INTELLIGENT BUILDING FACADES

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ABSTRACT

A responsive building envelops are one that facilitates co-evolutionary interaction between the building, the inhabitant and the environment in a meaningful way. One of the primary performance mandates for high-performance envelopes has been energy optimization and reduction in the use of resources and their inhabitants.

Key words: Intelligent facades, Thermally reactive, Operational membranes, Biomimetics, Double facades.


1. INTRODUCTION

Building facades architecture put their impact far deeper than this. They are climatic moderators in the sense they connect the inside and outside environments. The passage of air, solar radiation, sound, and moisture through the façade affect air quality, temperature, humidity, and sound levels, and hence influence our sense of well being.

Beyond this there are very subtle impacts that affect our mood, such as the view and our sense of time. So the materials that compose the façade are vitally important, and the way it is punctuated with windows all contribute as to whether the built environment is fresh, airy, and has lots of daylight. Lessons can be learnt from vernacular architecture and also from Nature. This, blended with a judicious use of emerging technologies, can offer facades which are sustainable in terms of energy consumption but also give pleasure and are healthy for the occupants.

New technologies, smart materials and distributed systems have spurred the introduction of biological models for understanding the behavior and design of building systems and their controls. A descriptive lexicon has emerged that employs decidedly biological terminology in conceptualizing architectural design the building’s envelope can be considered quite literally as a complex membrane capable of energy, material and information exchanges. It can be designed to operate, as part of a holistic building metabolism and morphology, and will often be connected to other parts of the building, including sensors, actuators and command wires from the building management system.
2. DOUBLE SKIN FACADES

The **double-skin facade** is a system of building consisting of two skins, or facades, placed in such a way that air flows in the intermediate cavity. The ventilation of the cavity can be natural, fan supported or mechanical. Apart from the type of the ventilation inside the cavity, the origin and destination of the air can differ depending mostly on climatic conditions, the use, the location, the occupational hours of the building and the HVAC strategy.

The glass skins can be single or double glazing units with a distance from 20 cm up to 2 metres. Often, for protection and heat extraction reasons during the cooling period, solar shading devices are placed inside the cavity.

The cavity between the two skins may be either naturally or mechanically ventilated. In cool climates the solar gain within the cavity may be circulated to the occupied space to offset heating requirements, while in hot climates the cavity may be vented out of the building to mitigate solar gain and decrease the cooling load. In each case the assumption is that a higher insulative value may be achieved by using this glazing configuration over a conventional glazing configuration.

Recent studies showed that the energy performance of a building connected to a double-skin facade can be improved both in the cold and the warm season or in cold and warm climates by optimizing the ventilation strategy of the facade.
Figure 2 Performance of Double skin facade in all seasons

Our double-skin façade is key to the sustainability credentials that earned a six Green Star rating for 1 Bligh Street, Sydney. The double skin provides great solar control but also permits the use of very clear glass – making the most of Sydney Harbour views.

3. OPERATIONAL MEMBRANES

Facades membranes are the continuous covering on building envelope. It allows a building to express, communicate and interact with its environment. Weatherproof breather membrane for transparent and open-joint facades. Membranes are permanently resistant to U.V. rays. It represents the perfect choice for creative ventilated façades behind transparent and open-joint cladding materials. The wide colour range available gives architects freedom of expression, as amazing colour effects and combinations can be designed.

Figure 3 Synthetic membrane on the envelope

Open to water vapour diffusion, rainproof and wind tight, facades membranes offers an excellent thermal protection. It is suitable for installation behind closed or slightly open cladding materials light, efficient and easy to install, they have a unique qualities for all kind of non-transparent, ventilated façades.
We’ve seen high-rise skins that adapt to the environment at the press of a button and others that manage indoor climates by magically breathing in and out. The more muscle you put into a structure — and the less you require of people — the better off for the environment.

4. INTELLIGENT FACADES

Intelligent facade has only been around for a few short decades, helped along by recent advances in chemical and material science. And over the past three years, we’ve seen the category boom. Smart surfaces and materials can play a significant role in intelligent, adaptive and responsive envelopes because of these intrinsic properties. Examples of smart materials used in high-performance building skins include: aerogel – the synthetic low-density translucent material used in window glazing, phase changing materials micro-encapsulated wax, salt hydrates, thermo chromic polymer films, and building integrated photovoltaic. One of the most significant characteristics of smart materials is that they have the ability to transform their physical properties and/or shape, or to exchange energy without requiring an external source of power. Hence, they are extremely attractive to building designers who aim to increase functionality and performance while at the same time reducing energy use.

Below, check out some of the most interesting building facades to come across in recent years: From a thermal metal screen that curls up when it’s hot, to a titanium dioxide-covered wall that scrubs the air of pollutants.

4.1. An Energy-Producing Algae Facade

This 2,150-square-foot wall, unveiled in Germany this spring, is the result of three years of testing by a group of designers from Splitterwerk Architects and Arup. Its vibrant characteristic isn’t just an aesthetic flourish — in fact, it's tinted by millions of microscopic algae plants, which are being fed nutrients and oxygen to spur biomass production. Facilitated by direct sunlight, the speedily-growing little cells end up heating the water, and that heat is harvested by the system and stored for use in the building.

![Algae sandwich in the window envelope](https://example.com/algae-facade.png)

**Figure 4** Algae sandwich in the window envelope

4.2. A Light-Responsive Facade That “Breathes”

This pair of Abu Dhabi towers are sheathed in a thin skin of glass — fashionable, but not ideal for the desert climate. So the architects at Aedas designed a special, secondary sun screen that deflects some of the glare without permanently blocking the views. At night they all fold, so they all close, so you’ll see more of the facade. It's using an old technique in a modern way, which also responds to the aspiration of the emirate to take a leadership role in the area of sustainability.
4.3. A Facade That Eats Smog

Back in 2011, the chemical company Alcoa unveiled a remarkable technology that could clean the air around it. The material contained titanium dioxide, which effectively "scrubbed" the air of toxins by releasing spongy free radicals that could eliminate pollutants. The stuff has made appearances on streets, clothing, and architecture since then—most recently, on the sun screen of a new Mexico City hospital. The hospital is cloaked in a 300-foot-long skin of Prosolve tiles. The technology is based on the same process: As air filters around the sponge-shaped structures, UV-light-activated free radicals destroy any existing pollutants, leaving the air cleaner for the patients inside. Even the shape of the sun screen is significant: It creates turbulence and slows down air flow around the building, while scattering the UV light needed to activate the chemical reaction.

4.4. A Low-Tech, Operable Skin

In Melbourne, Sean Godsell Architects sheathed RMIT’s design school in thousands of small, sandblasted glass circles—each affixed to a central rod. Based on humidity and temperature inside the building, these rods pivot automatically to facilitate (or block) the flow of air through the facade.
4.5. A Metal Mesh That Reacts to Heat

Bloom, a temporary installation by USC architecture professor Doris Kim Sung, isn't technically a facade. Snug's research deals with biomimetics, or how architecture can mimic the human body. This sun shade was made with thermo bimetal—a material that's actually a laminate of two different metals, each with its own thermal expansion coefficient. That means that each side reacts differently to sunlight, expanding and contracting at different rates—causing tension between the two surfaces, and ultimately, a curling effect. So when the surface gets hot, the thin panels on the shade curl up to allow more air to pass through to the space below—and when it cools down, it closes up again.

5. CONCLUSION

A responsive building envelops are one that facilitates co-evolutionary interaction between the building, the inhabitant and the environment in a meaningful way. One of the primary performance mandates for high-performance envelopes has been energy optimization and reduction in the use of resources and their inhabitants.

Within the rush of various technologies into the field of architecture new aspects has emerged into the idea of building façade and how it respond to the environment where more complicated design approaches and technologies have been introduced to the building facades using new high-performance glazing, improved shading and solar control systems, and greater use of automate controls. These technologies are known as interactive facades which should respond intelligently and reliably to the changing outdoor conditions and internal performance needs where it will exploit available natural energies for lighting, heating and
ventilation and be able to provide energy savings compared to conventional technologies, and at the same time maintain optimal thermal comfort conditions. As photovoltaic costs may decrease in the future, these onsite power systems will be integrated within the glass skin and these facades will become local, non-polluting energy suppliers to the building.

With this in mind, the future design of high-performance buildings is expected to involve active façade technologies, acting in intelligent collaboration with HVAC and lighting systems to produce comfortable indoor environments with reduced energy consumption.

REFERENCES