The Per[form]ance of Mediated Environments

"This view of architecture is essentially an epiphenomenon, dependent on socioeconomic, political, and technological process for its various states and transformations." — K. Michael Hays

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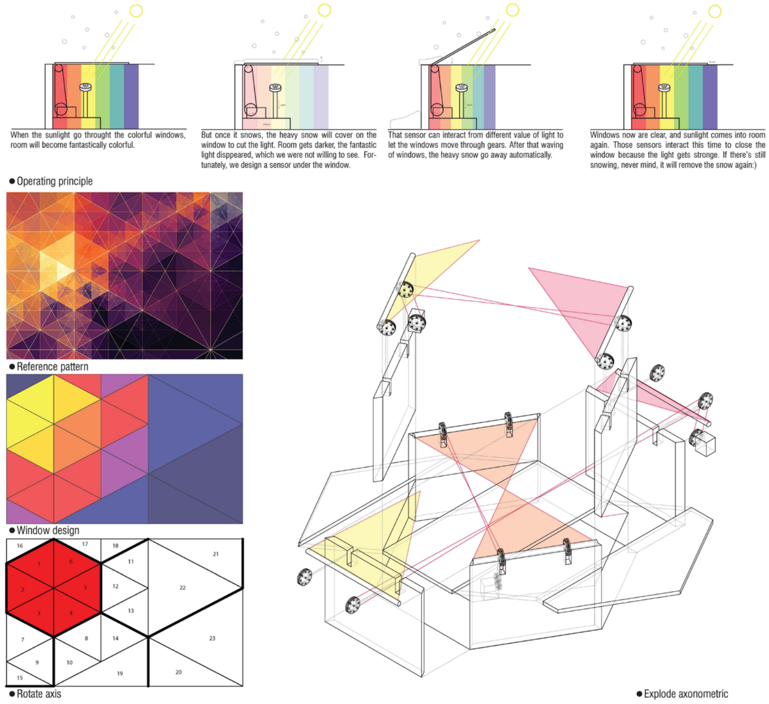
Today's physical world is becoming increasingly informed and shaped by the virtual and the digital. Everyday activities are largely removed from specific edifices or gravity-bound sites and increasingly managed through electronic gadgetry and websites. Depositing a check in the bank once required carrying a piece of paper to a built structure, but now it is simply a matter of some finger taps and a photograph. As virtual reality and smart object integration become progressively pervasive it will challenge the need or desire for distinctive, identifiable and unyielding physical space. Architectural form in the digital condition will not evaporate but it will increasingly be informed by contingencies rather than individual authorship.

Under the heading, "Architecture as an Instrument of Culture" Michael Hays describes in the quote highlighted above a contingent position—architecture as a side effect, a by-product, a secondary phenomenon, dependent on outside forces for direction and identity.[1] As one of the named forces, emerging technological processes, specifically "intelligent" objects and virtual reality with real world intersections, promise to make architecture one of the "things" in the "internet of things". Architecture in this context is a network element acted upon and recognized through other linked components. But the objects in the internet of things are also positioned uniquely unto themselves and maintaining their own identity. They act and are acted upon. Contingency understood this way is not dependency, it is mediation.

To particularize this condition the term "Mediated Environments" is used. As described by Michael Fox and Miles Kemp in Interactive Architecture "Mediated environments intervene, reconcile, arbitrate deficiencies and extend capabilities."[2] How design and construction tools overlap between the virtual and physical and how space might increasingly be defined through digital media, is the subject of the presented research. To reconsider the relationship between technology and form, a series of research was done utilizing two distinct methodologies.

The de-emphasis of the physical environment in favor of a virtual one may initially seem like a cause for concern for architects; however, the more optimistic vision recognizes that



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virtual environments and digital tools create an entirely new realm by which, for which, and through which the architect may practice. How that overlap between the digital and physical is manipulated, how space is defined through digital media, is a prime opportunity for reconsidering architecture as we know it.

According to Elizabeth Grosz, the virtual has actually always been a part of our environment.

> *"The virtual reality of computer space is fundamentally no different from the virtual reality of writing, reading, drawing, or even thinking: the virtual is the space of emergence of the new, the unthought, the unrealized, which at every moment loads the presence of the present with supplementarity, redoubling a world through parallel universes, universes that might have been." The difference now is in the promise of current technology to deliver that unforeseen universe via cyberspace, virtual reality, and the internet of things.*[3]

This research was done to explore those unforeseen possibilities. It was a series of projects assigned to and fulfilled in partnership with graduate students at Syracuse University. The initial method engaged digital media as an interactive tool. The second method explored digital media as a material for defining space in the physical environment.

METHOD 1—CONTINGENCY THROUGH INTEGRATED INTELLIGENCE

Method 1 began with an investigation and brainstorming exercise intended to identify the opportunities which embedded intelligence, as most commonly evidenced in the Internet of Things, creates for architecture. The overarching question posed was, "How are interactive environments and responsive architecture already changing how space is defined and form determined?" More specific questions and prompts included "What are innovative solutions for responsively controlling daylighting within buildings? What intelligent systems exist for controlling thermal conditions & ventilation in architecture? In clothing or cars? Find and describe projects with acoustic user interactivity. By what means can COLOR be interactive? What's the role of touch in interactive architecture? Describe kinetics in architecture? Are there responsive energy generation systems?"

Figure 1: Snow flower uses sensor technology to identify the presence of snow, and toss it off, allowing colored light transmission to the space below. Physical protoype model and diagram.

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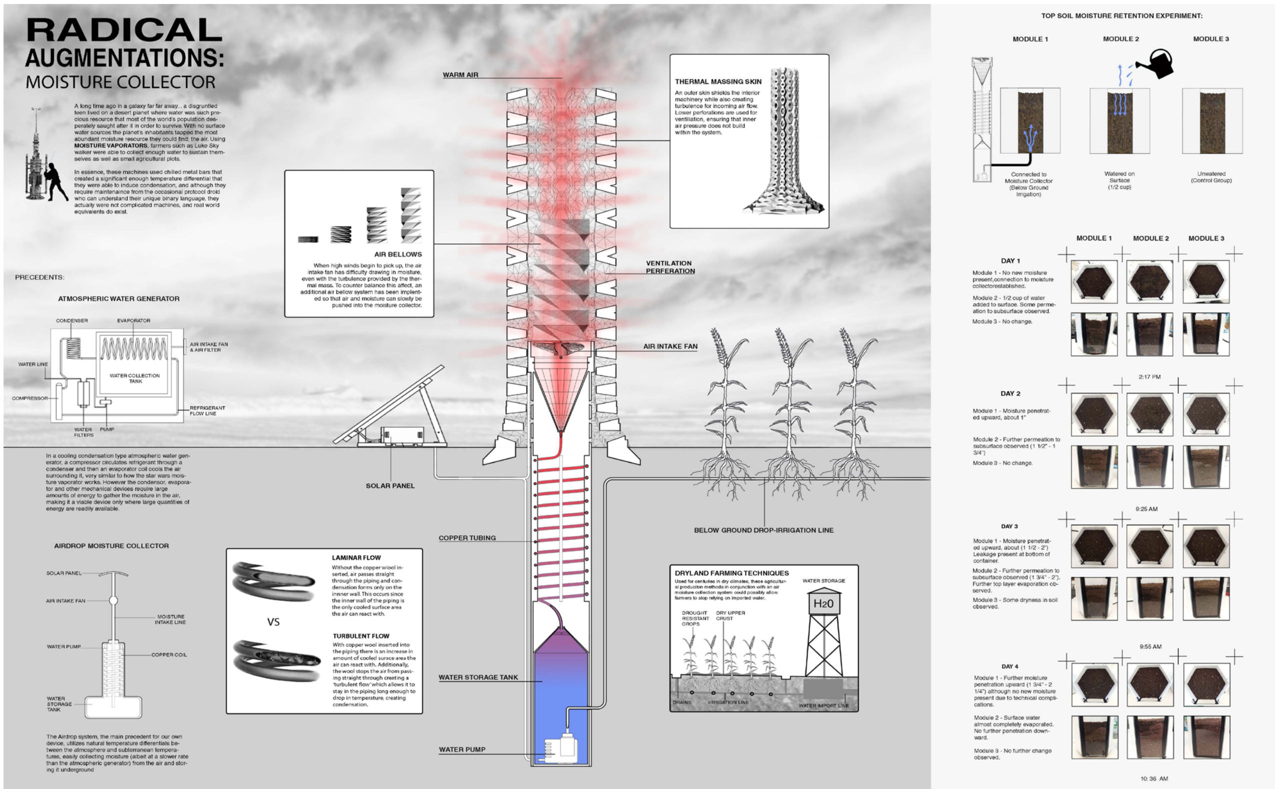


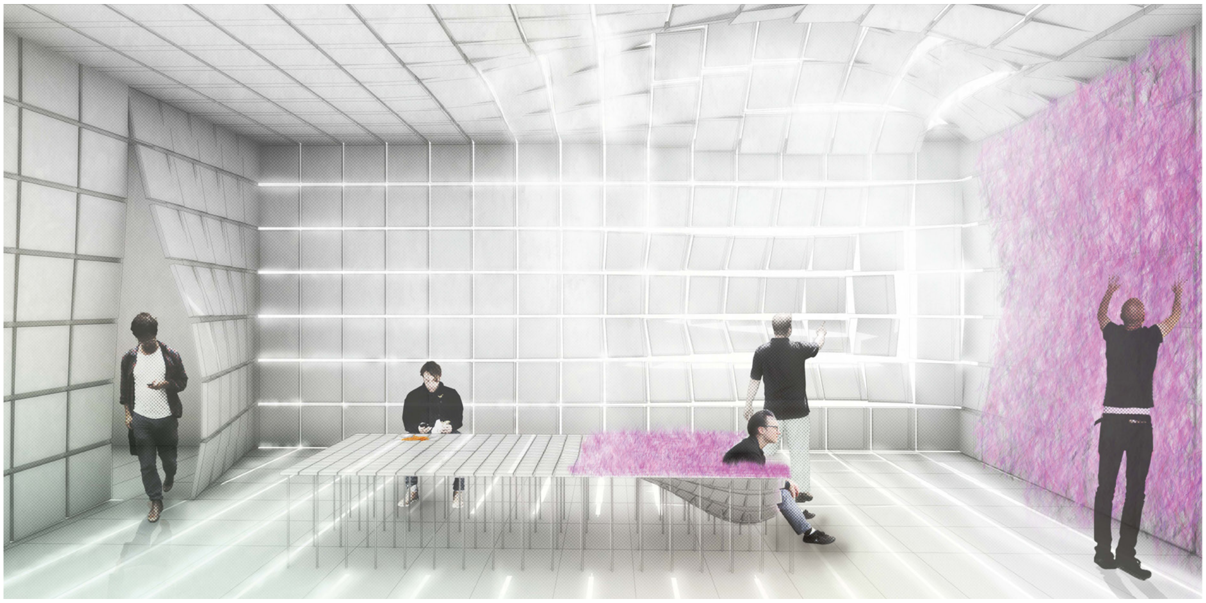
The resulting collection of information was aggregated into a catalog of references. . These references ranged from maker technologies like Arduino (the open source platform using easily accessible hardware and software), parametric and algorithmic scripting and extended to smart materials and robotics. Precedent projects included MediaTIC, designed by Enric Ruiz-Geli and Cloud 9 Architects of Barcelona. This project, named the World Building of the Year in 2011 by the World Architecture Festival[i], used Arduino microprocessors connected to façade sensors registering atmospheric changes to manipulate ETFE panels, curtains, and lighting through individual IP addresses, ultimately resulting in climate saving control via the embedded technology.[ii] Other precedents include HypoSurface, the physically active display system, an "info-form" which reacts to sensed data like light or sound and transforms responsively like a liquid wave,[iii] and Philip Beesley's Hylozoic Ground, the Canada Pavilion installation at the Venice Biennale in 2010 embedded with sensors and shape-memory alloy actuators to enable eerie and subtle gesticulation prompted by proximity.

Drawing on the compiled references the student research group was then asked to design biome specific machines to mediate material and energy flows specific to a designated environment. This work was done in concert with studio direction by Syracuse University School of Architecture faculty, Lydia Kallipoliti and Lori Brown, and required consideration of the implications of designing in both the Anthropocene era and the Digital Age.

The machine prototypes were designed and envisioned through multiple mediums and at three different scales:

1. an interactive and kinetically responsive physical model,
2. a dynamically reactive digital model,
3. a speculative but uniquely sited project proposal incorporating the machine in a landscape.

Figure 2: Moisture Vaporator for an arid environment uses cooled metal rods to collect condensate from the air for use as irrigation. Diagram and water collection experiments by Travis Tatabak and team.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Students used sensor technology, digital modeling, Grasshopper parametric software, Arduino open source microcontrollers (and Firefly as a bridging tool) to prototype interactive environments that tested how performative and responsive architecture alters the determination of form when the form's physical condition is digitally controlled.

One example of the resulting machines was a colored glass snow clearing roof sited in an arctic region. The roof structure sensed low temperatures, moisture, pressure and darkness to infer the presence of snow and then used a hinging mechanism to toss the snow off. The hinged condition and the imperative to capitalize on the light effects transmitted through the moving partitions resulted in an irregular triangular pattern across the roof akin to large scale stained glass. [figure 1] Other projects sensed and collected humidity from the air to provide water for drinking and irrigation in arid regions. These mechanisms, though formally different, expanded and contracted either to collect the water or in response to the weight of the water as it was collected. [figure 2]

Still other projects, situated in more moderate climates, concerned themselves with creating empathic environments. These projects responded to touch to create spatial conditions which opened up or closed in which allowed personally adjusted air flow, seating, and circulation into and through the building. It was even proposed that, much like the colloquial use of "empathic environment" as a narrative trope[4] these projects could be used to allow the environment to be an external manifestation of an internal state and could be programmed to create a more or less stimulating experience as might be desired. [figure 3]

In all cases, students used the previously mentioned technologies to move past theoretical discussion. Physically fabricated and kinetic prototypes informed by sensors and controlled via Arduino and Firefly were constructed along with a related Rhino digital model which used the visual programming language Grasshopper for simultaneous parametric activation. This work was contingent in two ways. First, the machines responded to external data collected via sensors that perceptibly transformed their formal conditions. Second, the environmental conditions of the biome in which each machine was situated informed the needs for which beneficial adaptation would be required. Though less ambitious in scale than the precedent projects referenced before, the work of this research does explore the potential formal and environmental consequences of embedding a subtle, practical and unobtrusive "intelligence" into architecture in a fashion similar to that of appliances or wearables in the Internet of Things.

Figure 3: Touch sensors activate the surface to provide for light transmission, seating, and circulation. Rendering by Chris Bressler and Colin Hoover.

METHOD 2—IMMERSIVE CONTINGENCY

Method 2 explored the more intangible expression of digital media as a material for defining space. Through projection mapping, animation, and virtual reality viewers the clear separation between the physical and the virtual is blurred so that the digital media is as much or more a demarcation of form as the built environment. In this way the spatial delineation and form become contingent not to the physical or atmospheric data as in Method 1, but to virtual projections of information. As evident from the previous reference to Elizabeth Grosz' text, the virtual has always informed the physical, creating a naturally contingent relationship between them. But technology is now making it possible for the virtual to be visibly integrated rather than invisibly present in the physical realm and therefore upping the contingency factor between virtual and physical in defining form.

The research question was whether or not it was possible through easily accessible media for designers to create virtual architectural conditions that allowed for digital realms to be immersive and environmental. Researchers focused on exploring VR technologies as a tool for this. The virtual reality (VR) technology available to the research team was limited to Google Cardboard. This VR platform uses a low-cost cardboard viewing device paired with stereoscopic lenses and a smartphone to deliver an immersive 3D effect.[5] Already there are a host of readily available applications and games for this platform and these, rather than traditional architectural models, served as precedents for how to develop compelling environments in this research. (The gaming and entertainment industry fields have been quick to exploit the emerging developments in virtual reality technology and because they are innately immersive experiences they lend themselves well to the medium. However, in its current availability it can be isolating in its delivery. To use a somewhat paradoxical expression, this isolation goes two ways. The user of VR is inhabiting a world of her own and any present witnesses are invisible. And at the same time, a person in a VR environment is inaccessible to those in the 'real world.' Bridging this chasm was deemed a promising goal for future research.)

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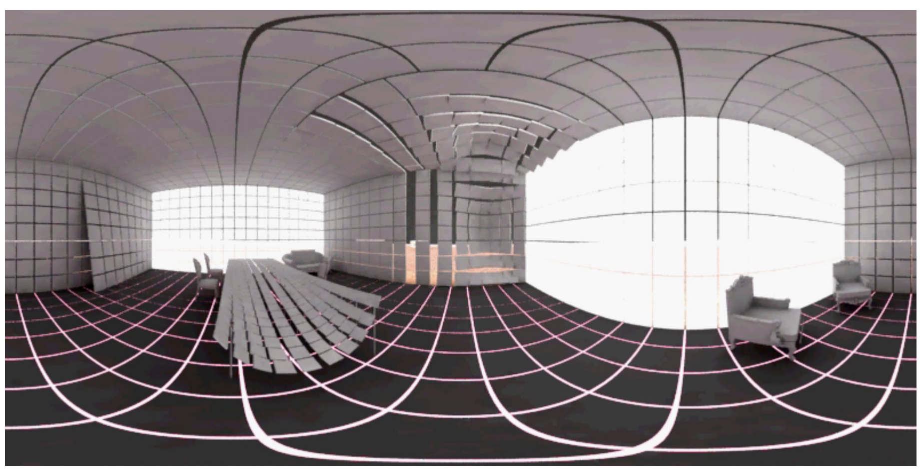

Figure 4: Spherical Camera Rendering creates a warped image in 2D that becomes 3D when viewed through a steroscopic viewer. Still image from animation by Chris Bressler and Colin Hoover.

The goal of Method 2 was to translate the machine and its biome setting from Method 1 to a medium that would be occupiable through the VR viewer. Doing this required rendering animations and/or images to be viewed stereoscopically. The simplest method for this cloned the image with a smartphone app and presented it in two windows simultaneously. This method has the advantage of allowing allowed the content to remain normative in its production and presentation outside of the VR viewer but 3-dimensional through it. More advanced exploration rendered animations using a spherical camera in the V-Ray rendering program for Rhino. This had a better 3-dimensional effect when watched through the viewer

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but looked oddly warped and duplicated when watched on a flat screen. [figure 4]Others chose to render photospheres, panoramic 3D environments, and combined them with utilization of the accelerometer in the smartphone for dynamic and 'real time' adjustment of the view.

The expected audience to benefit from this research into design methodology is both designer and the potential end-user to whom a particular design would be marketed. Obviously, VR broadens the possibilities for communication by making a whole new medium available but its most notable contribution discovered by the team is that it makes scalar conditions evident without requiring translation. For those who have difficulty understanding dimensional relationships as represented in a printed rendering and even for designers who are skilled and experienced at recognizing proportional associations VR is surprisingly effective at removing the gap between viewer and screen and putting the viewer in the scene at full scale.

Though effective at an introductory level and more immersive than watching a screen, the simple "cardboard and smartphone" viewer [figure 5] was found to have some significant limitations. For example the viewer is subject to the "screen door effect," the term used to describe the distracting visible pixilation apparent as a result of magnifying the phone screen through the viewing device. Also, at the time of this research tools for developing or translating architecture models built in Rhino to mediums that were VR friendly were not well documented or convenient. However developments and research grants in the field have been significant and rapidly forthcoming, so that in the fall of 2015 (just a few months later) major components or steps that were obstacles in the research progress are becoming streamlined, freely available and/or coordinated. As more investment in VR occurs, the opportunities for testing the initial hypothesis and obtaining effective results will increase exponentially.

The digital and virtual are well explored as tools for designing form but this research resulted in an extended awareness of the means by which design concepts might be realized by embracing those tools as a medium for representation, manifestation and interaction with form. Mediated environments extend the aptitude of architectural realization through virtual simulation, immersive animations, and physically interactive environments. While the de-emphasis of the physical environment in favor of a virtual one may initially seem like a cause for concern for architects the more optimistic vision recognizes that virtual environments and digital tools create an entirely new realm by which, for which, and through which the architect may practice by recognizing changing realities that provoke and necessitate innovative, dynamic conditions.

Figure 5: The google cardboard viewer secures a smart phone in the front flap to be viewed through different focal length lenses to create a 3D effect.

CONCLUSION

As with technologies that have come before, intelligence-integrated architecture, virtual reality, and the internet of things are creating an enthusiasm for future possibilities culturally, economically, socially, and architecturally. To quote Grosz again:

An awful lot of hype surrounds not only computer technologies but also their collective product, the Net, and the Net's most fantasy-laden component, cyberspace. Much of this commotion is due to a fascination with what the digital telecommunications revolution and its associated soft- and hardwares promise but have yet to deliver. In their nascent incompleteness, indeed in a form still more dreamlike than actual, these technologies are ripe, as it were, for various imaginary schemas, projected futures, dreams, hopes, and fears.[6]

Though in 2001 Grosz references "Cyberspace" as the culmination of the "Net", today we might substitute the "Internet of Things" which breaks the screen barrier and integrates cyberspace it into our physical environment. In either case, mediated environments will increasingly inform and mitigate future architectural conditions such that the existing contingency between virtual and physical is visually apparent. This will occur through intelligence laden components as illustrated through the microprocessor experiments in Method 1 to make performative environments, the scale, form, color and function of which may be informed by atmospheric measures or user interaction. Or as explored in Method 2, common access VR availability will make the relationship between physical and virtual more integrated by creating occupiable virtual environments within physical ones. But it will also transpire in ways which we cannot yet predict and have unforeseeable consequences both positive and negative. What seems inarguable, is that the dialogue between the physical and the virtual, currently most apparent via digital media manifestation, is becoming increasingly existent. And as its presence and influence expand so too will the contingent relationship between the worlds we design and inhabit—both virtually and physically. Cynthia C. ed. Davidson, 75-90. Cambridge: MIT Press.

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ENDNOTES

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