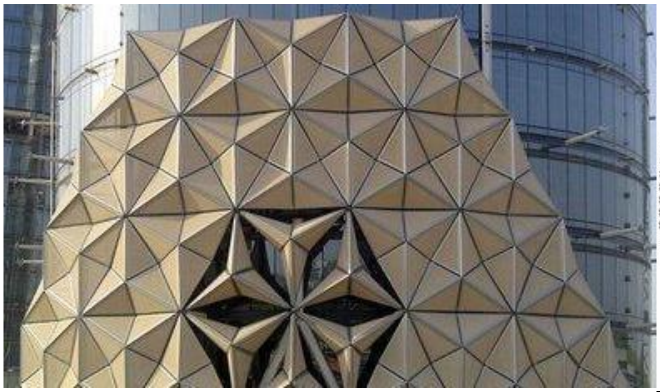
FIG-10

CASE STUDY

AL BAHAR

Al Bahar Towers is a pair of 25-story towers located at the Eastern entrance of the junction of Al Saada and Al Salam Streets in Abu Dhabi. The towers feature the world's largest dynamic façades. The "smart" facade of Al Bahr Towers is dynamically controlled by a building management system. This screen which was completed in 2012 is able to reduce the building's need for energy-draining air conditioning by 50%. The Al Bahar facade mitigates heat transfer by 50%, reducing carbon dioxide emissions by 1,750 tonnes a year. The system allows natural light through, reducing the need for artificial lighting.

The Al Bahar Towers are designed to reduce the amount of energy needed to cool the building. The facade is made up of a series of moving elements that open and close in response to the sun's position. This allows natural light to enter the building while reducing heat gain. The system is controlled by a computer program that adjusts the position of the elements based on the time of day and the season. The towers are also designed to reduce water consumption by using recycled water for irrigation and cooling. They are part of a larger effort in Abu Dhabi to promote sustainable development and reduce carbon emissions.



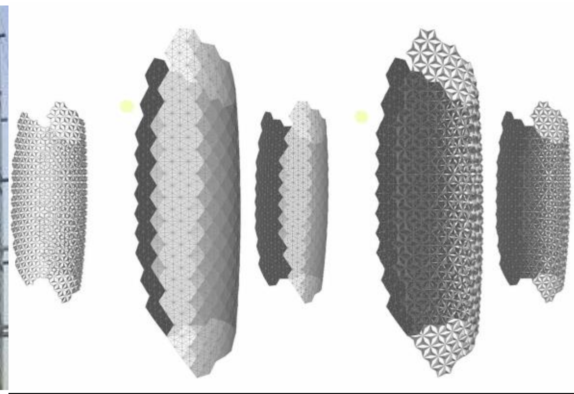


FIG-12

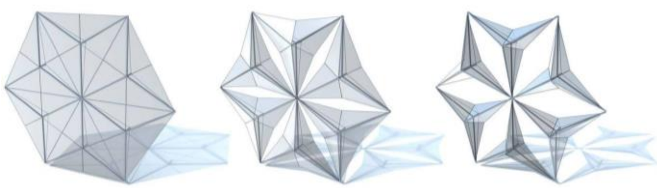


FIG-11

1.3 BRISE SOLEIL

Brise soleil is a feature of a building that reduces the amount of sunlight that enters the building. It does this by deflecting the sunlight away from the building. This helps to keep the building cooler and more comfortable for people inside. Brise soleil can come in many shapes and sizes, but they are all about breaking up the intensity of sunlight entering a building, creating a cooler, more pleasant internal environment. It is often used in hot climates where there is a lot of sunlight. Vertical brise soleil has become popular recently. Brise soleil systems react to a fundamental, unchanging truth of the universe: that the sun rises in the east and sets in the west. This is in contrast to the majority of other architectural features and building products that are influenced by location, altitude, climate, geology, drainage, and human factors. It moves along an arc and, unless you're in the southern hemisphere, reaches its maximum peak in the south.

Brise soleil systems therefore work best on elevations that face south. A horizontal brise soleil blade might offer protection from the worst summer sun in this area. It won't offer shade during the winter when the sun's arc is lower, but this isn't seen as a big issue because the sun's glare and heat are also less intense then. An internal window blind system is frequently used in this area to give shade.

On east or west elevations, when the sun is at a lower angle and will be shining underneath, horizontal brise soleil "shelves" will not function as well. A system that employs numerous vertical blades in front of windows may be more efficient in these circumstances.


FIG-13


FIG-14

BENEFITS

- Reduces heat gain within the building by deflecting sunlight
- Creates a cooler, more pleasant internal environment
- Can help to reduce energy costs by reducing the need for air conditioning
- Can help to reduce glare and improve visibility inside the building
- Can be used to create interesting architectural features on the exterior of the building .

CASE STUDY

STUDIO WORKSHOP

The Brise Soleil House, a modest 2-bedroom, 173 SQM residence, is perched atop a sloping, west-facing property close to Port Moresby Harbour, where it has a view of a former freight terminal. The home is a cast-in-situ concrete structure with an undulating wave-like timber wrapper that gives the master suite with shading, seclusion, and ventilation. The wrapper becomes a full-height movable screen for the top level gallery to manage the western sun and catch views of the Coral Sea beyond as it flattens out as it wraps around the structure.


FIG-15


FIG-16

Using a system of intricate joints and a high level of surface articulation, the wrapping pays respect to regional traditions of timber craftsmanship found in lowland stilt buildings and finely carved canoes (lakatoi). But, it does so with a digital perspective that has been updated to take into account the modern software and hardware tools' capacities to manage complex systems and to mass-customize sophisticated geometries with embedded assembly logics. The wrapper's design also contributes to a larger discussion of screens and veils in tropical architecture that is found in the canon of works by Ossipoff, Ferrie, Rudolf, and others from the Modern and 20th century.

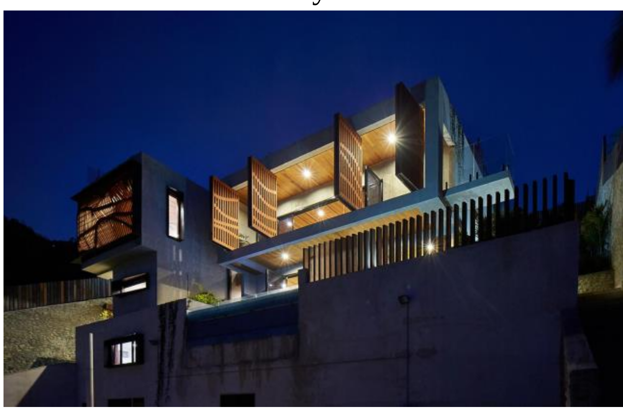


FIG-17

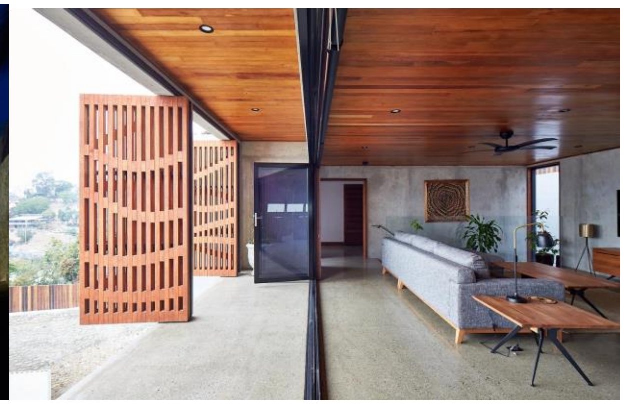


FIG-18

50x50 mm rough-sawn acetylated pine is used to build the wrapper and doors. At digitally executed intricate half-lap joints, the wood is bonded and doweled. More than 2200 pieces altogether and more than 700 unique parts with CNC milled half-lap joints, frequently on both ends, make up the wrapper and doors, which have a combined surface area of more than 80 square meters. The Gold Coast, Australia, workshop of the designers handled all milling, joining, finishing, and panel assembly before shipping them by container to Papua New Guinea for installation. A system of continuous 1200mm panels and doors has been used throughout the entire assembly, which not only makes transportation and erection easier, but also reduces the need for trained labor on-site. Although each panel was different, the installation process was the same, and it took a team of 3 workers 2 days to complete the task while working solely by hand on scaffolding. The installation of the 8 door panels took a single day.

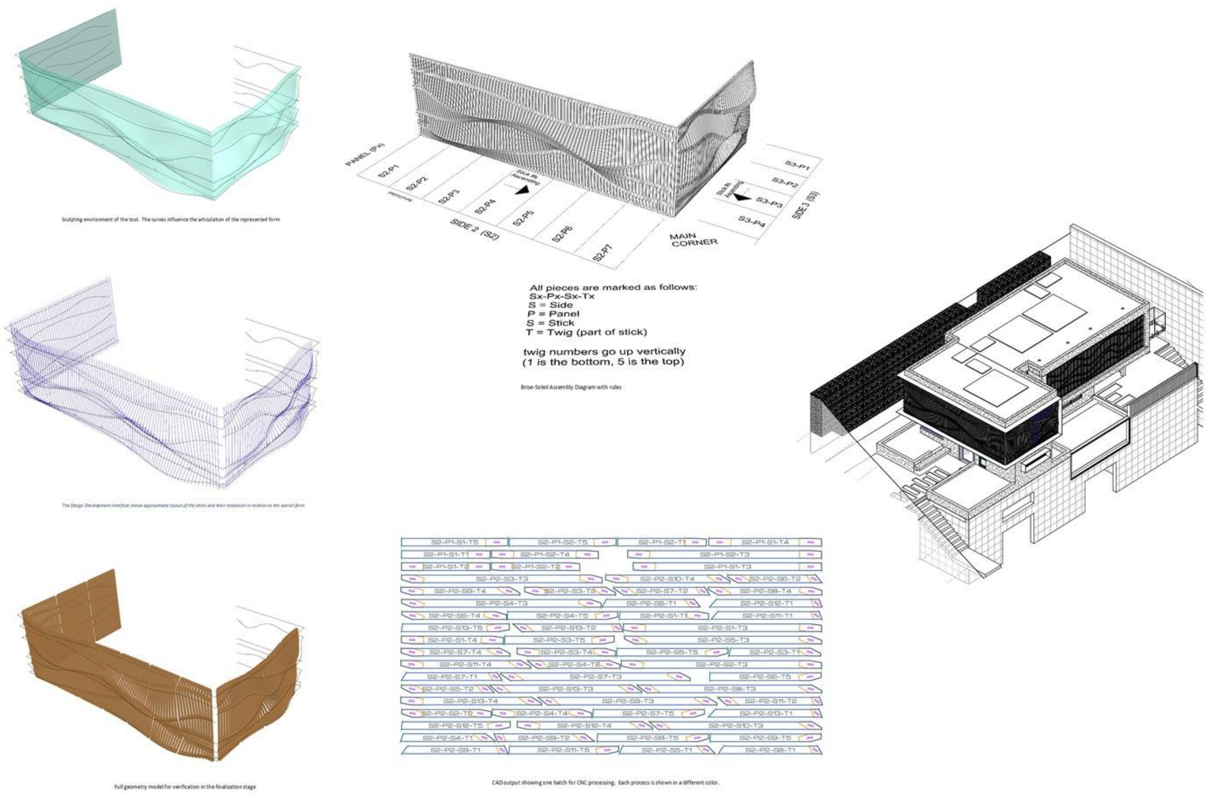

PANEL (Px)
SIDE 2 (S2)
MAIN CORNER
All pieces are marked as follows:
Sx-Px-Sx-Tx
S = Side
P = Panel
S = Stick
T = Twig (part of stick)
twig numbers go up vertically
(1 is the bottom, 5 is the top)

FIG-19

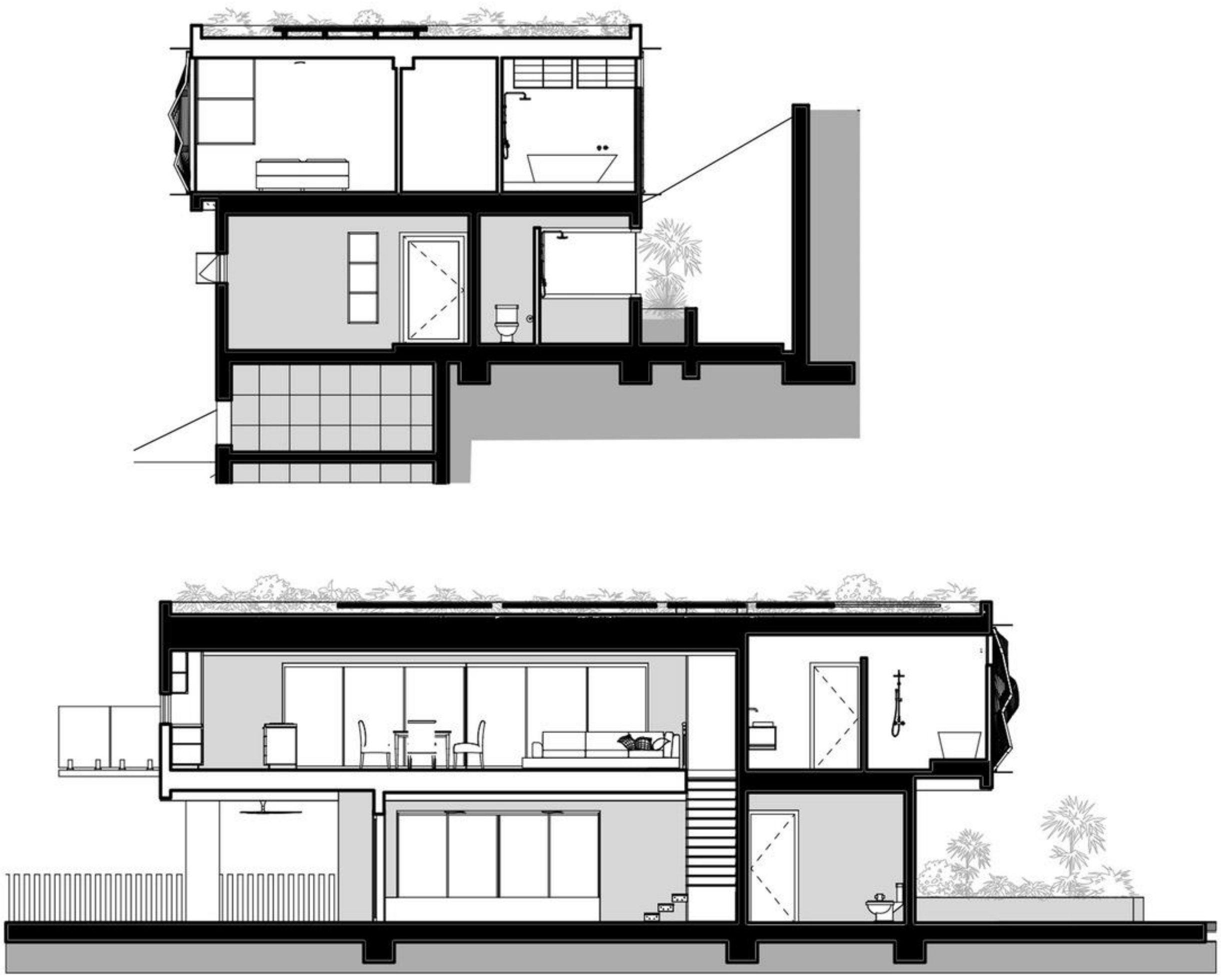


FIG-20

1.4 SUNBREAK

Sunbreak, a brand-new prototype for user-controlled sunshades developed by the international architecture company NBBJ, will not only reduce energy expenses but also give buildings a changing aesthetic throughout the day.

The ability to automatically control solar gain in buildings is currently possible, but this technology has its drawbacks. For example, many of these systems lack manual controls, and workers in contemporary office buildings frequently lament that they do not have enough control over their surroundings. Automated sunshades rise and fall according to the time of day, but if it's overcast outside or if users want natural light in a space when the shades are down, they could have no choice but to wait till the shades are down.

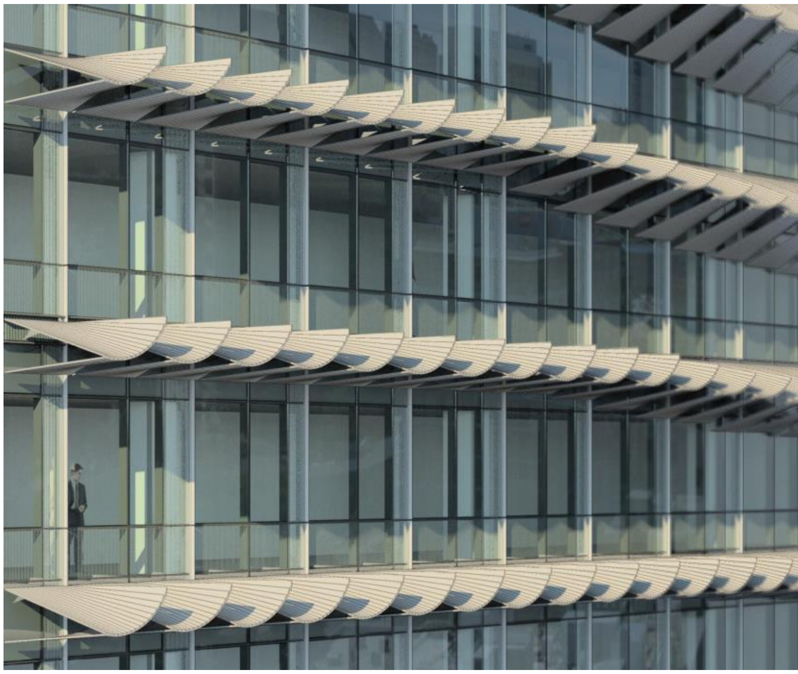


FIG-21

FIG-22

The current prototype makes use of folding geometry, a moveable track system controlled by sensors, and a mobile app. It was inspired by Santiago Calatrava's garage door design from 1985. This unusual geometry may change such that light can reflect off its surface and penetrate further into structures or fold down to totally block light.

Sunbreak will automatically raise or drop blinds and conserve energy at times when a portion of a building is empty by employing sensors to recognise whether people are present in a room. The shades will open automatically if someone enters the room to let in natural light, but an iPhone and Android app can also be used to control them. Building managers have even more control over how a building appears at night thanks to the shades' ability to be lighted with specific LED lighting.

In order to deliver the most natural illumination, sensors will detect the presence of clouds and adjust the curtains accordingly. In contrast to other sunshade systems already in use, which solely deal with visible light, the system is also set up to measure solar radiation. Buildings become more resistant to temperature swings as a result of the enhanced capability to adjust the system based on the weather and the amount of solar radiation.

FIG-23

FIG-24

2. CONCLUSION

There are many ways To maximize daylight in commercial buildings without increasing heat gain, but during my investigation, I discovered that there are fresh approaches to doing it. Like
A tensile membrane structure facade is a system of tensioned fabric or flexible membrane material that acts as a second skin to a building's exterior. It provides an innovative and cost-effective alternative to the traditional metal mesh facade screens. Tensile facades come in custom shapes and sizes. Tensile membrane building facades use a system of tensioned fabrics or membranes to act as a second skin to a building's exterior, which provides an innovative and cost-effective alternative to the traditional metal mesh facade screens. Tensile membrane building facades are a perfect way to address concerns about reducing solar heat gain while maintaining desirable visual light transmittance. They also play a major role in helping to minimize urban heat island effect in cities and business hubs that have a higher concentration of concrete as opposed to natural landscapes.

Another way is the mashrabiya is an intelligent building skin that can respond to changing environmental circumstances by moving, while also taking into account how people interact and behave. Regarding the high-tech modern mashrabiya that was previously described, it can potentially be utilized to generate electricity, reduce the need for mechanical systems like HVAC systems and artificial lighting, and assist mitigate a number of environmental issues.

Another way is Brise Soleil is a system that blocks or deflects the sun's rays. It can be both static or movable, and it can be located both in a facade or a roof. When positioned above or across windows or glazed building facades, the brise soleil blades cut out direct summer sun . Installing Brise Soleil on the external facade of a building is hugely beneficial to both the environment and the building's overall operating costs. It substantially reduces the need for air-conditioning during the summer and consequently reduces energy consumption.

And the last one is a Sunbreak is a brand-new prototype for user-controlled sunshades developed by the international architecture company NBBJ. It will not only reduce energy expenses but also give buildings a changing aesthetic throughout the day. And you can control this via a mobile app that will be available in android and ios.