THE PRODUCT PUBLICATION OF THE U.S. ARCHITECTURAL MARKET

Architectural PRODUCTS

SPECIAL ISSUE

PRODUCTS FOR GREEN/SUSTAINABLE FACILITIES

October 2014

Thanks to advances in technology, as well as a greater understanding of the human condition, building scientists believe facades must evolve to a more dynamic state that better mirrors how people themselves, change, during the course of the day.

FACADES

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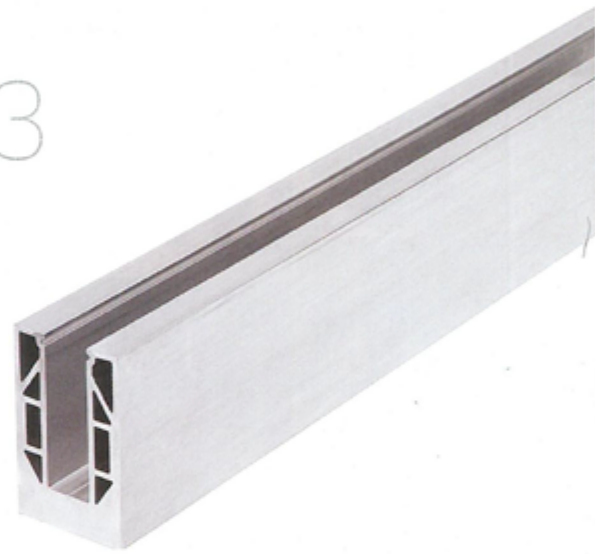

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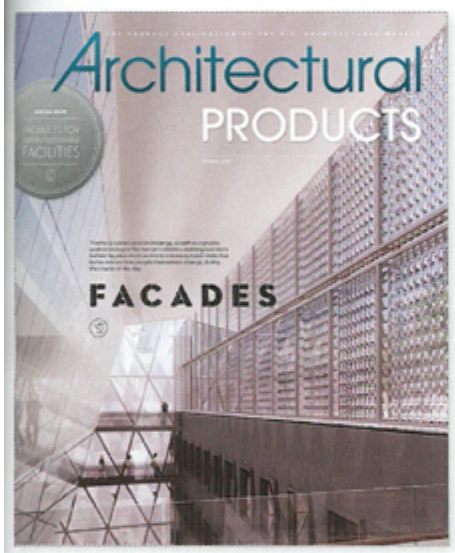

FEATURES

DESIGN KEYS: The Changing Nature of Facades

Dynamic Design

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Full Forward. Researchers at the Center for Architecture, Science & Ecology at Rensselaer Polytechnic in conjunction with SOM, are marrying innovations in seemingly unrelated technology with traditional cladding concepts for some interesting and interactive results.

by Megan Mazzocco

ON THE COVER

HeliOptix in Action
At the addition for the Fashion Institute of Technology in New York City, SHoP Architects is employing the transparent photovoltaic system developed by the Center for Architecture, Science & Ecology at Rensselaer Polytechnic. **Page 48.**

Image: SHoP Architects

Architectural Products Magazine, Volume 12, Number 8
Architectural Products (ISSN 1557-4830) is published monthly except combined issues in Jan/Feb and July/Aug by Construction Business Media, LLC, 579 N. First Bank Dr., Suite 220, Palatine, IL 60067. Periodicals postage paid at Palatine, IL and additional mailing offices.

POSTMASTER:
Send address changes to *Architectural Products Magazine*, 440 Quadrangle Drive, Suite E, Bolingbrook, IL 60440.

SUBSCRIPTION INQUIRIES:
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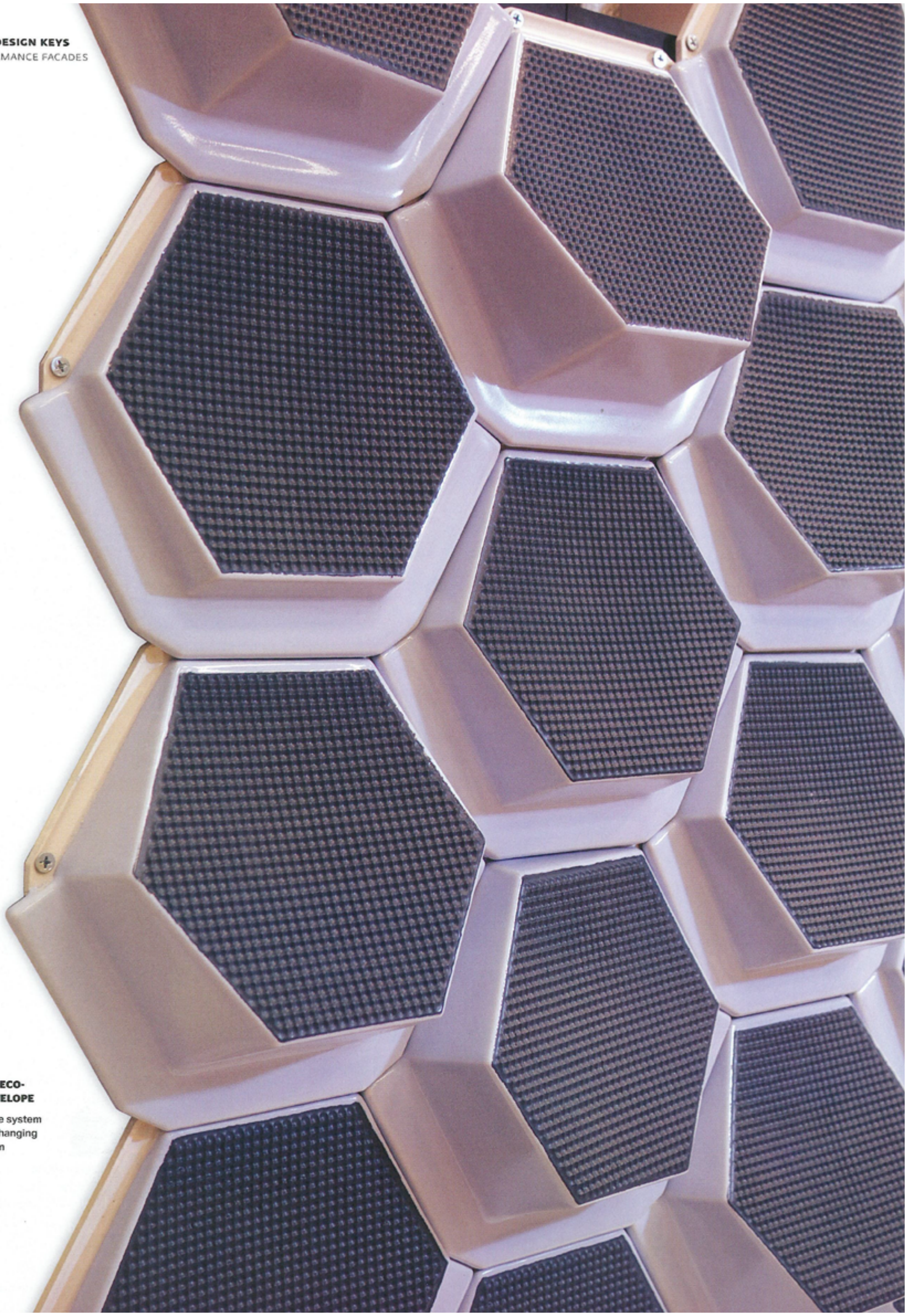
DEPARTMENTS



▷ ADVANCED ECO-CERAMIC ENVELOPE

Ceramic facade system with a phase-changing material system

High-performance buildings require facades that are not just idle, neutral barriers to the elements. Going forward, intelligent building skins will accommodate occupant-comfort levels while energy collected at the facade may be able to power the entire building.

THE NEW SHAPE OF FACADES

By **Megan Mazzocco,** Senior Editor

What will the facade of the future look like? Dan Nall, a sustainability expert with New York-based MEP firm Syska-Hennessy, has a pretty good idea: It will deliver high energy performance, provide lots of natural light and a view—all while controlling glare and minimizing heating and cooling loads.

The good news is that a lot of this is already possible as several building technologies, such as shading devices, mechanically actuated exterior blinds and electrochromic glass, can help envelopes attain a significant increase in performance.

That said, as thinking toward net-zero, net-positive and energy-independent buildings becomes more of the norm, thinking about facades must shift into warp speed, for tomorrow's facades must do more than merely keep performance in line, they must multitask.

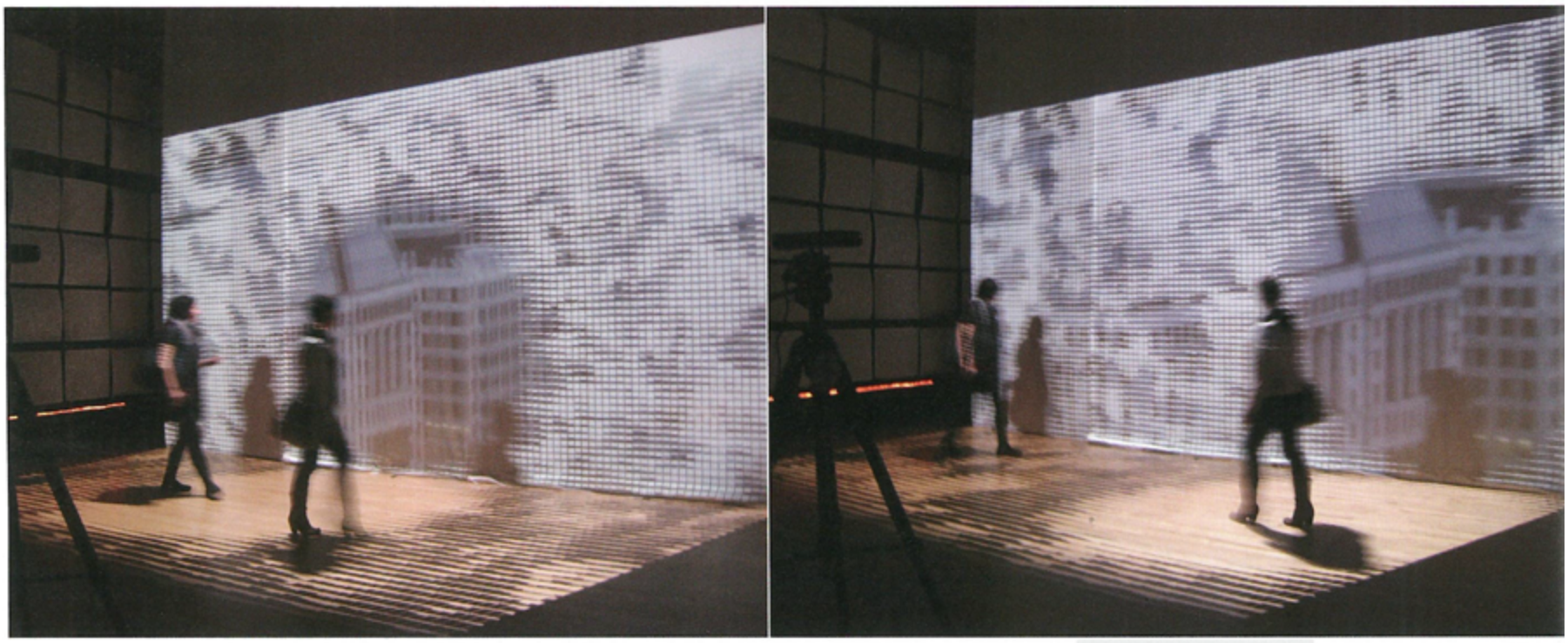
"People inside are changing constantly, so a static response from the building is not the way to go," says Nick Novelli, PhD Candidate at the Center for Architecture, Science & Ecology (CASE)—an initiative of Rensselaer Polytechnic and SOM.

Building science experts like Novelli and his colleague, Brandon Andow, are taking a second look at technologies in other sectors to develop the next generation of high-performance facades. For example, by combining Jumbotron screens, solar energy or phase-changing materials with conventional envelope components, facade performance can be boosted into hyperdrive. Such 'hyper'-facades, according to Novelli, could monitor exterior conditions, facilitate human comfort, and provide daylight and views, in addition to capturing and converting energy to be used onsite.

ADVANCED ECO-CERAMIC ENVELOPE

(Left) CASE's ceramic facade system which integrates phase-changing material."Here, the advantage of ceramics is that we've embedded as much intelligence as possible into the tile form's texture, color and shape," says Nick Novelli with CASE. The variations in surface texture affect turbulence, which will affect the performance of the material, specifically its heat transfer rate. In other words, the rougher texture creates a more turbulent flow, allowing more time to transfer heat to or from that tile. This allows a group of tiles, all the same shape and color, to perform uniquely based on location, climate, and orientation.

▷ More on ceramics page 50



ELECTROPOLYMERIC DYNAMIC DAYLIGHTING SYSTEM

Electropolymeric glass responds to the presence of people in interior spaces by "opening" to let in diffuse light and views. A photograph of a life-sized proof-of-concept of the EDDS. "Behind the tripod there are 15 people writing code to make the facade react to the people in the space," reveals CASE's Brandon Andow.

Electropolymeric Tech

On the subject of Jumbotrons, the CASE researchers have been developing a daylighting system based on electropolymeric technology. While it sounds like electrochromic glass technology, it is not, and it's an important distinction according to Andow. The latter, as far as offering daylight and views coupled with improved building performance, has enjoyed significant adoption, according to Brandon Tinianov, a senior director of business development with electrochromic glass manufacturer, View. "It is an enabling technology for net zero buildings," he says.

While he doesn't disagree, Andow points out that the adoption of electrochromic glass has been slow, in his opinion, due to its dark blue hue. First, he notes it can be a challenging aesthetic to work with, and second, there are health-related concerns, he says, as exposure to too much blue-spectrum light could possibly interfere with circadian rhythms. While that particular controversy is still being studied, Andow says technology can't come at the expense of the human element. In fact, balancing building engineers' aspirations for optimal performance with occupants' desires for creature comforts, can be difficult, but Andow and Novelli find that taking a human-centric approach leads to the most successful building performance compromise. "We look at the ecology between architecture and the environment and what the occupants need in there," Novelli says.

On to the subject of electrochromic glass, the researchers find it a noteworthy facade innovation in that it is solid-state technology. That's important, according to Andow, because building facade systems with fewer or smaller moving parts become more cost effective and durable. "New materials and technologies are getting smaller—on micro- and nano-scales—to reduce the mechanical movement as much as possible," says Andow.

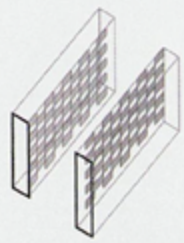
Based on this foundation, CASE has developed a next generation of dynamic glass that they feel hits the mark in allowing views without solar gain; plus, it does not turn blue. Dubbed an **Electropolymeric Dynamic Daylighting System** (EDDS), it is based on technology developed for outdoor billboards and Jumbotrons, and behaves, according to Andow, as if it contains thousands of independently automated "roller shades in miniature."

Like other kinetic facade systems with sophisticated sensors, the system responds to environmental conditions outside; but unlike a performance-driven system, it differentiates between occupied and unoccupied spaces. Specifically, electropolymeric glass responds to the presence of people in interior spaces by "opening" to let in diffuse light and views. "People will generally override any energy efficiency measures depending on what their preferences are," notes Andow. "We can offset that to provide for occupant comfort while maintaining the same building energy performance."

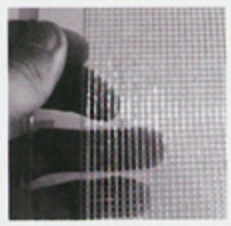
In other words, while one region of the facade grants occupants' wishes for daylighting and views, another portion of the facade will compensate, thereby maintaining optimal levels of energy performance.

Electropolymeric Dynamic Daylighting System Details

Electropolymeric (EAP) film



EDDS technology assembly



EDDS prototype

EDDS integrated with facade

Based on technology developed for outdoor billboards and Jumbotrons, an EDDS behaves as if it contains thousands of independently automated "roller shades in miniature."

A Crystal-Clear Photovoltaic?

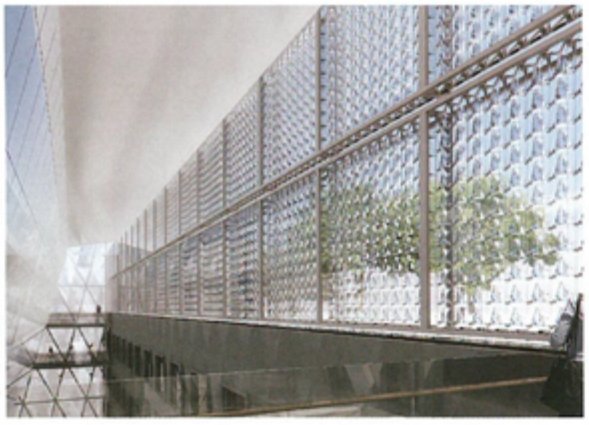
Another area of high-performance building technology that's getting a boost from CASE is photovoltaics. It has long been the quest of many designers to develop crystal-clear thin-film photovoltaics in order to take advantage of light and views while collecting energy on all fronts. Alas, the opacity of the photovoltaics, like electrochromic glass, remains a drawback to aesthetics; also, the efficiencies are low due to sub-optimal orientation.

Taking that into consideration, CASE's Novelli and Andow devised a system that uses high-efficiency solar cells about the size of a postage stamp. "In order to realize the original intent, we've integrated the system in a way that is vibrant and welcoming," says Novelli.

In a nutshell, the PV cells are formed like glass pyramids that track the sun across the sky, collecting the energy generated by both heat and light. The modules intercept the direct energy, and the rest of the light that penetrates past this unorthodox facade is diffuse. But it does more than just stop solar gain from entering the space: the thermal energy is used to power absorption chilling; after that, it can drive a building's hot water system. "When we separate the solar energy into these two components, we can use a lot more of that energy in the buildings," explains Novelli.

This variation on intelligent glass facades keeps them crystal clear while generating a significant amount of energy—especially in the hottest, sunniest climates.

The prototype glass photovoltaic system developed by CASE/Rensselaer Polytechnic.



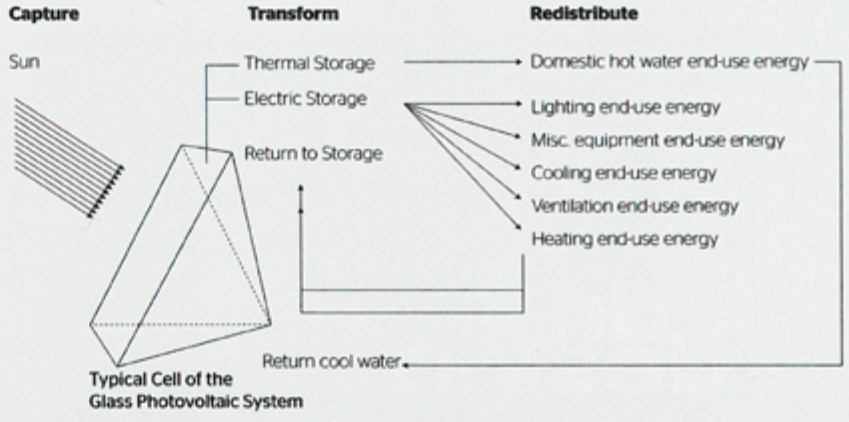
Images Courtesy of SHoP Architects

BUILDING INTEGRATED CONCENTRATING SOLAR FACADE

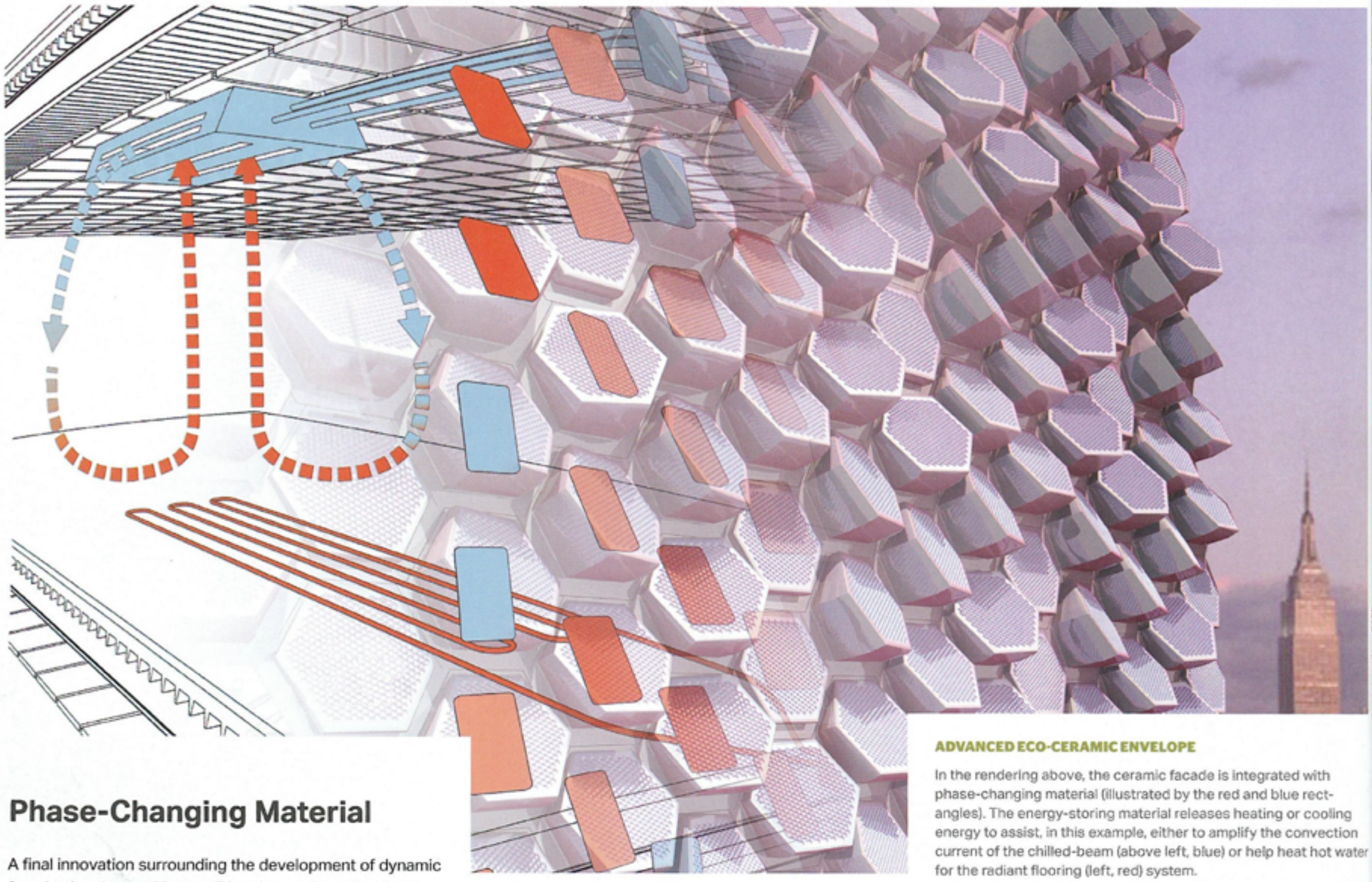
A rendering of the addition to the Fashion Institute of Technology, New York, using CASE's semi-transparent PV cell concept.

PHOTOVOLTAIC LIGHT ENERGY/HEAT ENERGY DISTRIBUTION

The PV cells are formed like glass pyramids that track the sun across the sky, collecting the energy generated by both heat and light. The modules intercept the direct energy, and the rest of the light behind this facade is diffuse. Thermal energy is used to power absorption chilling; after that, it drives the building's hot water system.



Typical Cell of the Glass Photovoltaic System



ADVANCED ECO-CERAMIC ENVELOPE

In the rendering above, the ceramic facade is integrated with phase-changing material (illustrated by the red and blue rectangles). The energy-storing material releases heating or cooling energy to assist, in this example, either to amplify the convection current of the chilled-beam (above left, blue) or help heat hot water for the radiant flooring (left, red) system.

Phase-Changing Material

A final innovation surrounding the development of dynamic facades involves pairing traditional ceramic material with phase-changing materials. Certainly, the buzz phrase associated with high-performance facades has been continuous insulation, typically linked to R-factors and U-factors. In fact, the number of continuously insulated panel manufacturers that have emerged in the past five years suggests that they've found the formula for truly high-performance facades. Ceramic's longevity makes it attractive to building owners and the endless variations in color, shape and size appeal to designers, but it suffers in the continuous insulation category.

When CASE researchers recognized ceramic's cost-effective versatility, they decided to see what would happen if phase-changing material (PCM) was added to the equation. In turn, they manipulated the shape, color and surface finish of the ceramic material to activate the PCM. "Here, the advantage of ceramics is that we've embedded as much intelligence as possible into the tile form's texture, color and shape," says Novelli.

The variations in surface texture affect turbulence, which will affect the heat transfer rate: a rougher texture creates a more turbulent flow, allowing more time to transfer heat to or from that tile. This allows a group of tiles, all the same shape and color, to perform uniquely based on location, climate, and orientation on the building. "The great advantage is that it's free to highly manipulate the form of the ceramics; we can really stretch that resource," he adds. The heat energy captured by the PCM system is then transferred to power building systems.

Integrate, Don't Litigate!

Novelli and Andow are modest about the breakthrough research they've participated in; they say that the systems of the future simply take "dumb" technology that's gotten along well all these years, and "pump it up on steroids." But if elegantly incorporating modern material advances into conventional building envelopes to produce high performance facade systems is no big deal, what's the hurdle to adoption?

Unfortunately, in the U.S., one significant hurdle is the entanglement of systems and the threat of litigation. This prompts owners, designers, consultants and contractors to maintain strict boundaries where responsibility for their system ends and the other guy's begins. "As soon as liability starts overlapping there's a pushback in this country," says Andow.

Even simple building technologies become highly complex when they are integrated as systems. This creates a challenge to the integrated design process, as well as a learning curve in the trades. "It's different than what they're used to: the idea that your facade is connected with your lighting—we still have a lot of work to do to get that message out," say Andow and Novelli. Above all, adds Andow, "the final arbiter to all of this is: do people want it?"

When researchers recognized ceramic's cost-effective, and creative versatility, they decided to manipulate the shape, color and surface finish to better activate the properties of the phase changing material.