Smarter Façades for Fine-Tuned Comfort Control

By Maryruth Belsey Priebe

Building envelopes have never worked as hard as those being designed with stunning bioresponsive innovations that move and respond to external and internal conditions to achieve the ideal temperature and light controls indoors. These smart façades are solving some of the most challenging problems for the built environment as structures take on increasingly complex designs and the world demands higher efficiency. And the results have never been more captivating.

Using Dynamic Façades to Augment Passive House Designs

Passivhaus designs are renowned for their ability to significantly reduce energy consumption for lighting, heating, and cooling by carefully orienting and designing buildings for the perfect balance of passive energy collection and reflection. But one complaint often levelled against the Passivhaus concept is the lack of windows on the non-southern sides of the building – a strategy used to minimize solar heat gain.

Smart façades can take many forms, and the Living Light house developed by a team in Tennessee for the Washington, DC Solar Decathlon 2011, uses a double façade system consisting of an outer pane of tempered R-1 glass and an inner plane composed of fixed R-11.4 suspended film tempered glass. Between the two panes of glass are motorized horizontal blinds that are programmed to provide the ideal mix of daylighting and solar radiation throughout the year depending on the season.

Two additional features improve the energy efficiency of this design. The first is a heat harvesting system that allows warm air captured between the panes to be put through a recovery ventilator to supply pre-heated air to the interior of the home if needed. The second is the ability to operate the panels to allow outside air into the house to regulate the interior temperature, again depending on the time of year. Together, these features make it possible to glaze virtually any surface of a building without compromising passive house goals.

Similar in concept to the Living Light house design are the functional layers designed by companies like Schüco. These layers constantly change and move to adjust the exterior of the building depending on the time of day. Opaque and transparent layers are moved over glazed surfaces as needed to provide shade or light depending on the amount of solar radiation available and needed. These dynamic façades can overcome this Passivhaus design challenge by opening up sides of buildings that would traditionally be always shaded.

In another take on the smart façade, the Kiefer Technic Showroom in Bad Gleichenberg, Austria, was created with 112 metal tiles controlled by a mechanical system to create a dynamic, changing building exterior. Using 56 different engines, the system can adjust both the light and temperature levels in any of the rooms to obtain the optimal conditions for current activities. Though there have been questions about how much energy is required to keep the metal tiles in motion, the concept certainly has garnered a lot of attention, both at home and internationally, as a high-tech solution for building efficiency.

Applying IT and Electropolymeric Technology for Higher Thermal and Informational Performance

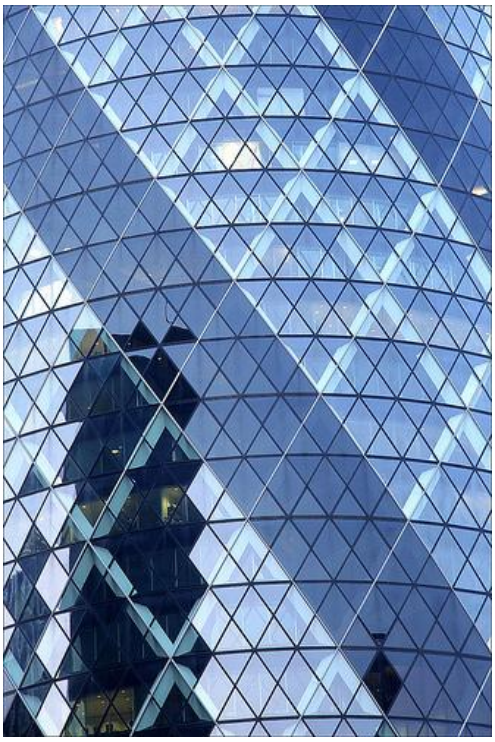
One of the challenges of traditional shading devices is the inability to response automatically to changes in daylight conditions. But a unique scientific group at The Center for Architecture, Science, and Ecology (CASE), is working on a concept called electropolymeric dynamic daylighting that will solve this problem. By using energy display technology, CASE researchers are able to create dynamic daylighting by controlling the spectral and geometric output of glazed surfaces.

The concept involves insulated glazing units (IGUs) that are multi-layered and variably translucent. Not only will they automatically control the level of transparency of various surfaces, adding more or less daylight as sunlight levels change, they can be controlled by users to provide more control on individual panes of glass. The vision is to produce a system with 16 transparency options that can be adjusted either manually or automatically, using interesting displays, including messages and geometric shapes of all colors and sizes.

With electropolymeric dynamic daylighting systems (EDDS), the translucency and pattern of a piece of glass can be changed throughout the day to reduce glare,

minimize electricity for lighting, and ensure optimal levels of solar heat gain. Additionally, a polymeric layer may be switched on to block infrared rays during warmer months to prevent overheating, and switched off to provide passive solar heating during colder months.

Double Skin Ventilated Façades for Temperature Control and Building Protection



Gherkin Building in London with Ventilated Façade via Flickr loop_oh

Another smart façade design that has been around for decades is that of a double skin façade. This concept works by cladding a traditional building exterior with a second skin that is positioned anywhere from 20 cm to 2 meters from the conventional building envelope. The space between the two layers allows for air to flow, to provide ventilation that offers benefits for heating and cooling systems. Some ventilated façades are also constructed using insulated exterior materials to add another layer that retains heat in cold months and protects against overheating in warm months.

The Gherkin building in London, UK, makes use of this technique. By creating gaps between the floors, air is allowed to naturally ventilate through the building through six shafts. Additionally, two layers of glazing on the exterior of the building insulate the building by controlling the movement of heat.

Together, these two layers help to warm and cool the building depending on the season. During warm months, warm air generated between the two cladding layers is vented through the shafts out through the building, thereby reducing energy required for air conditioning. During cool winter months, this same warm air is redistributed through the building naturally to reduce heating loads. The result is a building that is said to use half of the energy a building of its size would typically consume.[1]

KfW IPEX-Bank West Arcade with double façade wind energy exterior

Another great example of an energy efficient façade that integrates the double skin concept is the KfW Bank headquarters building in Frankfurt, Germany. Designed by Sauerbruch Hutton, the Westarkade is composed of red, blue, and green panels of glass (which appear colourless from certain angles), some long and some short arranged in a sawtooth fashion. The long panes of glass are fixed in place, while the short sides move mechanically as operational like vents. Information from a roof-mounted weather station such as temperature, sunlight, wind pressure and speed are relayed to the system to determine the position of the panes of glass.

In this design, building occupants are permitted to operate their windows to provide a personalized level of comfort not often seen in larger corporate buildings of this size. The skins are also fitted with automated blinds which help to regulate solar heat gain. And like the Gherkin, the building is also designed with a raised floor ventilation system and a heat recovery system to further increase the building's energy efficiency. In all, the building aims to consume a paltry 50% of the energy of an average European office building.[2]

Double skin building façades help to further reduce energy consumption for heating and cooling by protecting against thermal bridging. This problem occurs in areas where insulation is interrupted at the junctions between partitions, separating walls, and openings. By adding a second layer of cladding to a building, thermal bridges can be minimized or eliminated altogether, thereby mitigating any heat transfer that might have occurred at those junctions.

Not only do ventilated façades offer energy savings, they can also sound proof a building by insulating it against external noise. This depends on the types of materials used based on how well they reflect, absorb, or transmit sound, but when engineered correctly, these façades help to increase the comfort of building occupants by creating a quieter interior environment.

What's more, double skin building façades also offer protection for building materials. By layering materials over the load-bearing exterior of the building, inner layers are protected against stress from rain, snow, wind, hail, and other assaults from the environment, thereby increasing the life of the building materials.

Big Benefits from Dynamic Façades for Energy Consumption

The environmental and financial benefits of efficient façades are numerous. Most importantly, by providing much more fine-tuned control over solar heat gain, the energy required for heating and cooling can be significantly decreased. In many cases, a high-performance building façade through automated shading may allow for a reduction in the size of chillers and heating systems. When incorporated early in the building design process to influence critical HVAC design decisions, dynamic façades can significantly reduce system size.

Ventilated façades further cut energy consumption for cooling and offer increased comfort and control for building occupants. Of course, by providing greater control over lighting conditions, building lighting designs and energy consumption are also optimized, providing additional electricity savings and comfort for those using the spaces. Some research indicates that dynamic façade technologies can provide energy savings for cooling up to 40%, and reduce lighting energy consumption by up to 60%.[3]

Given that Germany has been recognized as one of the largest markets for energy efficient buildings in Europe, along with France, it's perhaps not surprising that many of the advances in smart building façades are coming out of this region. Not only is Germany the birthplace of the Passivhaus Institut, half of all German cities now require new public buildings to meet Passivhaus standards, likely the most energy-efficient green building standards in the world.[4] This combined with the abandonment of nuclear energy for the country has pushed officials to look for energy savings in building designs. In Germany and around the world, as material technologies, energy prices, and climate change continue to influence public policy and building costs, smart building technologies will no doubt grow in popularity and use.

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Maryruth has a special interest in cleantech and green buildings. In recent years, Maryruth has worked as the senior editor of The Green Economy magazine, is a regular blogger for several green business ventures, and has contributed to the editorial content of not one, but two eco-living websites: www.ecolife.com and www.GreenYour.com. You can learn more about Maryruth's work by visiting her site, www.jadecreative.com.

References

1. *30 St Mary Axe: A gherkin to suit all tastes*. (2008). Retrieved 2012, from Building.co.uk: http://www.building.co.uk/30-st-mary-axe-a-gherkin-to-suit-all-tastes/3111783.article

2. *Colorful, breathing building facade*. (2011, October 5). Retrieved January 2012, from SmartPlanet: http://www.smartplanet.com/blog/design-architecture/colorful-breathing-building-facade/976

3. *Integration of Dynamic Facades with other Building Systems*. (2008). Retrieved 2012, from Continental Automated Buildings Association: http://www.caba.org/resources/Documents/IS-2008-18.pdf

4. *Energy-Efficient Buildings: Europe*. (2011). Retrieved 2012, from Pike Research: http://www.pikeresearch.com/research/energy-efficient-buildings-europe