Future Façades

Advancements in Technology & Materials

Façades are the most important building element from both the users and the architect's point of view. They are the most difficult to design since the perception of iconic and technologically advanced façades is changing frequently.

As per the United Nations Environment Program, buildings and their construction together account for 36 percent of global energy use and 39 percent of energy-related carbon dioxide emissions annually. Since the building's envelope is the primary contributor of energy gain, and correspondingly its most important element in controlling the carbon footprint, it is no longer a matter of choice but mandatory to come up with technologies that perform better, are more functional and, of course, look great. Designers are researching and experimenting with new and complex façade and fenestration technologies.

We interviewed a number of experts, including architects and manufacturers of cladding materials, to know their views on future façades, fenestration technologies and materials that can accentuate the building design horizontally and vertically. This edition's cover story attempts to delve deeper into various aspects of future façade designs and materials and throws light into many aspects that would help building flawless 'future façades'.

Gift International Club, Gandhinagar by Designers Group

AR. KHOZEMA CHITALWALA
Principal Architect & Designer, Designers Group

AR. MANISH DIKSHIT
Partner & Principal Designer, Aum Architects

ROHIT SURAJ
Founder, Urban Zen

MOIZ ANWER KAMIL
Director, KaenatCorp

Along with the materials that furnish the look and feel of a building, technologies applied to façades and fenestrations are also changing, says **Ar. Khozema Chitalwala, Principal Architect & Designer, Designers Group**. Besides technology, materials like glass, concrete, etc., used for the building skin are an integral yet singular aspect of the façade design. Durable, malleable and scalable materials like zinc, aluminium and concrete are the choice for architects who innovate in designing functional cladding.

A façade can be constructive or destructive for any building. Major advancements have been made in the application of new techniques with the changing materials. Recent buildings are more responsive to the environment as well as the design. The deviation towards energy conservation and efficiency is for the better, says **Ar. Manish Dikshit, Partner & Principal Designer, Aum Architects**.

According to **Rohit Suraj, Founder, Urban Zen**, to protect a building from external elements, to maintain ambient internal temperature, and for ventilation and natural light at the same time ensuring visibility from inside, metals like copper, aluminium, corten steel, and brass alloys are now being explored as façade elements in India.

Moiz Anwer Kamil, Director, KaenatCorp notes that by empowering the user with technology, it is possible to bring a paradigm shift in terms of comfort. Designers are looking at new ways to pioneer energy efficiency. As a result, the façades have taken the technological route. He agrees that conventional products that were once used as the default cladding materials – such as ACP (aluminium composite panel) – are gradually being replaced by much better alternatives like slim porcelain slabs.

Deutsches museum proposed 3D-printed facade

Talking about the trends in façade architecture, **Ar. Kapil Mehta, Principal Architect, Kapil Mehta & Associates** stresses the need for architects to stay informed about the latest trends, innovations, and performance requirements which will maximise efficiencies in their projects. He agrees that iron panels, copper, steel, high-pressure laminates, aluminium, zinc, tile, stone, extruded resin, ETFE, etc. have taken up the trend.

Prachita Singh, Architect, GSC Glass Pvt. Ltd, observes that apart from creating panoramic views, façades can harness solar energy, double them up as a media wall, and allow the building to breathe. The smart glasses allow buildings to respond to the sun.

Sky Tower Ankara. Courtesy ALUMIL Systems India

AR. KAPIL MEHTA
Principal Architect,
Kapil Mehta & Associates

AR. PRACHITA SINGH
Architect,
GSC Glass Pvt. Ltd.

TARIQ KACHWALA
Director,
FG Glass

AR. UTKARSH GOR
Associate Architect,
Ingrain

Proposed design for a project by Urban Zen

From the advancement in terms of technologies, the façades are becoming smarter and are ably responding to the environment.

According to **Tariq Kachwala, Director, FG Glass**, some of the striking and notable material innovations here are electrochromic or photochromic glasses, energy-generating BIPV (Building Integrated Photovoltaic) façades, "green" algae-powered façades and external dynamic shading devices that are electronically controlled, just to name a few. These smart designs will ensure that the façades of tomorrow are not only different but more functional and practical than today's general norm.

Ar. Utkarsh Gor, Associate Architect, Ingrain notes that the approach towards the building façades has changed a lot, from 'conserving energy 'to 'generating energy' through façades. Technologies like Building Integrated Photo Voltaic (BIPV) are reforming our point of view towards the façade, he adds.

Hemant Rathod, National Head-Structural Glass Solutions, Saint-Gobain India Private Limited (Glass Business) too observes that with 'smart' being the keyword across every vertical, glass has also lived up to transform itself to align with the digital world. The electrochromic glass takes dynamism to whole new levels, allowing user preference to determine the appearance and performance of the façade. Dynamic and electronically tintable, it enables users to actively control daylight and solar heat, improving occupant comfort while reducing energy consumption and costs. It completely negates the need for traditionally used sun control systems like curtains and blinds, says Rathod.

Revolutionary products are available, says Rathod, which allows occupants to choose between transparency or translucency at the touch of a switch and thereby control their privacy. It can be installed as a façade or an interior glass as partitions, floors, doors, windows and even walls. Despite high light transmission, says Rathod, it ensures low power consumption. Some futuristic glazing solutions allow any image or vector file to be processed and printed onto it. It is ideally suited for both indoor and outdoor applications.

Dhurgai Kumaran, Director-studio, FHD group observes that the façade systems are moving from a climatic control/protective hermetically sealing role to an energy harvesting role. Tesla's solar roof is the best utilisation of the roof system for solar energy production

HEMANT RATHOD
National Head - Structural Glass Solutions, Saint - Gobain India Private Limited (Glass Business)

AR. DHURGAI KUMARAN
Director - Studio, FHD Group

AR. KIRAN KALE
Partner, Ingrain

as one can see in energy modelling on the roofs. Stressing on the need for physiological and psychological wellness with the increasing pollution and taller buildings and diminishing connection with nature, Kumaran suggests that the 'Biophilic' approach is the right way to integrate green in façades and roofs. "It promotes not only mental wellness but also cleans up the pollution (both chemical and noise) in the environment and produce clean air to breathe," he says.

Kachwala notes that static façades are perhaps the most limiting factor considering façades. The performance expected from façades during day and night, and during seasons, is entirely different and the occupants resort to additional shading devices like blinds or films. Another limitation inherent in most façades today is its non-interactive nature. These two areas are the ones where technology has the greatest scope of the transformation - and we are seeing new advancements, at an increasingly quicker pace in transforming façades to be dynamic and "living". While buildings are static objects, some of the more successful buildings have achieved a sense of movement or fluidity. As the sun travels across the façade casting alternating highlights and shadows on the surface, the dynamics of how that structure sits on the environment is an important component of becoming a respected partner in its surroundings, says Mehta.

Geneva airport, Switzerland - application: skylight renovation; product: SageGlass Climatop Classic; photography: Adri

SUSTAINABILITY & OPERATIONAL COST-EFFECTIVENESS THROUGH FAÇADE TECHNOLOGIES

A designer needs to engage in different design strategies for specific climatic zones. In terms of thermal energy, says Ar. Dikshit, façades can substantially pacify the amount of heat absorbed by the building in a hot climate zone. With the partial reflection of solar radiation by the covering, ventilated air gap and application of insulating material, a designer may achieve a considerable reduction in the costs of cooling and air conditioning. Vice versa, in winters, ventilated walls can manage to retain heat, resulting in savings in terms of heating. Also, high solar gain façades can be used to harness solar energy with solar panels.

Façade is being looked upon as an opportunity to harvest energy, while still maintaining high aesthetic value. **Ar. Kiran Kale, Partner, Ingrain** adds that efforts are being put to increase the efficiency of solar panels as a façade in the form of louvers, surfaces, shading devices, and so on. Attempts are being made to increase efficiency by using nanotechnology in the solar panels. Also use of solar panels and microturbines on the façade in selected locations can be an upcoming potential idea, adds Ar. Kale. Double skin façade and the airflow in between can also play an important role. Leading-edge technologies like photolytic glasses can be incorporated in the façades, notes Ar. Chitalwala. This glass on the complete building envelope acts as a solar panel, that can harvest energy during day time.

Ar. Kumaran points out that integrated façade products such as solar and wind turbines can increase the underutilised façades into a clean energy farm. As we have tools for energy modeling, i.e., the methods to evaluate and reorient the façades of the building to achieve maximum solar exposure or wind direction within the design logic of a project is possible, through which we can achieve the maximum potential of harvesting the energy through sun and wind. The tools can give accurate flow rates across the façade of different orientations, which

An example of coloured thin-films for solar energy generation, courtesy FG Glass

Metallic textured BIPVs, courtesy FG Glass

will help us to evaluate how much min/max energy will be produced/ optimised, adds Kumaran.

According to Kamil, the global market for zero-energy buildings is projected to achieve explosive growth from $629.3 million in 2014 to $1.4 trillion by 2035. In Europe and America, buildings consume around 40 percent of all energy – around 10 percent more than transport and create the same proportion of CO_2 emissions. That forced the governments of the countries to increase energy code stringency by implementing new building design standards - LEED Certificate, Living Building Challenge (LBC) certification and the most growing- Net Zero Energy Building (nZEB's), says Kamil. A nZEB solution means that the building uses as much energy over the course of the year as it generates from onsite renewables. Power Harvesting Cladding is a novel high-tech product developed as an answer to the architectural community to integrate solar power generation into building envelope keep focusing on architecture and aesthetics. Combining the latest technologies of a special glass treatment, newest achievements of the photovoltaic industry as a unique lamination solution, Power Harvesting Cladding provides multi-functional building material, generating clean solar energy as an add-on façade function, points out Kamil.

Ar. Mehta points out that by integrating energy harvesting systems onto building façades, one can maximise their potential energy output while decreasing their reliance on the power grid. The façades of tall buildings provide a greater amount of square footage to provide electricity and allow the building to function more self-sufficiently. In addition to this, a new system of windows, shading, and lighting will increase natural daylight inside the building and reduce energy costs.

While talking about advances in glass technology, Ar. Singh notes that earlier, glass panels were replaced by solar panels, thereby cutting out the natural light and creating un-aesthetic designs. With the advancement in technologies, we are able to create photovoltaic glass which converts light to energy. Responsive intelligent systems such as motorised shading devices, photochromic glass, employing light crystal technologies, SPD, etc. are new and upcoming technologies all over the world, adds Singh.

Rathod too spots on passive energyefficiency, like the solar-control offerings, which cut down on heat transmission, keeping the interiors cooler, even while allowing plenty of natural daylight. This would tantamount to a reduction in the use of artificial lighting and air-conditioning, and reduced electricity bills as a result.

Kachwala agrees that the most common form of energy-harvesting façade technology is BIPV systems. According to a recent study, the global BIPV market was valued at USD 16.86 billion in 2018 and is projected to increase significantly at a CAGR of 15.9% from 2019 to 2028. Such attractive numbers have unsurprisingly got many more producers of BIPV systems in the market. Higher efficiency numbers are the key to this technology picking up pace as use in façades. Developers need quicker ROIs, typically in four to five years, compared to the eight to ten years currently. "One of the upcoming solar cell technology called Perovskite solar cells have demonstrated efficiency values of 25 to 28% - and the huge monies invested in solar technology research will ensure these values will only get better with time," points out Kachwala.

Suraj talks about smart building technologies, which integrate the façade response to the internal lighting and heating conditions. On a warm day in an office building, for example, the shading devices on the façade tilt their direction to avoid direct sunlight entering the building glazing. At the same time, the internal temperature auto-adjusts to ensure a room temperature of 23-25deg and the lighting inside is brightened to compensate the reduction in natural light. That said, there is a fine balance to be achieved between the investment and operational cost-effectiveness of such cutting edge technology vs. sustainable long-term benefits of the same in every project, he adds.

Leading-edge technologies play a crucial role in terms of sustainability and operational cost-effectiveness. Truly successful façades play a vital role in driving or transforming building performance, engaging with the external environment, significantly enhancing durability and reducing energy consumption.

USE OF GLASS & SMART FAÇADES

Parametric façades are a great way to enhance both the appeal and the climatic adaptability of a building, notes Kachwala. It is also a great avenue for architects to showcase their innovative and smart design skills while amplifying the functional attributes of a building envelope. With its enormous flexibility and bespoke application adaptability, glass can be fabricated to fit in any parametric façade design. With virtually any complex shape possible, in laminated and insulated forms to suit the building's spectrophotometric requirements, glass is the product of choice that can add "smart" transparency to buildings and ensure conformance to all the building codes. With the popularity of cold bending also on the rise, glass can now take even more complex shapes and forms, observes Kachwala.

According to Rathod, glass allows infinite possibilities to architects in bringing alive their envisioned blueprints in more ways than one. Few materials can match the versatility and flexibility of glass, and it is precisely why it is lending itself seamlessly to parametric design.

According to Ar. Kale, glass is a NEVER die façade material and new inventions in glass properties and its use in parametric façade technology can change the perspective towards the glass. In a hot climate like India, the use of different types of glass in the parametric façade enables the possibility of designing the façade of climate adaptability. Low-E, frit, translucent, coloured, tinted, etched, mirrored, reflective, patterned and channel glass and various other glass types can be used by understanding the sun angle and the façade directions.

Ar. Mehta points out that improvements in the manufacturing process of glass have made it stronger, purer and thinner than ever before. These high-strength sheets can be shaped by machines, in specialised furnaces or on-site, without breaking, enabling architects to create sculptural glass buildings. These façades bend, twist and undulate, proving that in the parametric present, glass is the wave of the future.

Ar. Khozema notes that using the right kind of glass reduces energy consumption and it reduces the weight on the foundation and hence makes the building lighter as compared to constructing walls.

Ar. Kumaran explains that parametric façades are meant to achieve design solutions that are specific to internal pressures (such as user groups, lighting requirements, etc.) and optimising external parameters such as solar radiation, wind and glare, etc. Previous generation products, mostly respond to these issues in a more pre-engineered way of standardised format. Parametric methods allow us to explore the possibilities (variations) as well as optimisation of energy, and material.

Kamil adds that glass has not only given parametric façades a more premium look but enhanced the capability of a structure to integrate a conventional glass façade with incredible designs. This process has, in turn, paved the way for technological, creative and engineering advancements.

Glass, in its true form, has considerable elasticity which makes it a good building material for parametric architecture, agrees Suraj. There's no evidence that glass deteriorates overtime under stress. With its phenomenal aesthetic properties, it is also known to withstand the harshest of weather conditions. In addition, glass is also used to make materials like GFRC (Glass Fiber Reinforced Concrete) which is moldable and has an excellent environment performance (GFRC is a fire-rated material with class 'O' rating, does not corrode and is safe to handle, has acoustic properties, weather-resistant) and is very quick in its erection on-site, saving both time and cost.

Solar cells and façade glasses integrated in a parametric façade; courtesy: FG Glass

Parametric façade, New York; courtesy: FG Glass

Membranes for Optimised Energy Performance of Façades

STEPHANE RIONDET
Business Developer - Façade, Serge Ferrari India Pvt Ltd

Energy performance and energy savings are at the center of the concerns of architects and operators. Buildings-related CO2 emissions have continued to rise by around 1% per year since 2010. Buildings and construction together account for 39% of energy-related carbon dioxide (CO2) emissions. Solar protection devices equipped with membrane screens as a solution for exterior blinds or façade, reduce greenhouse gas emissions by optimising the energy performance of the building and reducing the energy needs for cooling.

The façade membranes, used as a second skin, save up to 75% of the energy used for heating and air conditioning, depending on the quality of the glazing and the location of the building. The air gap created between the building and the canvas creates an airflow that contributes to the building's energy performance.

Façade membranes, used as a solar screen, protect the buildings against the solar gain and helps in reducing energy consumption by blocking up to 100% of solar energy outside. They contribute to the finish and the aesthetics of the building, giving the building a unique identity. Metallic finishes have been developed in the past 5 years to meet the architects and market needs, special varnish for printing are used on the façade as communication support and photocatalytic membrane are used for self-cleaning benefits.

Flexible composite membranes are economical and lightweight solutions. Thanks to their flexibility, they allow all types of shapes and aesthetics. Depending on the season, the time of the day or the activity, users can open or close the blind to adapt and optimise the level of daylight in the room and limit the use of artificial light. Daylight, transparency and glare control contribute to the comfort and the wellbeing of the users.

One could improve air quality and the self-cleaning effect with TiO2 membranes specially developed for façade applications. The membranes, with other materials (such as a sound absorber), can reduce city noise. By using façade membranes, overheating can be controlled, which in turn limits heat islands in cities for human well-being.

Serge Ferrari Soltis FT 381 membraPlaza Guayarte in Guayaquil, Ecuador

A new parking structure at Rice University has a paneled façade printe

AUTOMATION IN FAÇADES & FENESTRATION

There has been a slow but very perceptible shift from the use of traditional masonry towards the use of compelling automation in façade and fenestration, observes Ar. Chitalwala. Motorised shades, switchable windows that modulate daylight and solar heat transmissions, model predictive controls for optimised performance end-user comfort, satisfaction, and acceptance of automated façade systems are the various ways automation is incorporated in façades and fenestration.

Automated façades ensure optimal use of the energy harvesting or conserving technologies used in the system, notes Ar. Gor. A façade performs multiple functions, i.e. it has to protect the users from rain, fire, theft, as well as regulate light and ventilation to ensure low energy consumption and also energy generation. If all these essentials are automated individually, the performance of the façades can be enhanced drastically. Technologies where elements of façade can be opened or closed, angles of louvers and other shading devices can be changed, based on the time of the day or depending on the seasons are already available in the market.

The new techniques used in façades by a single automating machine can control/regulate various aspects including daylight, climate, aesthetics and lighting, says Ar. Dikshit. The use of such techniques contributes to the various environment rating systems like LEED. Ar. Kumaran adds, with the help of IoT, the automation on façades and fenestrations are seamless and user-friendly. Combining with voice assistance like' Alexa 'and 'Siri', we are now able to do automated climate moderation, lighting, view and privacy control with operable elements of the façade. A 'Human-centric' design approach is considered in this automation, as things are adjusted in relation to human comfort and mood.

Technology can be provided within the glass or glazing assembly, or the functionality can be added to the façade either on the interior or exterior. In all these cases, sensors, actuators and control logic must be applied for proper functionality, points out Ar. Mehta. Traditional manually operated mechanical shading systems such as blinds or shades can be motorised and then controlled by the occupants or by sensors and building controls. In all of these cases, electric lighting should be controlled to meet occupant needs, while maximising energy efficiency and minimising electric demand. As with the fenestration controls, lighting control requires sensors (photocells or the human eye), actuation (switching or dimming), and control logic that determines what action should be taken under each set of conditions. These rigorous performance goals must be achieved with automation that is cost-effective and operates over long periods with minimal maintenance, explains Ar. Mehta. Ar. Singh agrees that automations in the façade, which can integrate motorised sun shading devices with BIM systems, are a great solution.

With improved technologies, glasses with high performance will have added solar control and insulating properties, thus maximising the benefits from the outside environment (in the form of natural light) and eliminate the excessive heats thus minimising cooling loads in our buildings that have begun to be heavily occupied, says Rathod. Static glazing, however, does not address the issue of glare, or the way of eliminating it, which can be done through dynamic glazing. Now, with the click of the button, the user is able to control the glare in the habitable space, Manufacturers of Electrochromic glazing have reached advanced levels in the technology that the tinting in the glass pane can acquire even a gradient form and therefore have an uncompromised view of the outside world with complete glare control, elucidates Rathod.

According to Kachwala, static façades have greatest limitations and the dynamic glazing that can change its light transmission, and correspondingly its heat gain-coefficient electronically is great innovations. There are now various technologies available in this space today, he adds. Special sputtered coatings, electrically charged laminate films and liquid crystal (LC) infilled units are some. While the construction technologies are strikingly different, most of these have a light transmission in the range of 1% to 50% and correspondingly the heat transmission ratios range

Merck dynamic glass from FG Glass

A mall entrance designed by FHD Consultants

EMAAR PIXEL tower by FHD Consultants

Elan Mercado, Gurugram - Aluminium elliptical louvers in pergolas inspired from European and Australian design and architecture. Courtesy: Kaenat Glass

from 0.09 to 0.40. Most of the products available in the dynamic glass category are electrochromic - giving users the flexibility to change the light and heat transmission on demand. All these systems today can be integrated into the building automation system and can be controlled by users with an app on a smartphone, reveals Kachwala.

INTERACTIVE FAÇADES - BENEFITS & LIMITATIONS

With the technological advances and easily programmable lighting systems, façades are being used as display screens for messages to be shared with people, says Ar. Gor. Through the use of sensors, façades can respond to any movements in particular areas which can be programmed. From advertisements to live gaming through mobile phones, can be projected on façades, and it acts as a digital canvas for any kind of animation.

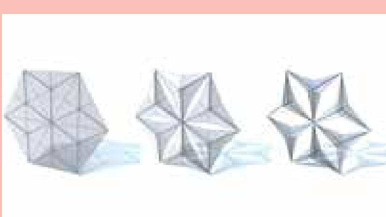
The interactive/media façade is a façade that is both aesthetically and functionally specific and in this manner states the connection between technology, architectural design, innovation and substance to new media introductions of present-day art as well as communication, explains Kamil.

The idea is that the user from within, and the viewer from outside can both interact with a dynamic 'face'. According to Ar. Dikshit, with the intelligent use of technologies, these visual interactions could be energy-saving and responsive to the exterior climate. Motion sensor lighting, pre-programmed laser effects or even projections of images or creative content visually uplift the modern cityscape. Interactive façades are now even seen as an effective tool for the propagation of social or cultural public service messages.

According to Ar. Kumaran, with electrochromic glass and liquid crystals, we are able to create media façades that are responsive, expressive and informative and in some cases entertaining. It could

Al-Bahar Towers, Abu Dhabi

Besides dynamic glass, use of dynamic shading is another upcoming trend and if given the budgets required, they are an architect's dream product! Consider the Al-Bahar Towers, in one of the world's hottest cities during summer months - Abu Dhabi. Designed by AHR (formerly Aedas UK), the double-skin façade utilises a high-performance silver low-E coated glass as the inner layer and this is further encapsulated with polytetrafluoroethylene (PTFE) based adaptive façade that automatically open or close depending on the intensity of sunlight. Adaptive façades can also be controlled manually or through pre-set timers that dictate its movement at different times of the day.



be an expressive architecture with environmentally-conscious, sustainable design – both for interiors and exteriors

Ar. Mehta notes that the term interactivity, relates to human experience with an intelligent, responsive building system. Through artificial intelligence and machine learning, this interactive architecture causes an intelligent response.

According to Ar. Singh, Switchable glass technology is becoming very popular in India, where the glass changes its tint/opacity depending on the amount of light and heat falling on its exterior surface. However, these prefabricated units are available in the market which

Façade louvers installed at Organo Naandi, Hyderabad, designed by FHD Consultants

have a size limitation. Motorised Shading devices reduces the amount of light directly falling on the glass surface, therefore reducing the heat travelling within the building, adds Singh.

Retractable sails on glass dome at Gardens by the Bay, Singapore (Automated façades)

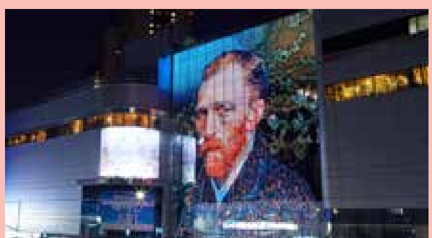
According to Kamil, bioclimatic architecture is an important new international design trend that can help to reduce building energy requirements and dependency on external resources. Bioclimatic façade architecture is about designing buildings and spaces, both the interior and exterior, but ensuring local climatic conditions are utilised to improve thermal and visual comfort.

ADVANTAGES OF MEDIA/ INTERACTIVE FAÇADES:

Today, when the buildings are becoming iconic, interactive façades act as a value add, both aesthetically and commercially, specifically in retail architecture, says Ar. Chitalwala.

Media façades allow correspondence by means of technology onto a façade as advanced media, and media architecture represents the social, cultural and financial ramifications of these façades for the instant environment, states Kamil. Interactive façades are devised through LED's. They are presently fit for yielding 135 lumens/watt so they are energy productive. They have long lifetime - 50,000 hours or increasingly if legitimately designed, notes Kamil. With LEDs, one can coordinate the light where it is needed. No light is squandered and gives rise to excellent colour rendering. Moreover, LED's don't wash out

Interactive Façades – Responsive & Expressive



An example of interactive media façade (courtesy G-Smatt)

The term interactive façade is self-explanatory - façades that are expressive, responsive, can change the appearance on demand and interact in ways that allow it to function as more than just a simple building envelope. While many iterations of this definition are possible, currently the most accepted and available technology available is LED integrated façades, more commonly called media façades. These façades can play content on demand, with varying resolution and colour saturations, and can transform a façade into a giant billboard or simply a great city landmark. Technologies for creating these media screens vary from LEDs embedded within a laminated glass unit to creating an LED-mesh network as a second skin. Since this is a relatively new technology, volumes today are relatively low at high price points - limiting their overall acceptance. However, their potential as a revenue generation source by creating giant advertisements can result in innovative ways to proliferate their use. As an example, manufacturers can offer this product at greatly subsidised costs and getting a share of the revenue generated through advertisement over a few years, thereby reducing the initial capital expenditure for the developers.

(Tariq Kachwala, Director, FG Glass)

hues like other light sources, for example, fluorescents, making them ideal for presentations and retail applications.

LIMITATIONS OF MEDIA/ INTERACTIVE FAÇADES:

The limitations of interactive façades are that they leave less scope for creativity aspect and it is left being monotonous and sometimes dull, note Ar. Chitalwala, Ar. Mehta and Ar. Suraj. Since most of the interactive façades are based on lighting systems, this technology is used on the exterior surfaces and generally targeted for viewers outside the building, says Ar. Gor. With the installation of interactive systems, most of the building façades typically will have the same façade dictated and certain plans that prevent any creativity, dynamism and spatial quality within and out of the project. The connection between the interior and exterior of the building is not created.

In media façades, LEDs are costly for starting expense and they must be provided with the right voltage and current at a steady stream, notes Kamil. The customary LED screens, especially in huge sizes, have gigantic ecological results that keep them from being deployed as building façades. They produce a huge amount of warmth that can't be dispersed without the utilisation of air-conditioners and don't permit the free flow of air and light from outside to inside, thus affecting the indoor condition and aesthetics.

Other disadvantages are light scattering and light pollution. Light scatterings that can annoy people on shining into houses. There is also a waste of electrical power. Light pollution, also known as photo pollution, (the presence of anthropogenic and artificial light in the night environment) is worsened by excessive, misdirected or obtrusive use of light.

Dancing with Nature, Hyderabad. Material used - MS steel fabricated frame with thermally stable pine; designed by Urban Zen

IMPORTANT TOOLS FOR CREATING FUTURE FAÇADES

The use of new and efficient tools such as Building Information Modelling (BIM) is remodelling the process of architectural design, says Ar. Dikshit. It integrates the design and technical data of the building on a single platform. Through this process, we actually perceive the entire building. It provides efficiency in productivity and time saving, which makes a combination of visual and geometric reasoning. Ar Suraj agrees that BIM is the future of architectural design. According to Ar. Chitalwala, investing in technologies like BIM allows designers distil options down to a set of criteria that meet the aesthetic ambitions and tactical requirements, ensuring that these are met with optimised environmental parameters.

Ar. Suraj too opines that the tool BIM enables designers to explore the building form real-time and derive key insights into the thermal, daylight and solar performance, informing decisions pertaining to the building orientation, solar shading, glazing, etc. thus, saving cost, mitigating error and increasing efficiency. The model can be analysed for structural loading, MEP clashes and contains all material specifications with their actual quantity estimates. The possibilities are endless, however, the software itself requires further refinement in terms of interface and performance on data heavy models, observes Suraj. Also, the power of the software is harnessed only when used in conjunction with MEP, structural and façade models, which means the entire team on board need to be well versed with the program and trained before a project.

3D printing is a very promising tool for future façades, says Ar. Gor. It has an exceptional ability to brace the relationship between

A project by ALUMIL Systems India Pvt Ltd

A project by Kapil Mehta & Associates

technology and art. With Additive Manufacturing (AM) method used in this system, the amount of waste generated can be brought down significantly with the use of precise quantities and specific geometries. Also, it is a much faster method than conventional ones, but the usage has been limited due to the high budget required. With attempts being made to bring down the costs, it can really be a boon to the industry.

Ar. Kumaran insists on the use of tools like Rhino3d with 'GrassHopper3D' for modelling parametric façades to explore various design possibilities. "We do Revit modelling for development and construction details. We use GH plugins along with 'Open Foam' for wind and 'DaySim' for solar simulations. We do climate analysis in 'Ecotect' and 'Climate consultant'," he adds.

Ar. Prachita Singh relays on softwares and plugin available in the market from Grasshopper, ecotect. Some other softwares available are honey bee plugin for Rhino. "These softwares are not used only for energy modelling or wind tunnel analysis, but they are able to compute how the façade or fenestration responds to various parameters such as light, heat, fluid design. One is able to extract fabrication details and understand

GlassPro Live and Signature Façades

Saint-Gobain has developed unique digital services: The Glass ProLive and the Signature Façade, which will shape the façades of the future.

GlassPro Live (GPL): The decision-making of glass appearance in façades is largely based on 1' x 1' samples or small-sized physical mock-ups. The final appearance of the façade post-installation can have some discrepancies as compared to what was seen in the mock-up stage, due to sky conditions, angle of viewing, environment, etc. GlassPro Live is a digital mock-up tool that enables the AEC community to take a call on the glass to be used in the façade based on appearance – giving them the freedom to simulate the whole façade entirely with glass and not get restricted to small samples. It is a revolutionary physico-realistic visualisation of glass on the building geometry to understand the appearance of different glass products on the façade. The GPL requires 3d model – 3ds max, 2D Drawings – Plan and Elevation in AutoCAD, rendered image for reference to arrive at a full-scale physical-realistic rendering. It uses actual physical measurements of the façade for representing the glass in renders and this is the reason why these renders are a more accurate representation of the glass than traditional photorealistic rendering.

Benefits of GPL: GPL is a decision-making tool for stakeholders in the façade design process. It makes possible visualisation of glass options on larger façades than in samples. It can simplify the glass selection process, allowing one to view different products from different angles in different sky conditions. As compared to actual physical mock-ups, it ensures a lesser carbon footprint.

Signature Façade: Signature Façade is a tool to visualise glass products on different building types and different patterns. It helps to understand the appearance of glass in different building types. Signature Façade uses physico-realistic visualisation technology from Saint-Gobain to represent the appearance of different glass products. When multiple glasses are to be used on the same façade, this tool simplifies the selection process by the concept of mix and match.

(Hemant Rathod, National Head - Structural Glass Solutions, Saint-Gobain India Private Limited (Glass Business))

Section - Togetherments at Miiyapur, Hyderabad. Designed by FHD Consultants

each element 3 dimensionally. Which enables us to pre plan in case of any issue and finish the project on time", says Ar. Singh.

FUTURE OPPORTUNITIES FOR SMART FAÇADES, ADAPTIVE FAÇADES & INTEGRATED FAÇADES

Smart façades, adaptive façades and integrated façades - all are systems to keep the energy efficiency of the building in control. These can collaboratively bring exceptional results if assimilated suitably.

India is the world's fourth largest energy consumer and fifth largest source of greenhouse gas emissions, says Kamil. With the building sector contributing 35% of the total electricity consumption and projected five-fold growth in the constructed area anticipated by 2030 - from a 21 billion Sq ft in 2005 to 104 billion Sq ft, building energy efficiency plays a major role in managing energy use in India. Building façade design and engineering is critical considering air conditioning loads through solar heat control, natural ventilation and night cooling, effective daylighting, and even free passive solar heating in cooler climates.

According to Ar. Gor, the approach towards façade design has to be on all-inclusive learning from the nature of structural systems, including organic designs, biomorphic designs, etc. Innovations in the field of biomimetic façade systems have a lot of opportunities. With smart and adaptive façades being used to respond to the environment, adding biomimetic properties to them through programming, or materials that can mimic how nature responds to environmental conditions can be a step forward.

Ar. Mehta too votes for Integrated Façade Systems (IFSs) - where different technological solutions are integrated to improve performance and to lower the impact of the building—are still an underdeveloped yet a fast-growing field of research. Such systems can reduce solar heat gain, lower air conditioning costs and lessen the glare while maximising the use of natural light and help produce energy.

Ar. Chitalwala and Ar. Mehta says that developing adaptive façade systems, represent a growing field of research and exploration. These systems react to a single parametric situation and adapt dynamically to changes they detect in stimuli. Integrated façades, where different technological solutions are integrated to improve performance and to lower the impact of the building, is a fast-growing field of research with a broad scope of application and significant positive impact on the environment. Today, with the use of technology buildings are getting smarter. Energy conservation usually starts from the façade perspective of a building. Architects have been connecting their designs with building management systems, while integrating them with the IOD. Buildings may also change its behavioural pattern with the climatic and geographical conditions. Apart from architects, specific consultants need to be involved in the process of designing façades in order to make the built forms more energy-efficient and sustainable.

Integration of green, photovoltaic and responsive interfaces with relation to climate and human comfort will be the future in opposition to the static, hermetically sealed façades, predicts Ar. Kumaran. Integration of green will be the important aspect for the ever increasing chemical and noise pollution in the air. A 'Biophilic' approach has already been adapted in other developed countries in response to global environmental catastrophes.

CONCLUSION

With the manufacturers offering state-of-the-art intelligent materials that can respond to the environment, architects have begun their adoption in the buildings they create. These dynamic material solutions powered by the Internet of Things (IoT) can be integrated with the overall building management system to build intelligent buildings that are efficient in use and easy to maintain. It is a matter of time and increasing rate of adoption before futuristic building becomes commonplace in the Indian skyline. Continuous innovations bring in products and solutions and serve the façades of today and tomorrow in an intelligent, energy-efficient and sustainable manner. It is this sense of agility from manufacturers, and curiosity and sense of experimentation from designers that will help us leapfrog into the arena of 'futuristic façades'.

Mahindra Livespaces, Pune. Materials - Glass, concrete and aluminium fins. Designed by Aum Architects