A Performative Dance of Agency

Emerging material opportunities are fundamentally shifting our current expectations of building envelope functionality – both in terms of environmental performance and for aesthetic expression and user experience. A fundamental change is underway: until this point, there haven't been building envelope technologies that have provoked the engagement of occupants to the degree that they offer now. Never before have we had materials that can respond to environmental inputs while simultaneously interacting so subtly or explicitly with the preferences, moods, and individual expressions of their individual authors and inhabitants.

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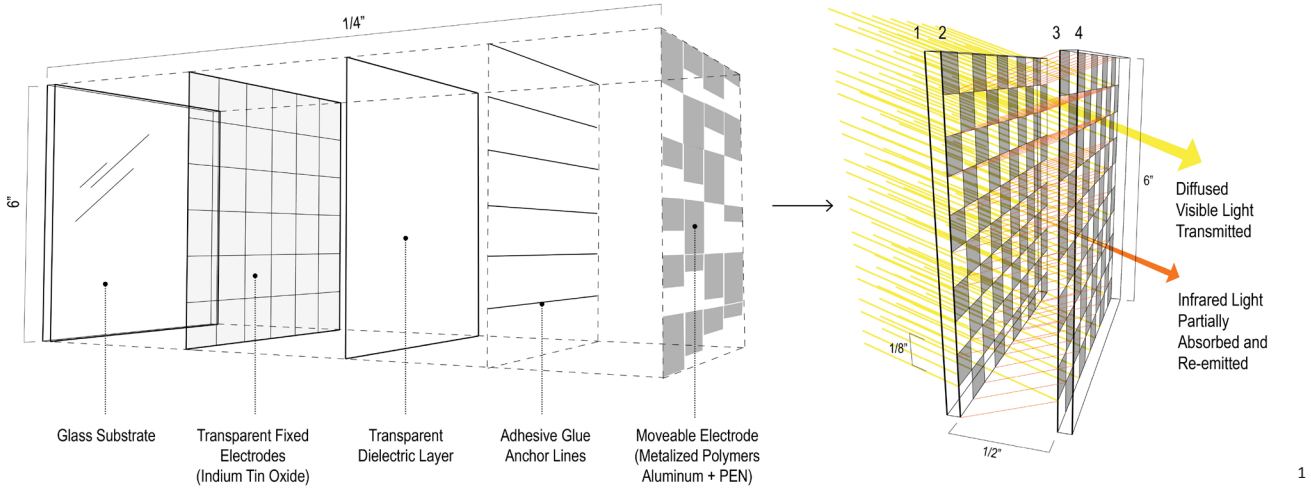
REIMAGINING BUILDING ENVELOPE PERFORMANCE

Micro material innovations investigating the environmental performance potentials of electroactive polymers (EAPs), such as Decker Yeadon's Homeostatic Façade or ETHZ's Shape Shift capitalize on the extreme flexibility, responsiveness, lightness, and smooth actuation of EAP materials integrated into the building envelope for a controlled or automated response. Recent systems prototypes for an Electropolymeric Dynamic Daylighting System (EDDS), developed at the Rensselaer Polytechnic Institute Center for Architecture Science and Ecology (CASE), demonstrate how the technical transfer of EAP micromaterials to dynamic architectural surfaces could offer a both/and condition relative to the schism between energy and aesthetics. The EDDS embeds electropolymeric display (EPD) technology[1] or 'micro-muscles', into the interior surfaces of insulated glazing units for responsive building envelopes that provide dynamic solar control with a range of choices over the clarity of views, daylighting effects, information patterning and occupant responsiveness[2] (Figure 1). Experimentation with immersive and interactive simulations affords the opportunity to observe and record bioresponsive feedback loops, in which the display materials respond to multiple environmental and/or aesthetic inputs from both ambient conditions and design preferences.[3] Critically, this design research allows for the development of a computational design tool: a series of algorithms and programmable code that provides the opportunity to both measure and simulate switchable dynamic patterns within the glazed envelopes and receive real time interpretations of the multiple energetic and informational performance effects of the various formal choices. As a result of this design experimentation, a new set of

architectural criteria embodying environmental performance and user-driven aesthetics is pushing for far greater adaptability of materials at the nanoscale. It's also suggesting a new improvisational architecture continuously in flux, whereby certain material parameters are pre-assigned by the architect, but the behaviors and visual outcomes are a result of the collision of solar- and occupant-responsive interfaces, atmospheres, and effects. These interfaces strengthen the building's energy profile, but also have profound implications for occupant psychological and physiological well-being.

With the objectives of building energy self-sufficiency and on-site net zero energy, emerging material systems point towards other physical phenomena for glazed building envelopes to operate as a transfer function between external stimuli and internal desires and demands. Current research in multifunctional building envelopes at Rensselaer/CASE is using earth-abundant nano-structured materials operating within insulated glazing units (IGU) for energy harvesting, increased environmental comfort, user control and information display.[4] The controlled manipulation of nanoscale surface phenomena is allowing for an unprecedented responsiveness to a multitude of bioclimatic and biological inputs. Research at the Lawrence Berkeley National Laboratory (LBNL) has demonstrated



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novel independent control over the visible and near infrared subspectra through thin film nanocrystals in order to address the heating and cooling loads on buildings while maintaining visible transparency for daylighting.[5] The spectral control of solar radiation could alter the way we psychologically perceive architectural surfaces, spaces and light, and in the way we physiologically maintain human circadian rhythm entrainment. The filtration of different wavelengths affect our bodies' metabolism, energetics, reproductive physiology, and embryonic development.[6] Based on these material innovations we will increasingly be able to program precise mechanical, electrical, and optical behaviors of materials to respond to a range of environmental inputs, building demands, and physiological needs and individual desires., Environmental and aesthetic criteria at the building scale are informing the design and engineering of new material behaviors at the micro and nanoscale. This multiscalar approach is leading to technical strategies for solar tracking and spectral selectivity for improved glazing performance, and it's also leading to design strategies that amplify the variable patterning, information exchange, and biomorphic expression of buildings. Crucially, data- and

Figure 1: EDDS details of the elecropolymeric material assembly on a glass substrate and applied to surfaces two and three of a double-paned IGU and optimized in this instance for environmental performance.

desire-driven responsive building envelopes are shifting our prejudices of sustainable design as a rigid set of quantitative performance metrics towards flexible interfaces that visibly express what Andrew Pickering might call a performative "dance of agency"[7] between occupant desires, material behaviors, and fluctuating energy flows. Participants become active agents in the modulation of their built environments.

A PERFORMATIVE DANCE OF AGENCY

The architectural implications of the new multifunctional envelope materials are momentous. The control over electropolymeric or nanocrystal material densities can optically blur the distinction between two-dimensional surfaces and three-dimensional space, altering our perception and interpretation of architectural identity and form. These material breakthroughs are redefining the meaning of performance for building envelope technologies, transforming their role as static and sealed enclosures to material tectonics in flux. In a proposal for a public plaza, the dynamic swarm-like effects of a responsive building interface are informed by both pedestrian activity below in conjunction with the system's tracking and filtration of sunlight (Figure 2). Legitimized in the building science community by their ability to address quantitative energy performance benchmarks, novel envelope material possibilities are challenging traditional architectural notions of boundary and space, physics and energy, experience and perception, and author and interpreter. Their remarkable malleability and responsiveness will enable building envelopes to effortlessly capitalize on local environmental flows. At the same time it also subjects them to the wants, desires and whims of the people who reside in their presence. With these new info-material possibilities, what types of pattern will be expressed? And who will curate this information? These questions are beginning to be addressed through the design of control algorithms and programmable behaviors of building envelope functionality that enable simultaneous bioclimatic and occupant response.

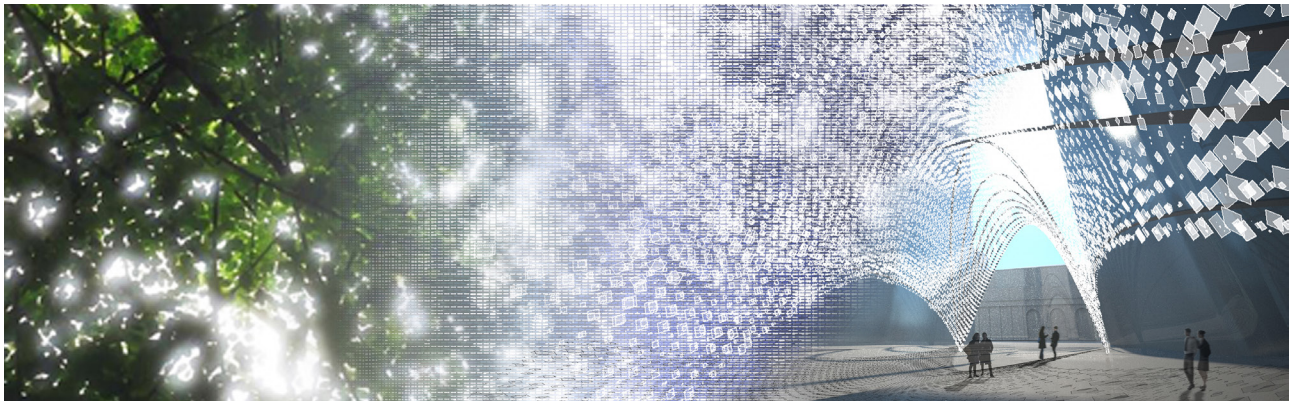

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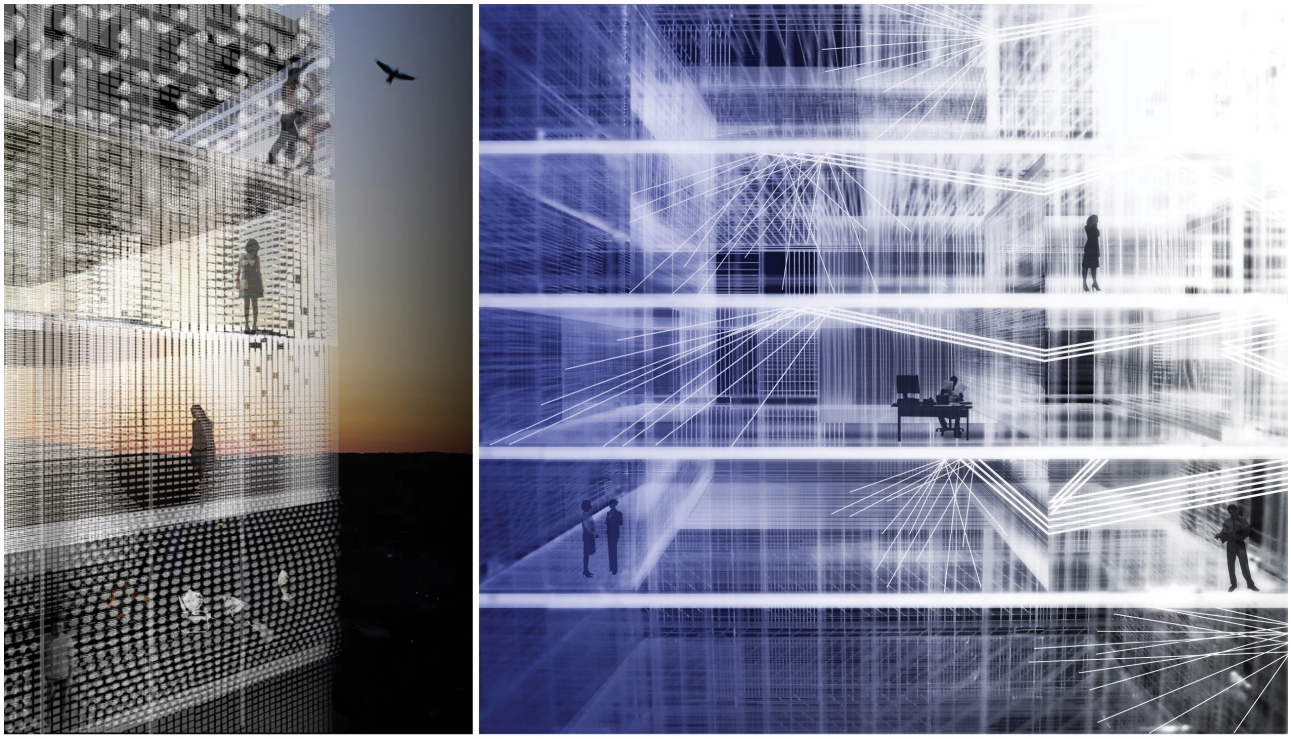
Figure 2: Design proposal from CASE/SOM for a public plaza examining how fluctuating programmatic activities inform the atmospheric patterning of responsive electropolymeric materials for dynamically filtering sunlight.

Although existing environmental control systems remain restricted in flexibility and human input, there are interesting precedents in human-machine entanglement and art that incorporate human intervention within the performance of responsive systems. Experimental work in the 1950's by cybernetician Gordon Pask explored an emergent relationship between the human and machine through an invention called The MusiColour Machine. MusiColour was a performance system of colored lights that illuminated in concert with audio input from a human performer (i.e. a musician on an instrument). Using the musician's frequency and rhythm as its two inputs, MusiColour manipulated its colored light

outputs in such a way that it becomes another live performer, creating a unique environment of colored lights with every iteration.[8] The result is a performance between two extremely complex and dynamic systems engaging with each other in an improvisational dance of agency.[7] Here, new methods for negotiating human agency with a responsive system break out of the symmetrical feedback loop, resulting in unexpected and emergent environmental and sensorial experiences from which artist and audience can learn. Pickering suggests that this multi-agent hybrid leads to ontology in action, whereby a performance was a joint product of a human-machine assemblage from which performer had to find out what constituted a synesthetic relation between sound and light and how to achieve it. He goes on to suggest that this search process leads to a temporal emergence of desire rather than of a preconceived goal that governs a performance."[7] The responsive system moves beyond its performance goals of displaying choreographed light and color into an extension of human performer, expressing emotion and desire.



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In the process of incorporating human agency in architectural environments, environmental- and occupant-responsive building envelopes raise questions of power that concern individual desire and control with building regulations focused on energy efficiency. How can a control system regulated for energy efficiency allow for human intervention, when human behavior is often considered a weak link in the energy conservation equation? Will people be rewarded for energy-conscious behavior or punished for abusing their freedom? How will they react knowing restrictions are in place? These questions highlight ethical concerns between global energy goals and the well-being of individual inhabitants, making the design of hybridized control systems that negotiate these criteria seem nearly impossible. But perhaps multifunctional building envelopes can offer socio-technical insight to the designers and engineers of these systems. As

Figure 3: Multiple identities meet on the exterior and interior responsive interfaces for momentary combinations of transparent, patterned or diffused surfaces.

Sherry Turkle notes, people adopt technologies, not necessarily for what technologies do for them in a pragmatic sense, but for how technologies make them feel. When we call technologies "tools," we underestimate their evocative power. We make our technologies, and they, in turn, shape us.[9] The responsive facade is not simply an autonomous machine working to control solar heat gain. It instead is an evolving performance between human and material, both informing and being informed by the occupants' desires for vibrant expression or preferences for privacy. While the system empowers its participants through interactive and evolving performance, it is not devoid of authorship. The responsive facade still relies a control system designed with intentions. The authoritative role of the designer becomes ambiguous to his participants. User empowerment comes with participant agency that adopts and learns from the design framework set forth by the performance criteria and technological structure. Human preferences, needs and ideas evolve based on their exposure to the technology itself. Through this ontology in action, the coupling of a design framework and material behavior could hybridize performance goals by co-constructing individual desires for empowerment and expression with that of building energy performance.

The simultaneous performance may result in an improvisational "dance of agency" whereby environmental and sensorial experiences emerge from a responsive human-material assemblage. The multifunctional building envelope moves beyond its energy performance goals and into an extension of human performer, expressing emotion and desire through architectural and atmospheric effects. Through digital or gestural interfaces we can signal the behavior of architectural surfaces to bathe us in sunlight for certain hours of the day or shade our eyes through position tracking. We can upload personal patterns, images or graphics to the building envelope itself. With endless material configurations dynamically operating at increasingly precise scales, the infinite possible outcomes for buildings are both fascinating and bizarre. Questions of ownership and authorship come into play: how does the responsive building envelope negotiate not only bioclimatic flows and individual desires, but multi-user demands and desires for expression or privacy? These questions are being explored through new multi-user interactive simulation techniques and human factors experimentation at the human and interior scale.

In the context of architectural discourse, on the one hand, the 'insiders' can leverage the sleek and invisible performance characteristics of intelligent materials to achieve their formal, spatial, or surface ideologies without sacrificing appearance. On the other hand, the 'outsiders' have less environmental constraints but are faced with the challenge of defining a common language for ecological architecture. Will the 'outsiders' leverage the logic of the 'insiders' to communicate a common ideology? Or will a new hybrid emerge? Perhaps the question isn't 'what is the formal language of ecological design?' It's 'how can ecological design enable multiple readings, interpretations, and degrees of user engagement?' The environment schism isn't something to be resolved, but rather systems such as the EDDS offer a both/and condition, where energy and aesthetics are informing each other, unable to be separated. In this dance of agency, one foot slides along the 'energy' spectrum and the other in 'aesthetics'. While this dance may not necessarily define a new ecological form, it generates a new ecosophical[10] language capable of embodying multiple architectural ideologies and agendas. Regardless of the outcome at the macroscale, the potential of micro and nano-materials to dynamically define shape, space, figure, form and identity

situates architectural ideologies in a both/and position within the logic-cause debate. It's not the two-faced architect who is residing in the schism of this battle; it is now multiple identities residing in one architecture (Figure 3).

MULTIFACETED ARCHITECTURAL IDENTITY

Performance comes in many guises for these micro- and nanostructured intelligent materials. The precise control over their surface properties for the spectral modulation of incoming solar radiation allows them to temporarily assume the appearance of optically transparent glass. The thin film nanocrystal materials at LBNL would allow for dynamic glazing to reversibly modulate transparency in the infrared region while essentially maintaining a high visible transparency. The ability for reversible transparency allows for a momentary expression of structure and the machine aesthetic, fulfilling the modernist universal ideology of form and space while satisfying environmental demands for reducing heat gain.

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The recent reemergence of pattern thinking in architecture reminiscent of the postmodern era demonstrates desires for symbolic content to be icongraphically expressed in architecture, particularly on the façade. Increased attention to surfaces, pattern design, and ornamentation are strategies for communicating meaning architecturally. In contrast to its modern predecessors, the postmodern sensibility embraced all things contextual, particular, plural, and performative, while emphasizing the expression of individual (as opposed to universal) identity politics. According to Mark Garcia, "postmodernist patterns opposed the hygienic, white, functional, light, and rational ones of Modernism with the fragmented, de-centered, heterogeneous, disembodying, formless, and illusory ones that reflected the fragile contemporary subject and the now more problematic spaces of social and everyday life".[11] While Robert Venturi and Denise Scott Brown called to reinvigorate the symbolic content of architecture through pure sign, their reliance on surface iconography in their formal analysis overlooked other critical architectural vectors such as bioclimatic flows, human scale, localized cultural connections, patterns of use, and interior and exterior spatial relationships. Their communicative value operated at the level of the iconographic which prevented a more sensuous spatial experience and the penetration of deeper levels of cultural meaning.[12] Another precedent that points to the aesthetic potential of environmental effects appears on Reyner Banham's The

Figure 4: Systems like the EDDS allow for a both/and sensibility relative to modernist concerns for spatial transparency and postmodern preoccupations with "pop" signs and symbols on a two-dimensional surface.

Architecture of the Well-tempered Environment. Citing the lighting displays of Las Vegas, he writes, "The point of studying Las Vegas, ultimately, would be to see an example of how far environmental technology can be driven beyond the confines of architectural practice by designers (for better or worse) are not inhibited by the traditions of architectonic culture, training, and taste."[13] Systems like the EDDS allow for a both/and sensibility relative to modernist concerns for spatial transparency and postmodern preoccupations with "pop" signs and symbols on a two-dimensional surface (Figure 4).

A revamped interest in values such as responsiveness, adaptability, bioclimatic diversity, communicative meaning and cultural expression can be seen in contemporary spatial pattern designs and mediated surfaces. However, the ability to achieve more than one of these criteria is difficult. Many of these projects strive to enable a clear human connection within our transitory, multi-cultural society, but actually reflect a socio-ecological divide despite their "multistatic, multidimensional, and multifunctional" performance aspirations.[14] Making the shift to interactive and dynamic architecture through the innovative application of micro- and nanomaterials offers opportunities to take advantage of the variability that is available, and allows for a transformation from manufactured to mediated environments.

DESIRES FOR MEDIA AND MEDIATION

Within the last ten years there have been considerable efforts made by architects, media designers, and technology experts to integrate the previously disconnected layer of the "urban screen" with the building itself through a hybrid media façade structure. In some instances, the media facades appear to be 'draped' over a three-dimensional surface for added depth, as in the BIX façade by architects realities:united. In addition to generating display content that implies an architectural ornamentation,[15] media façades are also being employed within genres of interactive or communicative art, for example in Rafael Lozano-Hemmer's Body Movies.[16] Many of these mediated surfaces are pushing the envelope through the use of emerging digital technologies, systems, interactions, scales, and identity play. These recent installations have led to remarkable visual effects at the architectural scale, transforming a building's presence diurnally and in relationship to depth perception, communication interfaces, and the urban context. While the communicative potential can empower people and transform a building's identity, in the end many media facades are one-liners. Focused primarily on a visual and interactive social agenda, they're spatially and environmentally challenged, often having little to do with the architectural program or the inhabitants. Despite the implementation of low-impact, zero-energy, or transparent media facades, the energy required to power these projects has no ecological gain. However, interactive mediated architectural surfaces still seek architectural multidimensionality. Other works by realities:united and UNStudio focus on architecture's participation in the reproduction of media society rather than simply transforming buildings into a dynamic visual medium. In social media applications, such as Blinkenlights, the goal is to create a balanced communicative interface which contains various social media tools and their aligned patterns of behavior.

Reimagining building envelope performance through new materials makes it possible for architecture to embody both socio-political and environmental agendas. Together with the new techniques and materials, a design approach

for mediating information and energy offers opportunities for architecture to engage the senses of building inhabitants and the public context, socially and environmentally, individually and collectively (Figure 5). A hybrid of agendas and techniques for implementation will soon exist. Assuming as much, how can architectural space create mediated three-dimensional environments that promote diversity and the exchange of energy, people, and information? As designers encountering new material possibilities and palettes, we are increasingly responsible for implementing them into the built environment in meaningful ways. Multifunctional materials will gradually seep into our architectural palettes, and we may choose to simply accept their predetermined functionalities for what they are or participate in designing their criteria for response. If we participate, what will be the motivations for choreographing their formal compositions? And what effect will these decisions have on a building's spatial experience and architectural identity?

TOWARD USER EMPOWERMENT

It should be emphasized: performance-driven and culturally-driven design are not necessarily at odds. When considering the design of mediated environments and enclosures, a synthesis of ecological concerns and the pluralistic desires of building users allude to a new kind of spatial experience. Both the interior and exterior effects of the architecture have the potential to become specialized—customized to individual preferences. These special effects are a product of the re-activated individual modifying the building skin in pursuit of one's conception of environmental comfort and aesthetic predilections. In the process an individual expression of one's own identity emerges. The result is a diversified experience that is at once sustainable and empowering.

The possibilities of occupant control over the visual qualities of building envelopes could have significant impacts on the way exterior facades are perceived and interior spaces are experienced. Introducing individual agency--and perhaps most importantly, various degrees of choice--to the expression of the architecture opens up an adaptive opportunity not only for building-integrated energy performance, but also for redefining and diversifying cultural expectations for visual and thermal comfort. Variability and choice could lead to greater satisfaction of building occupants while meeting the requirements for the reduction of energy consumption in buildings. The accessible control over optically dynamic glazing allows for individuals to remotely interact with and program the modulation of natural light and surface patterning, while also offering the potential for establishing a flexible socio-cultural or commercial identity that is visible throughout the interior spaces or across the exterior surfaces. These atmospheric effects can be experienced both internally and externally at the scale of the individual, or through collective participation. This adaptive quality allows these experiences to keep pace not only with the temporally specific demands of users, but with the increasingly ephemeral quality of contemporary culture.

The atmospheric and spatial variation of mediated light and information can offer a stimulating experience that collapses notions of energy, adaptability, and symbolic expression rendered through the surfaces and experienced both internally and externally. Whether a building envelope takes the form of an expressive pattern or visual play between surface, space and perception, a hybrid introduces opportunities for the existing modern curtain wall to channel

symbolic significance through active user participation in the control of visibly dynamic surfaces and atmospheres. This thus breaks free from the universalizing and homogenizing tendencies and false assumptions of contemporary sustainable architecture into a more culturally sensitive and expressive form of space-making.

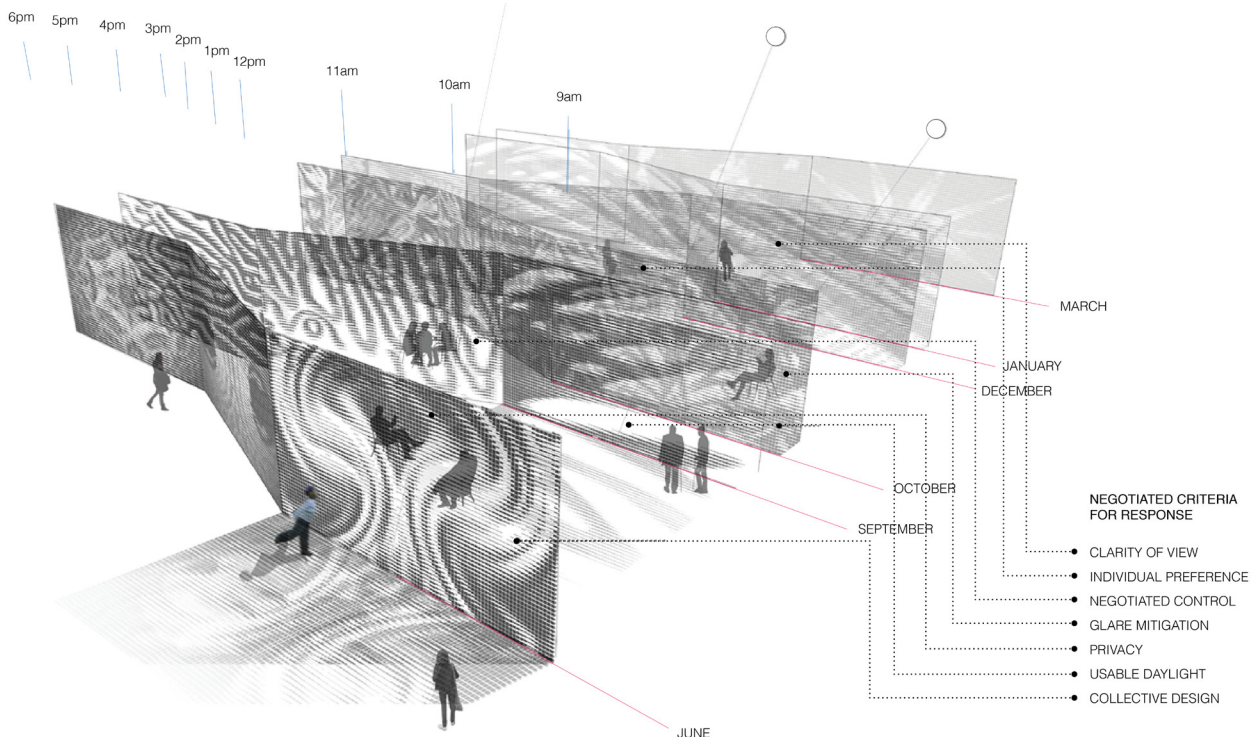

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Figure 5: Examples of proposed design formations and fluctuating visual effects through the active response to expanded performance criteria

BALANCING AUTHORSHIP AND AGENCY

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