

Architecture in the Age of Ubiquitous Computing

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In January, 2007 Apple Computers introduced the first generation of the Iphone. The Iphone wasn't the first "smart phone" to combine telephony with internet access but it had advantages over other smart phones. The Iphone connected consumers to a boundless "community" of content developers, incorporated a multi-touch interface and wrapped its features in a stylish hardware package that looked more like a museum touchscreen than a telephone. The Iphone was immediately successful and by 2009 was on pace to reach a projected global market of 1.5 billion dollars in sales.ⁱ

More important than the Iphone's technological and commercial success was its impact on popular culture's relationship with wireless computing. The simple finger taps and slides of the Iphone entered consumers into a Faustian bargain where they are asked to give up the last vestige of their digital privacy in order to gain access to digital content. Where the American public had decried the Bush administration's use of phone tapping technology to collect suspected conversations between American citizen's and Islamic jihadists during the Iraq War, the same public willingly capitulated to corporate data tapping of their cell phones in order to get the latest Miley Cyrus ringtone after the advent of the Iphone.

Smart phones are only the most obvious technology to bridge the gap between wired and wireless, digital and analog spheres. Less visible, but rapidly expanding, are myriad other wireless, embodied digital technologies like microchips, nanochips and radio frequency identification tags (RFID). These small, relatively simple devices, are increasingly embedded in everyday objects from swipe cards and bracelets, to smart car readers and retail security systems. Collectively smart phones and embedded data technologies demonstrate a technological shift that poses interesting issues for architects. Human beings are now both the consumers of digital information and the vectors by which information is relayed. Cell phones, hand-held devices and RFID technologies require that humans physically link one part of a communications network to another. And of course, because they provide us with information we crave, we willingly oblige and voluntarily play our part, filling the gaps in a vast and growing global information network.

In computer science circles this interdependence of physical and digital technologies is known as "augmented reality." Information Architect Luke Skrebowski provides a concise definition.

"Augmented reality is the layering of the virtual over the real. As such it is the logical conclusion- actualized in a technological apparatus- of the loss of any absolute distinction between "true" reality and semblance, materiality and information."ⁱⁱ

Augmented reality is distinct from virtual reality or cyber space. It is the overlap of digitally-conceived, non-physical experience with real, physical, human-driven

interface. While it sounds like science fiction, augmented reality is abundantly real. It is the increasingly common phenomenon witnessed on street corners, in malls and in cafes of people relying on wireless routers and handheld devices to support their daily experiences of work, play and commerce.

Frederic Jameson, Terry Winograd and Marshall McLuhan have spoken about the digital technology in architectural terms for decades. Terry Winograd's description of software in 1996 speaks about software not as technology but as a kind of tectonic material.

"Software is not just a device with which the user interacts; it is also a generator of space in which the user lives. Software design is like architecture; when an architect designs a home or an office building, a structure is being specified. More significantly, though, the patterns of life for its inhabitants are being shaped."ⁱⁱⁱ

The economically robust software industry has similarly borrowed the language of architecture and created whole new professions dedicated to carving out spatial possibilities in information systems. What their co-opting of architecture brings to light is the subtle and possibly irrelevant distinction between digital and physical space. After all what is space but the locus of relationships?

Ours is an era where the familiar and local is so small and finite relative to the extent of our knowledge that it barely shows up on maps except as a pixel of color in a galaxy of streaming vectors, or in the fold of a fabric that seems to have no beginning,

middle or end. Yet this small place is easily spied on by anybody and everybody with access to an internet browser. We are at once everywhere and nowhere, cosmopolitan and insignificant, consumer and consumed.

Increasingly the job of architecture is to organize the context in which information is exchanged and to view physical information as a part of a continuum of information types that also includes energy transfer, sound levels, luminance and many other elements of our perceptible world. Viewed this way, information flow does not replace traditional social interactions in physical space, it merely doubles up the occupancy load, requiring that the spaces we construct support the body and its communication needs in equal measure.

Geographer David Harvey calls this change the "annihilation of space through time"^{iv} and is one theorist among many who argues that this has led to a shift and shifting perspective that is "disorienting and disruptive" but also potentially productive. Harvey places the current anxiety of spatial perspective within a historic continuum noting that it is formally similar to previous epochs from the Enlightenment through the birth of Modernism when society's conception of time and space was in flux. He points out that this anxiety or flux can be generative for those in art, ethics and politics but can just as easily be used to subjugate us to authoritarian control. He argues that epochal changes are not inherently good or bad, but are instead defined by the ethical behavior

and imagination of those individuals and groups who successfully capitalize on the possibilities presented by change.^v

Life with Ubiquitous Computing

"A critical practice challenges prevailing values through work based in some other set of values."^{vi}

Malcolm McCullough

Augmented reality impacts architectural practice in several ways. Its most powerful impact is in the cognitive changes humans experience moving through space which in turn leads to new social behaviors and expectations. Again, the very recent step to mobility enabled by advances in wireless information delivery is a significant technological shift. Like the invention of the telephone and the television, the invention of the internet has had revolutionary consequences for human behavior.

One of the best known is the Stanford Study of the Social Consequences of the Internet. Published in 2000 the Stanford Study indicated that increased time spent using the internet, whether for work or pleasure, led to decreased social engagement and increased physical isolation. Commenting on the results, Dr. Norman Nie said provocatively, "We're moving from a world in which you know all your neighbors, see all your friends, interact with lots of different people every day, to a functional world, where interaction takes place at a distance."^{vii} Follow up studies conducted at Stanford

and Carnegie-Melon showed internet use in specific age and demographic groups corresponded with elevated levels of depression, but noted that younger users of social networking sites seem less susceptible to isolation and depression.

The debate rages in popular and academic media about whether digital ubiquity adds to, or reverses, these overall anti-social tendencies of heavy internet use. Some have argued that the capacity to carry our digital "gadgets" with us has enabled people to reconnect with place and social activity. Others argue that rather than free us from cloistered spaces, digital mobility has just ensnared us more deeply in endless virtual communications demands. Perhaps it is too soon to tell which of these theories is correct. But an exciting area of potential research and investigation for architecture lays in the midst of these questions. If we assume that the pressure to stay digitally connected has made us less aware of our surroundings and less capable of experiencing sensory or social diversity can we reverse that tendency either through better spatial interface with information devices and information streams or better design of physical space?

Sensing and Social Interaction

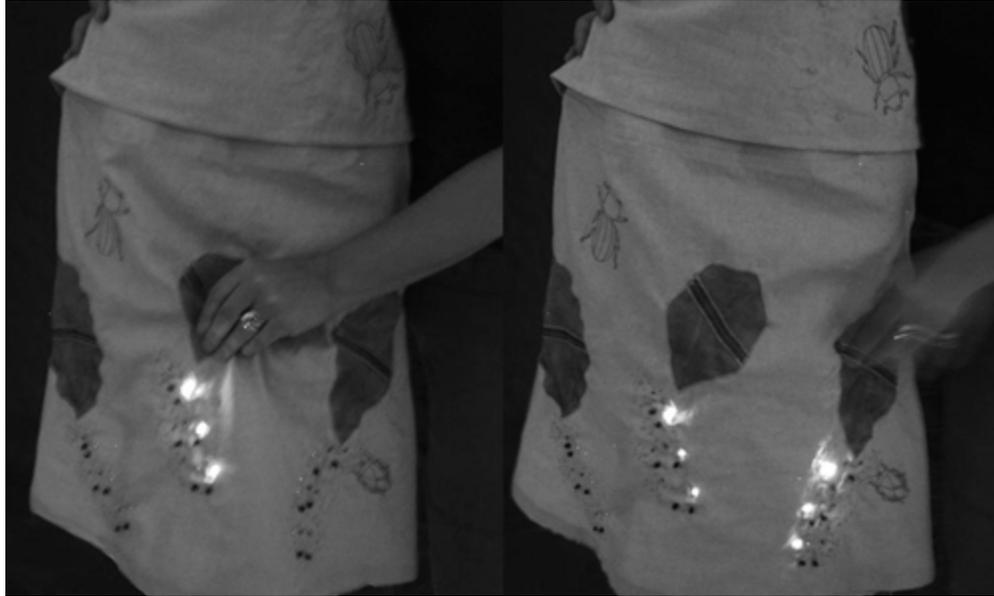
To date the major players responsible for implementing digital technology in public spaces have been government agencies, security contractors and major retail chains. Walmart, for example, monitors inventory through the world's largest RFID network; and some retailers have begun experimenting with digital signage that uses

surveillance cameras and data analytics to customize window displays to suit the pedestrians standing nearest.^{viii}

When companies like these set up an AR system they typically turn to hardware and software engineers for design expertise. But as technology becomes more affordable and accessible, opportunities arise for the general public to design AR systems based on their own subjective aspirations, hopefully leading to more useful and less Orwellian applications of these technologies.

Joanna Berzowska, a professor of Computational Arts at Concordia University, is an interesting example of a non-commercial artist experimenting with these technologies. Berzowska embeds textiles with the same technology used by retail stores for surveillance, but with the intent to promote social interaction rather than social calming. In *Constellation Dress* Berzowska embeds sensors, magnets and LED diodes in a dress, enabling the dress to attract and respond to other dresses. When a connection is made between two dresses, the wearers enjoy an embedded light show.

While the dresses are mere prototypes, they are a useful references for an architectural exploration similarly interested in promoting awareness of social, local relations. Berkowska's coverings are akin to the facade or skin of a building. Rather



Memory dresses by Joanna Berzowska

"The magnetic snaps act as a mechanical and electrical connection between bodies, and their irregular placement induces wearers to create playful and compelling choreographies to connect their circuits."^{ix}

than merely protecting us from the elements or subdivide space into interior and exterior, Berkoska's *Constellation Dress* makes one wonder whether walls and glazing systems might not be designed to function as the means of communication between dwellers and passers-by.

We are already accustomed to room sensors detecting our presence and using the information to effectively limit energy consumption. Could we not use them just as effectively to instill awareness of self and others? Like the Wailing Wall in Jerusalem where religious Jews go to pass messages in written prayers to God, a wall can be

reconceived as a means of delivering expressive messages of human thought rather than corporate messages intended to extinguish thought.

Sensing, Surveillance and Public Space

The simple sensors Berkowska uses have been around for years and are used heavily in monitoring industrial processes on assembly lines and in building security systems. About twenty years ago the entertainment industry began appropriating sensors to control the flow of entertainment to tourists at theme parks. Today when Disney or Universal Studios begins work on a new attraction they first lay a vast network of sensors including traditional devices like capacitance switches, sound and IR sensors. But increasingly they are adding biometric sensors that detect heart rates, perspiration, and respiration, and vast systems of cameras that track motion and enable facial recognition. Matthew Du Plessi, a subcontractor to Disney explains the logic, "it is easier to monitor everything you can monitor and decide later how you are going to use the information you gather."^x

Disney is not alone in promoting this idea of the pervasive network of sensors. Since 9/11 the Department of Homeland Security has distributed millions of dollars in research grants and contract work to IT companies to investigate the implementation of biometric and camera based surveillance systems in public squares and buildings. Hoping to extend the market for such systems beyond the federal government, many IT

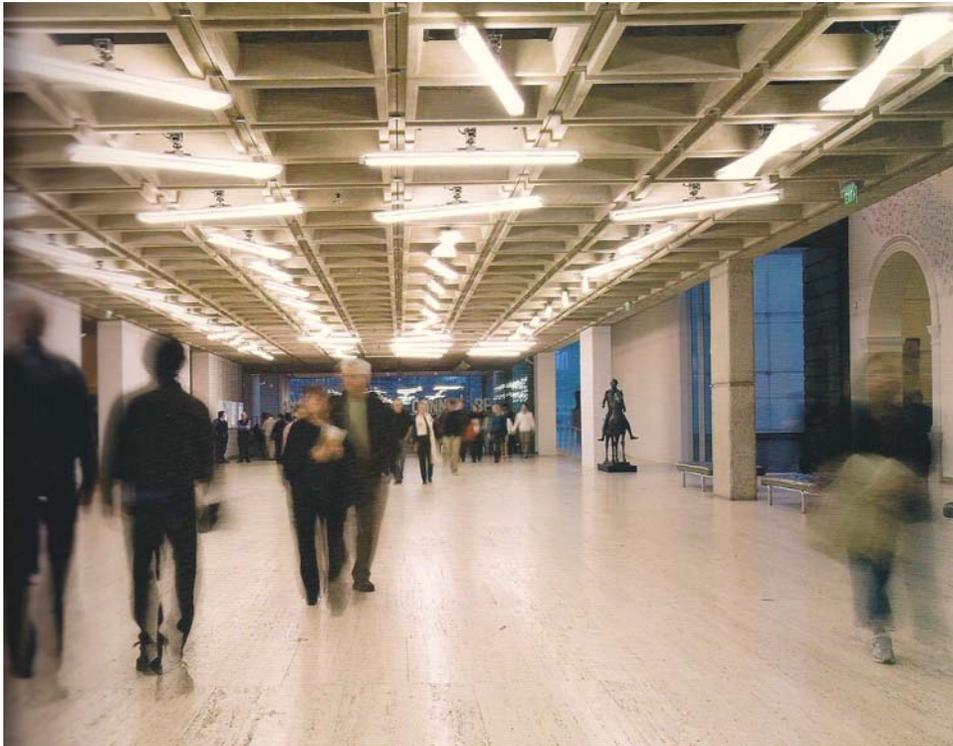
companies including IBM, Cisco Systems and Microsoft have begun peddling their technology and services to municipalities.

The most obvious example of such a system is your local traffic monitoring technology. The basic system uses timers, relays, IR sensors and digital cameras to capture in digital video the movement and license plate information of cars running red lights. The systems have proven to be widely popular to city administrators and widely unpopular to lead-foot motorists because the IT component enables automated issuance of traffic citations. In other words, they raise revenue for city's without the added expense of putting additional cops on the streets.

Artists and activists have been organizing against this use of surveillance technology for some time. Of the many artists interested in surveillance technology artist Rafael Lozano-Hemmer is intriguing because his work goes beyond the critique of big brother voyeurism to see how offer alternative relationships to technology might be formed. His works also bravely enters the domain of architecture, questioning architecture's role as a mediator of social relations.

Constructed in 2006, *Subsculpture 7* is one of Lozano-Hemmer's first works to directly combine architecture and surveillance technologies. In *Subsculpture 7* a large passageway is lined with a motion-tracking sensor network and lit by an array of bare fluorescent light fixtures. As occupants of the space move under the light fixtures the

sensors signal robotic pivots to respond to the movement and rotate the fixture. The playful twisting and turning of the lights distracts the passerby making them aware of the architecture and the lighting fixtures they may have taken for granted.



Subsculpture 7, Lozano-Hemmer, from his website

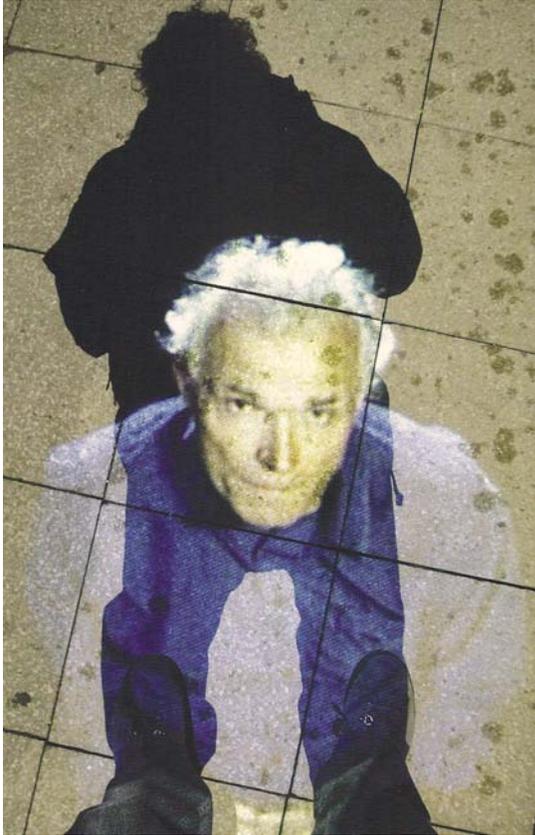
Lozano-Hemmer says the piece was "an intended contrast to the... grids that organize most of modern architecture." What is interesting here is that he views the work not just as an effort to drawing attention to pervasive surveillance technologies, but also as a way of connecting those technologies to modernism. Modernism's history of technological fetishism has been viewed by some architectural historians as evidence

of the architect's traditional unwillingness to confront fascist or authoritarian tendencies.

Returning control of public space to the public is one of the objectives of Lozano-Hemmer's explorations in a later piece, entitled *Under Scan*. For *Under Scan* Lozano-Hemmer lines a public square with surveillance cameras, video projectors and a single, powerful yoke mounted HMI projector to create an unexpected interactive spotlight on a town commons. The HMI projector illuminates the entire square from a harsh angle enabling people crossing the square to cast long shadows on the paving stones in front of them. Motion tracking software monitors their movements and directs pre-recorded video sequences into their path. When their shadow falls on the pre-arranged intersection a video portrait is projected at the feet of the pedestrian revealed by their own shadow. The video ghost then engages the pedestrian with gestures and beseeching looks.



Underscan, by Rafael Lozano- Hemmer



Quite consciously Lozano-Hemmer uses the piece to provoke an almost intimate interaction between two strangers in the context of a specific, nearly forgotten public space. His decision to work within the context of a small community is intentional. That he uses surveillance technology in the same manner as a military unit or as the Disney Company does demonstrates that the technology itself is always neutral. It is how it is applied that determines its ethical status. Lozano-Hemmer goes to great lengths to reveal his intentions to his audience, posting detailed notes around the square and breaking out of the effect every seven minutes to revealing the projected gridlines of the surveillance system.

The take away from Lozano-Hemmer's work is that it is possible to draw people's awareness back to their immediate surroundings and relationships. In this piece Lozano-Hemmer does what Disney chooses not to do, he encourages people to acknowledge the real, the everyday and the immediate rather than cater to their desire for escapism. That he does this in a compelling way, and then reveals the technology involved in the act also displays a politically powerful choice. The Brechtian moment of the reveal is almost as important as the rest of the work because it stands in stark contrast to the invisible proliferation of hidden cameras and undisclosed acts of information harvesting that are a growing part of our daily experience.

The Computer as Architectural Precedent

Modernism's origins have long been attributed to technological advances that occurred in the late decades of the 19th century, chief among them, the development of glass and steel as construction materials. That a change in construction technology should lead to such dramatic rupture in architecture's formal conventions is not an entirely obvious conclusion. Could it have not just as easily occurred that architects might have made only minimal adjustments to their design process to take advantage of these new materials?

In fact, such a continuation of conventional form is unimaginable because the shift in technology, as we observed in World War I, was also accompanied by a shift in

human relationships to the environment. Plate glass, for example, extended to architecture not just the possibility of larger windows but also an altered relationship between indoor and out. Steel didn't just replace masonry in supporting mass, it also diminished the relationship between human beings and the ground, literally expanding our domain vertically. Architects willing to explore the functional possibilities of these new materials were never just making accommodations for new technologies. They were opening their minds and suspending judgment on notions of beauty and form, and in doing so were discovering an entirely new architectural language. A similar process of discovery awaits us in the information age.

Greenlaugh's maxim that "form follows function" carries two corollaries: "forms change when functions change , and new functions cannot be expressed by old forms."^{xi} Information technologies open the door to a range of new functional possibilities in architecture. The idea that a building can sense its occupants and respond to their presence, relate the presence of one occupant to another, or use building assemblies or building occupants as vessels for the transport or expression of data radically changes the notion of what a building "does." To explore this line of inquiry is a lifetime's work. The best I can do in this limited time frame and in the design stage associated with this project is rummage around in the basic concepts.

I've tried to document the things I find most compelling about information technology and sensing technology at the dawn of the 21st century with the intention of

using these observations as guidance in design. In doing so I've come to the conclusion that a useful angle for investigation is to think of the computer as an analogy for architecture rather than as an appendage to architecture. Looked at as a class of designed products, computers and other information technologies have traditionally focused less on appearance and more on their capacity to handle data. As a result, in just 50 years computing has gone from punch cards and mainframes to far more powerful laptops and handheld devices. Perhaps architecture should strive for a similar development curve and similar focus on responsiveness. Perhaps we should start pushing information processing capacity into architectural systems at a low bandwidth with aspirations of eventually achieving something in the high bandwidth.

To explore the ways information technology might alter the function of architecture more usefully, more democratically and more ethically requires a direct engagement with the technology in the context of real communities for a situated purpose. To assume a blank slate leads to the kind of fantastic, locally-disconnected architecture that is already crowding its way onto the architectural stage. Instead, I choose to work in the manner of Joanna Berkowska's *Intimate Dress* and Raphael Lozano-Hemmer's *Under Scan* and *Relational Architecture*. Note that both Berkowska and Lozano-Hemmer engage technology in order to achieve specific ends. For Berkowska the interactive dress aspires to extend social interaction. For Lozano-Hemmer, the re-appropriation of surveillance technology is aimed at re-activating an underappreciated and underutilized public space. Following in their footsteps, I seek to

insert a new, information processing architecture into architecture with the intent of re-activating space in communities struggling to maintain local relationships.

ⁱ Hiner, Jason. Znet Magazine, 9/8/2009.

ⁱⁱ Skrebowski, Luke, *Augmented Reality: Pervasive Computing, Spatial Practice, Interface Politics*, from Did Someone Say Participate (Miessen and Basar, Cambridge, MA: MIT Press, 2006), p. 42.

ⁱⁱⁱ Winograd, Terry, Introduction to Bringing Design to Software (New York, NY: ACM Press, 1996).

^{iv} Harvey, David, The Condition of Postmodernity (Malden, MA: Blackwell 1990), p. 120.

^v Ibid., p. 183.

^{vi} McCullough's is an excellent exploration of the intersect between computing and architecture. McCullough, Malcolm, Digital Ground: Architecture, Pervasive Computing, and Environmental Knowing (Cambridge, MA: 2004).

^{vii} Scheer, Robert, *USC Annenberg Online Journalism Review* citing a previously published article in the Washington Post, April, 2002.

^{viii} This means that the odds are higher of getting the Hooters ad if you are 5'10" and have broad shoulders, which may not be a bad thing if you hate Hooters ads. This is an emerging technology. One example is Cognovision, now owned by Intel.

CognoVision Acquired By Intel Corporation, Cognovision Solutions, Inc., Markham, OT Nov. 15, 2010.

^{ix} Berzowska, Joanna. "Memory Rich Clothing: Second Skins that Communicate Physical Memory." XS Labs, 2006.

^x Matt Duplessi, Interviewed in Foxborough, MA by Dorrie Brooks, August 31, 2010.

^{xi} Mumford, Lewis, Symbol and Function in Architecture (New York: Columbia University Press, 1952), p. 2.