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Situated Architecture in the Digital Age: Adaptation of a Textile Mill in Holyoke, Massachusetts

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**SITUATED ARCHITECTURE IN THE DIGITAL AGE:
ADAPTATION OF A TEXTILE MILL IN HOLYOKE, MASSACHUSETTS**

A Thesis Presented

by

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DEDICATION

In memory of Michael and Joseph Brooks,

and Professor David Dillon.

ACKNOWLEDGMENTS

I would like to thank my wife, Helen, and my children, Harper and Joe, for their support through the duration of this thesis project and the years spent just getting to the starting line. Because of you, I feel rich in the things that matter.

I add to my wealth a few more brain cells thanks to the generous support of my academic advisors, Joseph Krupczynski and Kathleen Lugosch. Not everyone gets to graduate and keep the hall pass. I look forward to working with you both on future projects with less stringent deadlines.

ABSTRACT

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The City of Holyoke, Massachusetts is one of many aging, industrial cities striving to revitalize its economy based on the promise of increased digital connectivity and clean energy resources. But how do you renovate 19th century mills to meet the demands of the information age? This architectural study explores the potential impact of sensing technologies and information networks on the definition and function of buildings in the 21st century. It explores the changes that have taken place in industrial architecture since 1850 and argues for an architecture that supports local relationships and environmental awareness. The author explores the industrial history of Holyoke, appraises emerging uses of sensing technologies, and presents a thorough narrative of her site analysis and conceptual design of a digital fabrication and incubation center within an existing textile mill.

PREFACE

Over the past fifteen years the boundary between digital and analogue technologies has blurred as is evidenced by the growing popularity of 'smart' cars, 'virtual' workplaces and social networking 'sites'-- each an example of a hybrid terrain where "the digital" relies on "the real" for its means of conveyance, and "the real" relies on "the digital" for content and experience. The impact of this overlap of real and digital on architecture is still not widely address in the education of architects, evidence of a collective uncertainty about where digital technology fits in the architect's tool kit.

This thesis hopes to raise the volume on such conversations by studying the challenges and advantages to architecture of our cultural absorption of wireless, digital technologies into everyday life. Chapter One will set the groundwork for this investigation, introducing the unique and not-so-unique aspects of Holyoke, Massachusetts and the events in the summer of 2010 that led me to this line of inquiry. Chapter Two will examine recent developments in sensing technologies and explore ways these technologies might reframe our understanding of architecture's responsibility to building occupants. Chapter Three will apply the conclusions of this research to the design of a digital incubator center adjacent to a proposed high performance super computer facility in Holyoke.

While I will look at digital information as a material to be explored, I admit to a personal agenda. I hope to find a way to bend digitally augmented architecture into something that supports stronger social relationships with place. Towards this end, my investigation will also explore my own capacity to wrestle with these sometimes esoteric questions in the context of a localized architectural design. I will explore the historic, social, economic and physical characteristics of a particular study site and will ultimately bring the globally relevant question of the role of digital technology in architecture up against the site specific questions one always asks on any architectural project-- how does design respond to the site, its history and its inherent possibilities?

I apologize in advance for the inevitably nonlinear nature of my writing. I am not the kind of designer who can move in a straight line towards any end result; nor do I aspire to be that kind of designer. Instead my process involves an intentionally broad consideration of many issues and questions. Some end up on the cutting room floor. But even these leave an impression on the final design. I have done my best to present a clear narrative without sacrificing the missteps and diversions that are part of any open-minded research or design project.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

CHAPTER 1

INVESTIGATING HOLYOKE

Figure 1. Third Canal, Holyoke, Oct. 2010, by author

To Bilbao Or Not

One of the things I learned growing up in the Air Force is how to do good reconnaissance. My mother taught me. Every 18 months our family would breeze into a new town and set out to get our bearings. When I moved to Western Massachusetts ten years ago I followed procedure and drove the local network of poorly named Massachusetts roads until I knew them by heart. Along the way I fell in love with Holyoke.

Holyoke is one of hundreds of post-industrial landscapes scattered across New England. Laid out in the 1850s for the manufacturing of paper, Holyoke reached its economic zenith in the 1940s when it boasted a population of 60,000 residents. Today little more than half that number remain and the once vibrant paper mills are largely vacant.[1]

The canal district is Holyoke's most striking feature. It is roughly four square miles of 19th century brick mill buildings lining three functioning canals nestled in a wide bend of the Connecticut River. Just to the north of the point where First Canal leaves the river, a thirty foot high dam collects and controls the Connecticut River's water. In 1847 a team of hydrological surveyors were able to prove to their clients that the force of water falling at this point in the river was sufficient to power as many as fifty large scale factories. Their presentation led to the formation of the Hadley Falls Company and, in two short years, the incorporation of the City of Holyoke.[2]

While water still flows through Holyoke's canals, the city as a whole is mired in frustration and poverty. Holyoke began its economic decline in the 1950s, but the die was cast for Holyoke's collapse as early as 1930. Holyoke's industrialization was predicated on water-power. But from the beginning water power meant enduring outages and cutbacks when water levels were insufficient to drive the city's turbines. By 1930 crude oil prices fell to an all-time low and a nationalized power grid became a reality. Local power was no longer sufficient enticement to industrialists tempted by cheaper labor costs and lower taxes elsewhere.

Figure 2. Skinner Mills and Whiting Coal Depot (Courtesy Holyoke History Archive)

As the city's fortunes waned in the late 20th century, affluent and middle class residents turned their back on the historic industrial district and moved west towards the new highway. Successive city administrations struggled to stanch the flow of capital and labor from the city but were largely unsuccessful. When I began this project in the Spring of 2010 Holyoke had one of the highest unemployment rates and lowest per capita income rates in the State of Massachusetts. The canal district, while intriguing to students of American industrial history, is only a shadow of its former self. One third, or three million square feet of the city's industrial square footage is vacant and nearly 40 percent of the canal district consists of lots made vacant by arson, demolition and neglect. [3]

The scale of the industrial district is a challenge unto itself. Because the heart of Holyoke was planned as an industrial complex, its downtown core lacks the mix of economic activity other more heterogeneous cities enjoy. Shops and residential areas are confined to relatively segregated areas of the city while factories, canals and rail lines dominate the physical form of the urban core. The decline of activity along the canals over time withered the downtown economy and sent ripple effects to the very boundaries of the city. By 2010 12.5 percent of the downtown housing stock sat vacant and nearly 50% of the entire stock of residential units was owned by the City of Holyoke or Holyoke Housing Authority.[4]

A secondary concern for the downtown is the increasingly obsolete nature of the industrial architecture in the canal district. As the city grew despondent, the world around it continued it to accelerate into the information age. By the 1980s most American industries had transferred labor intensive assembly processes, the bulk of Holyoke's jobs, to countries where labor was cheaper. The jobs being retained in the United States were primarily in design, management or service-related sectors.

Precision-manufacturing and munitions are the only traditional manufacturing processes that have kept a significant foothold in the region.

The stars of the new economy of the late 20th century looked to a different kind of architecture to accommodate their needs and to express their cultural sensibilities. Sleek glass boxes and digital cubicles on suburban campus settings in Silicon Valley, Northern Virginia and suburban Boston have come to symbolize late 20th century productivity. The things that made Holyoke attractive to investors in 1880, a self-contained urban core, a concentration of low-skilled immigrant labor, and an abundance of industrial square footage, are now viewed as drawbacks.[5]

In time Holyoke's reputation in industry was replaced by its reputation as a revitalization conundrum for urban planners and academics. The city's archive contains an entire bookcase of proposed re-development strategies and master plans. Reading them is a humbling experience to any student of planning. Like the story of the princess that wouldn't smile, Holyoke seems to have spent decades waiting for the right suitor to come and claim her hand.

No single work of architecture can rescue Holyoke from its economic malaise. The Bilbao Effect is also a myth; and many cities have gone bankrupt trying to imitate that city's improbable success with a Gehry-designed Guggenheim Museum. Instead of Bilbao-izing Holyoke, I walked the streets of the city in the summer of 2010 trying to figure out what resources the city had that it could build on. The skills we bring as architects are not simply those made visible in the construction of a final model, but also in the analytical processes that help us to formulate the questions that lead to solutions. I believe that the most realistic architectural response to Holyoke's problems is to be found in careful study of its history, its context and its best attributes.

"Why Not Holyoke?"

A group of very high-powered players walked onto Holyoke's stage in the Fall of 2009. In October, Massachusetts Governor Duval Patrick announced a partnership between MIT, UMass, Harvard and Boston University to locate a shared high performance computing center worth 100 million dollars in Holyoke's canal district. The university players were lured to Holyoke, according to press releases, by Holyoke's low cost, clean power.[6] The four universities were spending millions of dollars a year to lease computer time in private facilities and hoped to lower their costs by jointly investing in a shared, state-of-the-art facility. The proposed facility would provide computing power for visualizations and intensive computations and would be remotely tapped by investigators at each of the individual schools.

For its part the Patrick Administration hoped the city and regional planning authority, Pioneer Valley Planning Commission, might be able to leverage the computing facility into a symbol of what can happen in Holyoke. As the Governor and his staff repeatedly stated, "we are hoping others will say, why not Holyoke?"[7]

In July of 2010 the newly formed Massachusetts Green High Performance Computing Center (MGHPCC) was officially incorporated and its Board of Directors announced that an architectural review of three sites was underway to determine the final location of the facility. The first candidate was Open Square, a large re-developed mill complex between Dwight and Lyman Street owned by John Albion, a well-known local businessman. The second and third candidates were also mill structures that shared a parcel on Bigelow Street between Cabot and Appleton Street. All three sat within the most productive stretch of industrial property in the city, a strip of land not more than 300 feet wide that separated First and Second Canal.

It is impossible to capture the buzz on the streets of Holyoke throughout the Summer and Fall of 2010. The city had not seen so many gray-suited Boston dignitaries since the 1840s. Residents of all stripes vacillated from skepticism to optimism and back again. First announced as a 100 million dollar project, the number gradually crept up to 168 million by November, 2010. At the same time spokesman for the MGHPCC were careful to point out that the facility would not generate a significant number of jobs. At most only 25 people would be employed at the facility and most benefits of the facility would be derived in the research labs housed at the universities.

During the same gestational period one of the private partners of the computing center, Cisco Systems, announced plans to make Holyoke a prototype "smart+connected city." As the world's dominant producer of internet protocol technologies, Cisco had been looking to expand its market into small and mid-sized cities and was actively courting projects that would cultivate the market for faster, more bandwidth-intensive institutional uses. Cisco offered to meet with city department heads and propose ways services could be met more efficiently through information and communication networking improvements.

A Spurned Site's Second Chance

My architectural investigation begins at this point in the story. For most of the year I carefully watched the unfolding events in Holyoke while doing my own independent investigation into Holyoke's history, topography, culture and financial conditions. When the Innovation District's boundaries took shape I began to explore precedents of comparable cities, past and present that had hung their hopes on information technology districts. Eventually I became so distracted by the MGHPCC and the "Smart+Connected City" projects that I decided to make the intersection of computing and architecture the primary focus of my research. The MGHPCC and Cisco projects flagged a fundamental question that my investigation exploited. What does it take to make a 19th century industrial city vibrant and productive in the information age? If the nature of work has changed as a result of globalization and digital communications, how has the architecture that supports the workplace responded? Shouldn't the paradigm shift that has occurred in digital communications be met by an equivalent shift on the part of architects and urban designers?

As these questions began to coalesce in my mind the MGHPCC came back with the results of its site studies. Though two of the three existing mill structures were deemed structurally suitable for redevelopment, the Board of the MGHPCC opted instead to purchase and demolish one of the existing mills on Cabot Street and build an entirely new facility. New construction was more cost effective and enabled easier site control.

Disappointed in their decision to reject an opportunity to revitalize one of Holyoke's mills, I approached the MGHPCC's new director, John Goodhue, and asked if I could use the mill building at 1 Bigelow Street as a study site for my thesis. There were no plans for this serviceable old mill which was about to become the MGHPCC's next door neighbor. At three stories high and 96,000 square feet of floor space it would work as well as any mill for the purpose of this academic investigation. And perhaps my design process would give the MGHPCC some ideas as to how they could use the building to its highest and best use.

In the Fall of 2010 I began to explore literature and precedents I felt were relevant to the larger issue of architecture's relationship to sensing and computing technologies. Then, in the Spring of 2011 I began a more focused investigation and architectural design process at 1 Bigelow Street. Chapters Two and Three will present the results of this two stage process.

Notes

[1] The most scholarly work on Holyoke's history to date is Constance Green's A Case Study of the Industrial Revolution in America. See bibliography for a complete citation.

[2] Wyatt Harper's account The Story of Holyoke gives a good synopsis of the city and dams construction. See bibliography for a complete citation.

[3] RKG Associates, *Baseline Economic Conditions & Market Characteristics: Holyoke, Massachusetts*. Holyoke, MA, 2010.

[4] Ibid.

[5] Murro, Mark et al., *Reconnecting Massachusetts Gateway Cities: Lessons Learned for An Agenda for Renewal*, Boston, MA: Mass Inc., Feb. 2010.

[6]Denison, D.C., *Holyoke Chosen for Computing Center*, Boston Globe, June 10, 2009. For complete coverage of the MGHPCC's site selection process see the archives of the Innovate Holyoke Task Force, http://www.innovateholyoke.com.

[7] Ibid.

CHAPTER 2

ARCHITECTURE AND THE AGE OF COMPUTING

Introduction

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.[1]

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 I phone.

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."[2]

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."[3]

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?

The growing popularity of social networking stands as an example of this blurring of linguistic boundaries. Launched in 2004, Facebook registered its 500 millionth user in July, 2010.[4] That means 500 million people or one twelfth of the world's population "go to" Facebook to interact with friends, acquaintances and family members. Given this wireless, ubiquitous flow of digital information passing through real space on its way to carve out new virtual ones, perhaps it is time to re-think architecture in computer science terms rather than the other way around. Digital data is arguably no less important to human experience today than light, heat and air and therefore, must be attended to by the architect in equal measure. Instead of speaking of digital space in architectonic terms, perhaps we need to speak of architecture in computer science terms, as a hardware that channels and moderates the flow of data.

Geographers and theorists have been angling towards this kind of a re-reading of space since the onset of the age of mechanical reproduction. Lefebvre introduced us to the idea of the "production of space" in 1974 and Manuel Castells suggested in the 1980s that we have moved to the era of the "space of flows" where capital organizes and routes the movement of resources, labor, and information, and in doing so creates entirely new, heretofore nonexistent "spaces."

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 mind in equal measure.

Information Technology and the Boundaries of Space

To create a form that fits in this increasingly information saturated world, we first need a mental image of the extent of our world. Architecture is inherently bound in this way to geography. Renaissance mapmakers depicted the Renaissance understanding of the limits of the known universe. Renaissance architects worked within this image when creating built forms. While architects today can imitate Brunelleschi's methods and material's, we cannot grasp his understanding of the world and therefore cannot understand the context of his artistic inspiration.

To find the inspiration appropriate to our own time and place, we first need to establish an image of our own hybrid digital/real world. What are the extents of our hybrid terrain? Where does digital space leave off and real space begin?

Many people see the internet as the "fabric" of this increasingly digitally dependent universe. In 2003 a young computer scientists named Barret Lyon completed a stunning visualization of the internet that corresponds to this popular image.   Wired and wireless on the internet speaks to each other through "internet protocol" or IP, a language for communication that IP far exceeds either English or Mandarin in its global reach.   Lyon set out to map IP communication over the course of a single day. He chose to depict the transactions that take place on the internet as vectors moving away from nodes like the seeds of a dandelion. The end result is a 3D net that looks like an intense concentration of celestial bodies.

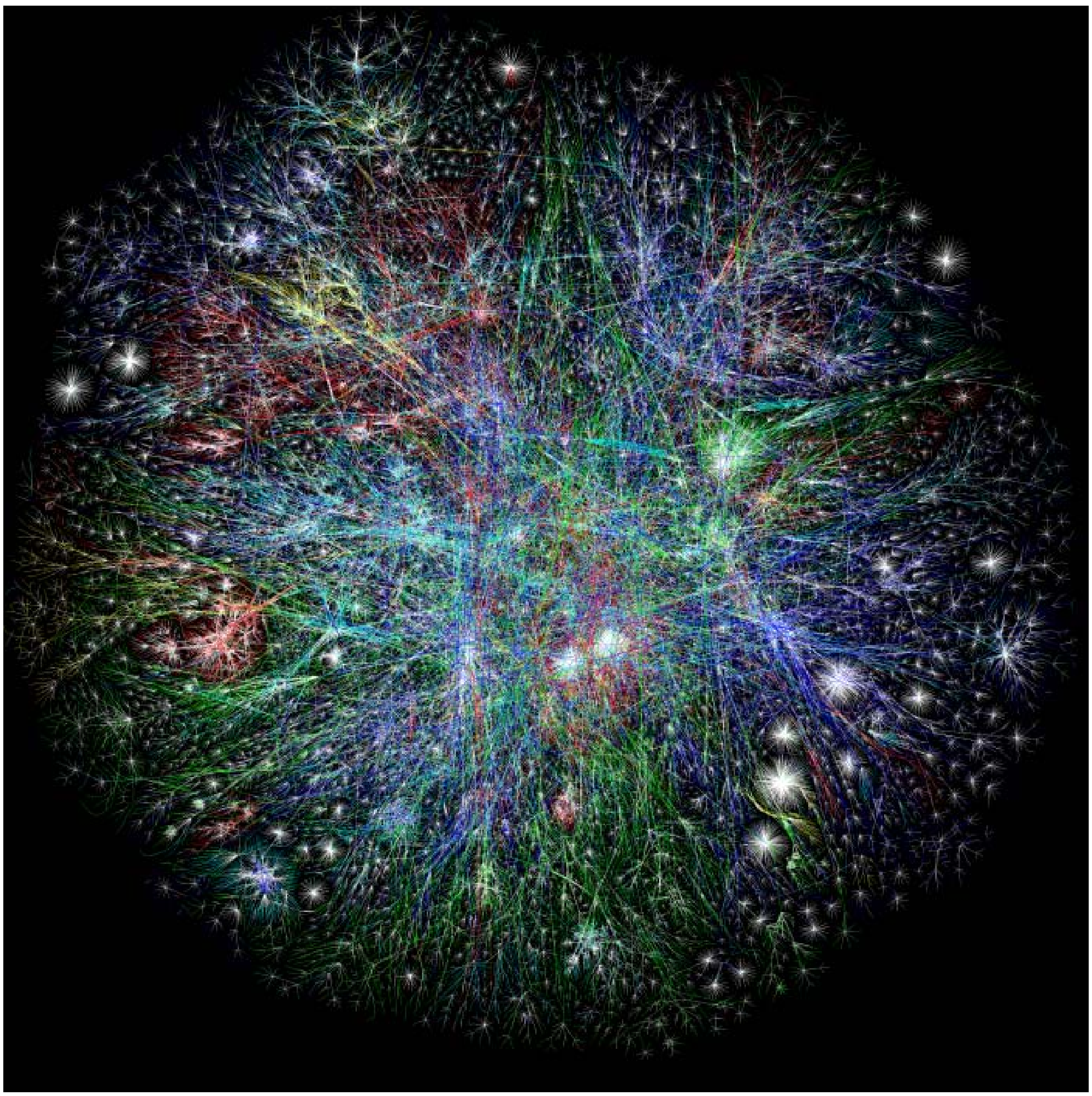


Figure 3. The Opte Project, (public domain)

This second image by cartoonist Randall Monroe maps the world subjectively. Randall's cartoon map replaces the names of real places with digital ones on a collage that borrows outlines from the familiar Mercator projection. In overwriting the names of "real" places Randall speaks to the fear we have that virtual experience is replacing real experience. By making calculated decisions about how these spaces relate to one another he also speaks to the fact that this digital space is not as aimless as we often imagine. There are ways in which digital "places" correspond to each other even without the advantage of actually existing in space.

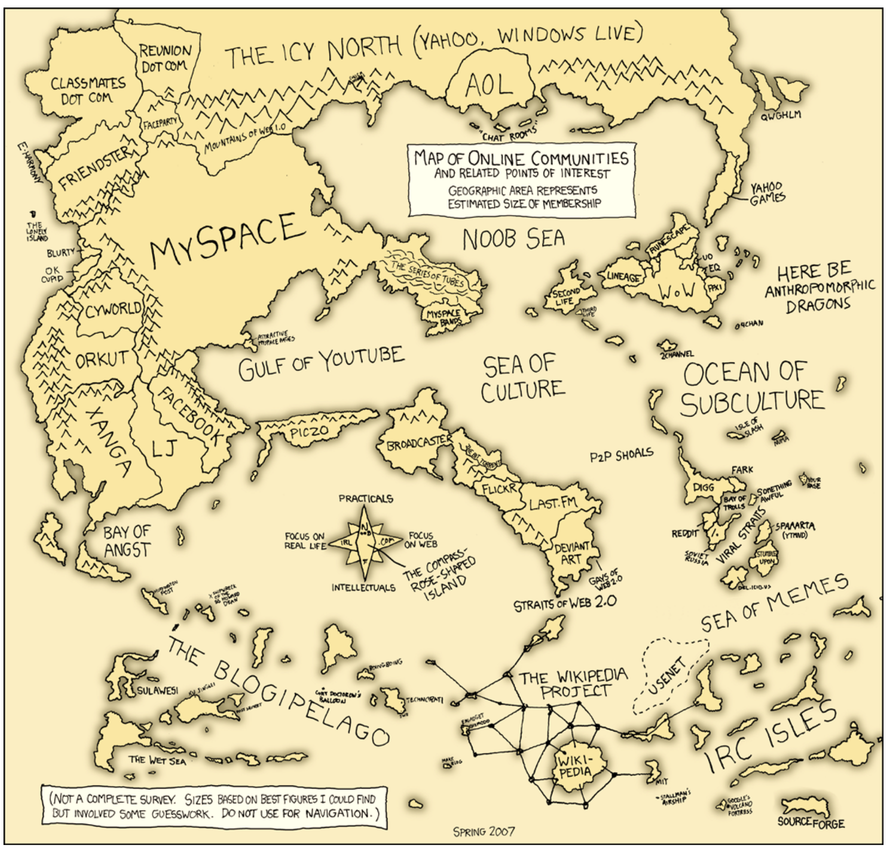


Figure 4. Cartoon by artist Randall Monroe, xkcd.

But neither Randall's nor Lyon's images satisfies our need to understand the extent of our hybrid world. Part of the problem is that maps are typically drawn in 2D or are applied to a globe or 3D surface. But this type of representation does not capture the fourth dimension, time. The rate at which information moves over distance far exceeds anything we have experienced before in human history and is the primary reason why we still express a sense of surprise at our capabilities. Digital communications enable us to make connections that defy the perceived logic of spatial relations. We can see and be seen in any corner of the globe through the click of a button and can just as easily return home in milliseconds.

Geographer David Harvey calls this change the "annihilation of space through time"[5] and is one theorist among many who argues that this process of shifting perspective is " disorienting and disruptive" but also potentially productive. Harvey places the current anxiety of 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.[6]

Not knowing if it is possible to combine these competing images, the comic, mathematical and the philosophical, I strive to keep all of three in my head as a kind of map of the universe I live in. The point of having a map, like the point of the Renaissance map to the Renaissance architect, is not to mimic its contours in architecture, instead it is to develop a keen understanding of the perspective of our era.

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. Faced with such an overload of existential angst, architects need to work harder to provide a place for our free floating identities to land.

Life with Ubiquitous Computing

> "A critical practice challenges prevailing values through work based in some other set of values."[7]
>
> 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. For me the first signs of these momentous changes showed up in the early 1990s with the advent of email.

From 1994 to 1997 I worked at the University of Wisconsin Instructional Media Development Center as a video producer. During that time the UW-Madison set up its email system and encouraged staff and faculty to learn to use it. Before email, my day consisted of arriving at the office, chatting with colleagues, working in production and editing studios and engaging with clients or content specialists by phone or in occasional face-to-face meetings. As email was introduced my work habits began to change. Like Twitter today, email users in the early 1990s demonstrated a hip, upstart attitude. But gradually email lost its edge as even the most fossilized workers succumbed to its advantages.

The primary advantage of email was asynchronous immediacy. You could rapidly and informally correspond without needing to control the presence of the person on the other end of the communication. Bound as we were to desktop computers, this did not immediately bring about the kind of physical fluidity we experience today. But it did gradually change our habits. It led us to reduce the amount of time "wasted" waiting for the phone to ring or for the meeting to begin. It also reduced the time spent in face-to-face social interactions with the people in close proximity or with clients. Nearly twenty years down the road, I feel my own life provides a pretty good example of how the adoption of this technology has led to greater social and physical isolation.

My personal experience is well substantiated by many reputable academic studies conducted over the last twenty years. 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."[8] 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.[9]

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 censors, 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.

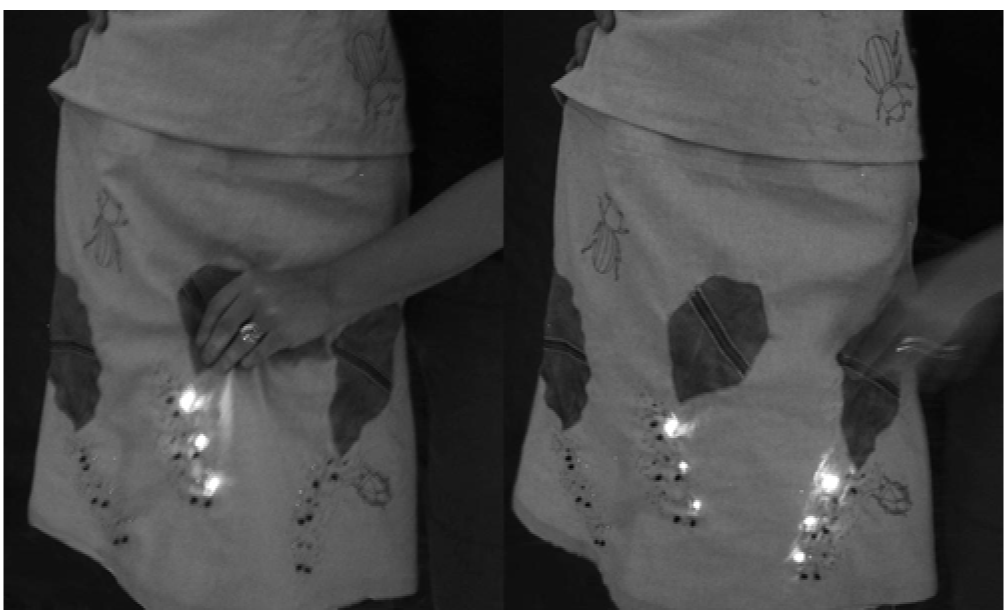


Figure 5. Memory dresses by Joanna Berzowska

"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." [10]

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 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.

<u>Sensing, Surveillance and Public Space</u>

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 of 5 Wits Productions in Boston, 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."[11]

Disney is not alone in promoting this idea of the pervasive network of censors. 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 Smart+Connected prototype in Holyoke is a part of Cisco's efforts in this arena.)

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, but 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.

Figure 6. 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.

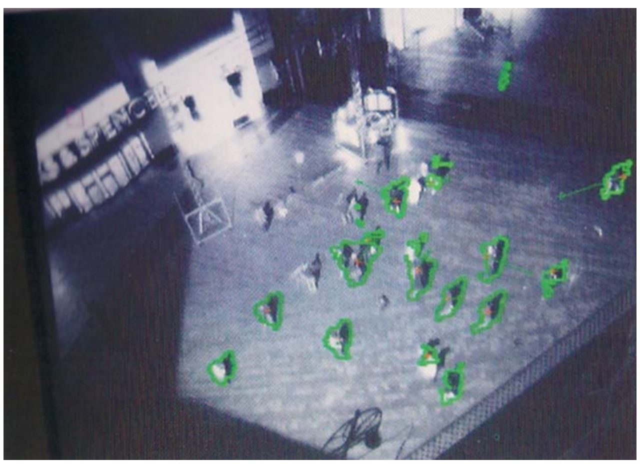
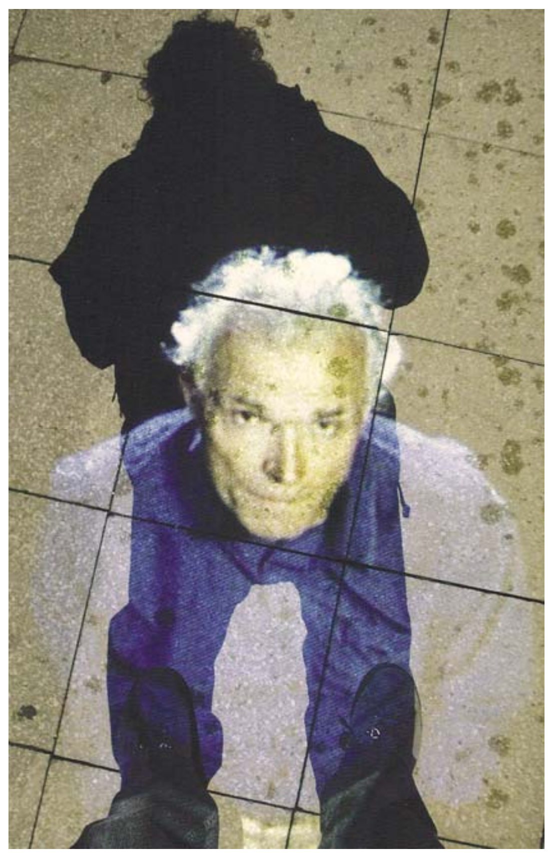


Figure 7,8. Underscan, by Rafael Lozano-Hemmer



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 for me 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.

It is interesting to note that Lozano-Hemmer expected pedestrians to be alarmed by the moments of reveal when the square was bathed in neon gridlines. Instead many people relished the release from the human gazes coming from the ground. Their body movements during this "break" are liberated and spontaneous. Children especially enjoyed the opportunity to dance and interact with the mapped space. Like Lozano-Hemmer I am curious as to why this occurs. Is it that people are still uncomfortable locking eyes with strangers in the street or just that they are more comfortable in a place that feels like Hollywood's idea of cyberspace?

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 the thickness of the walls or the size of the apertures in buildings 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."[12] 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.

In this chapter 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 dedicate the next chapter to exploring a similarly purposeful investigation. I seek to insert a new, information processing architecture into Holyoke with the intent of re-activating an underutilized industrial space in a community desperate for social and economic revitalization.

Notes

[1] Hiner, Jason. Znet Magazine, 9/8/2009.

[2] 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.

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

[4]Barnett, Emma, Telegraph Co., London, UK, 21 Jul 2010.

[5] Harvey, David, The Condition of Postmodernity (Malden, MA: Blackwell 1990), p. 120.

[6] Ibid., p. 183.

[7] McCullought'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).

[8] Scheer, Robert, *USC Annenberg Online Journalism Review* citing a previously published article in the Washington Post, April, 2002.

[9] 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.

[10] Berzowska, Joanna. "Memory Rich Clothing: Second Skins that Communicate Physical Memory." XS Labs, 2006.

[11] Matt Duplessi, Interviewed in Foxborough, MA by Dorrie Brooks, August 31, 2010.

[12] Mumford, Lewis, Symbol and Function in Architecture (New York: Columbia University Press, 1952), p. 2.

CHAPTER 3

CONCEPTUAL DESIGN

OF THE TURBINE CENTER FOR DESIGN AND INNOVATION

Site Analysis

The structure that occupies 1 Bigelow Street is known locally as the Diamond Water Building. It is a poetic name one might assume comes from the building's unique site characteristics. The three story mill looks out over the slow moving waters of a canal. In truth the name Diamond Water belongs to its most recent tenant, the Diamond Water Filtration Company.

Approaching the building on foot moving from the west down Cabot Street I am struck by the imposing force of the mills of the old Alpaca Farr Textile Company that the Diamond Water Building once belonged to. The older 5 story mills at the top of the street stand like sentries glaring over First and Second Canal towards the Connecticut River. Directly next to the Diamond Water Building is a sister building recently occupied by Mastex Industries. The Mastex building is a one story structure in poor condition that is about to be removed to make way for the new high performance computing center.

Moving eastward in front of Diamond Water on foot, the atmosphere changes quickly. The old Hadley Falls Water Power Company mill is directly across from the entrance to Bigelow Street, but is stepped back creating a substantial vertical gap into which direct southern light falls throughout most of the day. The front of the Diamond Water Building is 144 feet long and uninterrupted. The sidewalk slopes slightly downhill. Passing beyond the building you feel you are walking out of a concrete and brick canyon into a field of light. The Second Canal and the wide, white Cabot Street bridge combine to create a vast expanse of open space that ends 180 feet to the east on Race Street. On a winter's day in January when I first visited the building this luxurious southern and eastern exposure and the reflected light from the canal washed the humble brick facade of the Diamond Water building in a remarkable wave of warmth and daylight.

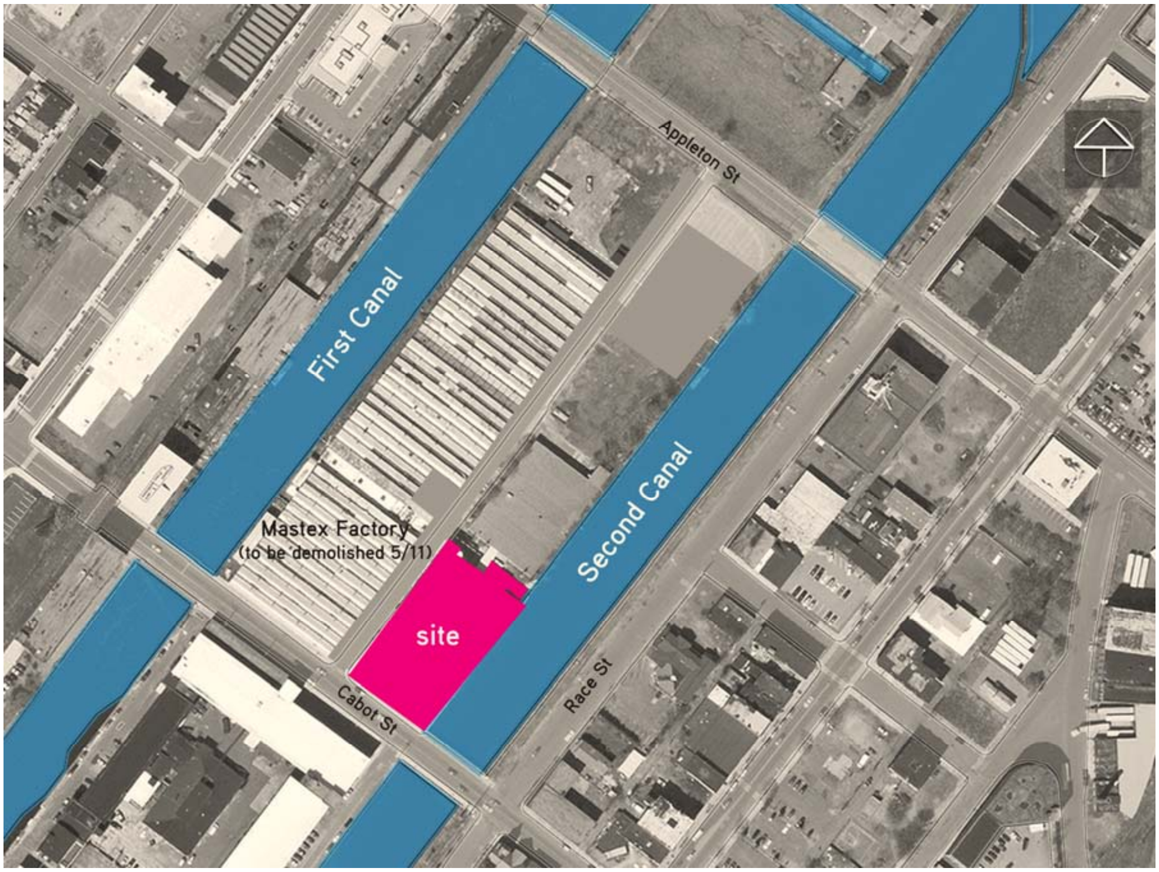


Figure 9. Site map (by author)

Walking back up Cabot and turning onto Bigelow Street you see evidence in the brick work of the building's accommodation of history. The mill was built in two stages. A small one story section was constructed before 1890. A second larger, enveloping structure was completed by 1910. Holyoke in the years before World War I was a vibrant industrial town, and the Farr Alpaca Company, a relatively late arrival to Holyoke, was just entering its most profitable years. The company's directors were not inclined to boast about their profits with architectural decorations. Thus the mill displays none of the architectural flourishes one finds in earlier mid-19th century mills.

Figure 10. View from south over Second Canal. (by author)

Figure 11.   View from across Cabot. Mastex on left. (by author)

There are no bell towers or decorative cornices. Its overall sparse, utilitarian design foreshadows the streamlined qualities of modernism.

The entire building stands roughly 50' feet high from first floor to cornice. Large windows line the perimeter of the building at the first and second floor level. Other than small apertures in the mid-point of the floor spans, the entire third floor is lit by north-facing light monitors. While the monitors are boarded up, and have been since the 1940s, they are extensive, running the length and width of the entire roof. The saw tooth profile of the roof system is still the most distinguishing feature of the building's exterior. It is easy to imagine the regular lighting they once provided to the building's occupants.

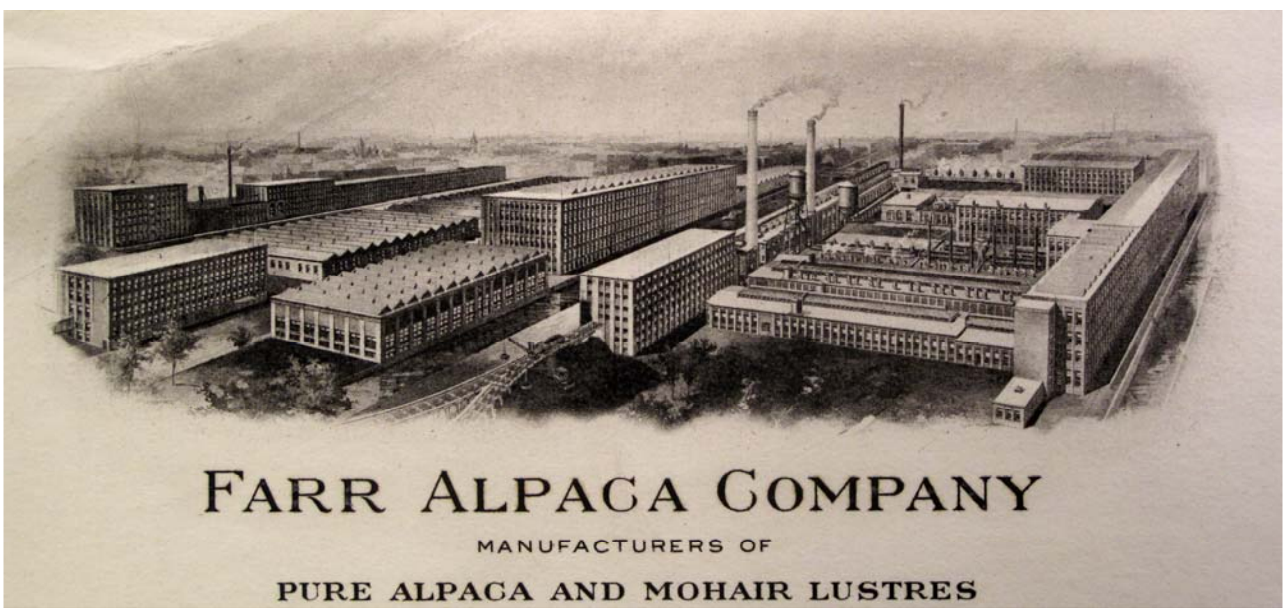


Figure 12. The Farr Alpaca Company, from The Story of Holyoke, by Wyatt Harper

The mill's entrance is discrete to the point of confusing. The two "sister" buildings, Mastex and Diamond Water, are accessed by service entrances on the alley. One can imagine that delivery trucks and workers once shuttled back and forth between the two buildings with great regularity, but today both mills sit vacant. It is hard to figure out how to enter either one.

The middle of the west side of the Diamond Water Building has been altered from its original construction to support a second loading dock and a handicap accessible entrance and service elevator. The entrance to the building is tucked in next to this popped out loading dock. A mess of wiring and window air conditioners lines the building's west side.

One realizes upon entering the building that a subtle grade shift occurs between First and Second Canal. The entry point puts us into a landing midway between floors. Encased in the same brick as the exterior masonry, this stair core dates to the original design. The entry and exit points from the stairs to the main floors are marked by low, narrow doorways. Once inside the mill it is clear that the stairs and utilities serving the mill from Bigelow Street are all intentionally ganged on one side of the building to keep the mill production floor free of clutter. The interior of the space is a sea of exposed, uninsulated steel columns. A few partition walls break up the monotony of the space, but they are clearly recent additions.

The first floor is 12' in height which makes this vast horizontal expanse and dense column system overwhelming. Workers for Diamond Water have moved their activities to the perimeter of the space and punched windows into the plywood that covers the old glazing system. The daylight from these small apertures gives visual relief to the space and hints at what might it have been like before the windows were boarded up. The depth of the window sills reveals the remarkable width of the exterior walls. They are, by my measure, a full 2 feet thick.

Figure 13. Behind the truck, the original and still intact glazing system (courtesy Holyoke History Archive)

The structural system of the Diamond Water Building is known as "caged construction" and is unique to buildings erected between 1890 and 1910.[1] Caged construction is a historically hybrid building technique where a steel-based structural system, or cage, was encased by a traditional self-supporting masonry shell. The shell was densely filled with layers of brick wythe. The walls of caged construction buildings do not contain any steel members.

Despite certain advantages to sheer strength and structural redundancy, caged construction was abandoned after 1910 when architects moved towards taller structures enabled by steel transitional frame systems. By 1940 the modern cavity wall system was fully established in the United States. The technique of cavity construction, still in place today, enables the facade of the building to attach to the frame while the structural system supports the building's vertical load. Such systems are considered more sound seismically because they are less rigid.[2]

Moving up through the Diamond Water building one discovers that each floor is of a different height with decreasing column widths. The second floor is 16 feet high and the third floor is 19 feet to the bottom of the monitors with another eight feet to the peak of the monitors. The third floor is the best place to study the details of the structural system. In addition to the steel I-beam columns that are roughly 14 inches in width, the system consists of steel beams of roughly equivalent depth and wooden girders of at least 16 inches in depth. This two-way structural system has the advantage of allowing higher ceilings and thinner floor widths because it eliminates the need for floor joists. Its downside is that it requires relatively tight bay configurations. Diamond Water's bay dimensions are only 10 feet by 17 feet.

At the north end of the building a sturdy brick and mortar loading dock of similar vintage to the main building creates an L-shaped access point for truck deliveries. A temporary metal building stands close to Diamond Water on its northern side, closing off what might have been a pleasant exterior courtyard and canal overlook for the entire block. The MGHPCC intends to remove this building and replace it with a parking lot.

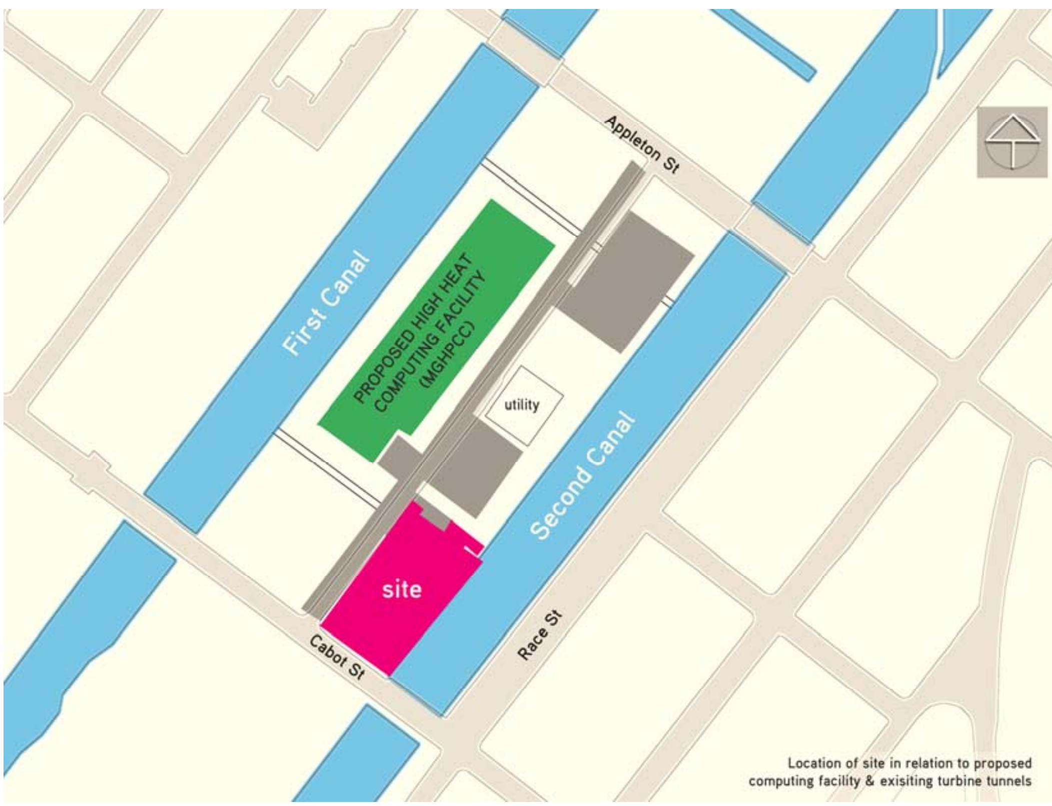


Figure 14. Proposed site changes (by author)

The east side of the building is the most public face. This facade runs 233 feet in length along the canal with not a hair's width of space between the exterior wall and the canal's wall. In the era in which the mill was built, the mills and canals were an integrated system. Towards the north end of the east face where the canal wall meets the water there is evidence of a tunnel running beneath the building. This tunnel is an extremely important discovery.   Each prime industrial block of the original canal system contains two turbine tunnels. The turbines powered the mill's machinery. Later they were converted to hydro electrical generation. At some point, this particular turbine tunnel was closed off and discontinued. Several hundred feet further north the second turbine tunnel is still active and still generating electricity.   The perpendicular axis of the turbine tunnel becomes a central focus of later design explorations.

Program

Like the Diamond Water Building, the workers of Holyoke are waiting for a shot in the arm. For six straight decades unemployment rates in the city have lagged behind those in the rest of the State of Massachusetts. Rather than replace lost mill jobs with new, low wage industrial jobs, the proposed program for Diamond Water imagines the creation of a digital education and incubation facility geared towards the development of the skills and creative output of residents of the city. Not only does such a program meet an urgent need,[3] it aligns with the assumption of the project that the nature of work has changed such that new models of work and work spaces have to be explored.

Holyoke has been ill served by corporate interests that make use of Holyoke's resources, but feel no compunction about leaving when they find their interests can be better served elsewhere. Given that it is not in the city's power to extract long term commitments from private investors, perhaps it is time to look into refashioning , underutilized, industrial spaces into incubators that can spawn local creativity, knowledge, wealth and, most importantly, jobs.

Professor Neil Gershenfeld's concept of a digital fabrication lab (Fablab) proposes just such a place. Fablabs are community work spaces outfitted with traditional and digital fabrication tools, often called personal fabricators. They are typically located in economically disenfranchised communities. The idea behind Fablabs are that communities can evolve local networks of informal knowledge around the emerging field of digital design and physical production. Citing the old adage about turning swords into plowshares, Gershenfeld argues that increasing access to technologies empowers communities to identify and solve local problems, breaking the paralyzing cycle of dependency.

Giving out sophisticated computer-aided equipment with little more than a manual might not have made sense in the 1950s but in the year 2011 with the power of social networking firmly established, Gershenfeld's ideas are proving to be very sound. The Fablab concept has only existed for about ten years but already has spread to hundreds of communities as diverse as villages in Ghana and urban neighborhoods in Providence, Rhode Island. It has also led to the development of world-wide networks for digital DIYers (do-it-yourselfers) and has spawned several for-profit imitations. Want to create your own solar oven? Want to learn how to wire a circuit board or a remote control? The Fablab is the place for you. Fablabs combine traditional metal, plastic and wood fabrication tools with electrical labs, digital printing, laser cutting and robotic milling equipment. The informal slogan of the Fablabs, adopted from Gernshenfeld's class at MIT is that they are "the place where you can build almost anything."[4]

Holyoke's Fablab, which I've named the Turbine Center for Design and Innovation, proposes extending the concept of community accessible digital fabrication tools available on a membership basis, to include spaces for digital classrooms, shared computer lounges and flexible incubator work suites.

What is architecturally interesting about such uses in the Diamond Water Building is that it places into stark relief the transformation that has occurred in how we work as a result of the information revolution.

The 19th century mill is a coherent expression of period-specific architectural technology and cultural attitudes. The masonry walls, tight column configuration and expansive glazing systems met the needs of 19th century industrial work and workers. In New England a typical late 19th century textile mill employed young immigrant women recruited from farming communities. These young women, often no more than 14 years old, worked 54 hours a week standing at weaving looms or sewing machines. The column system discussed earlier was the logical choice to support the load of the machines. The glazing systems was a necessity to provide light for the women to work by.

Imagine what the floor of 1 Bigelow would have been like with hundreds of sewing machines whirring, no mechanized ventilation, no privacy or separation between workers and no place to gather and or get relief from the noise. It is no wonder strikes were common, even at mills like Farr Alpaca known for progressive owner/labor relations.[5] One hundred years later such work conditions, while still present in many parts of the world, are no longer easy to find in New England. Labor intensive industries like textiles have relocated to cheaper labor markets. What has been retained of the New England textile industry in the U.S. are the design and management jobs that require knowledge of digital tools.

Turning 1 Bigelow Street into a workspace suitable to today's economy requires several architectural adaptations. First, the large horizontal spans need to be converted into more varied spaces capable of accommodating more diverse kinds of work types and interactions, from classrooms to workshops, laptop lounges to exhibition spaces. Second, the circulation and lines of visibility between spaces needs to accommodate contemporary preferences for mobility and visibility. The tendency of work, especially digital work, to physically isolate workers in cubicles has led to a backlash, as evidenced in the growing popularity of internet cafes and open plan work environments. While it may seem contradictory, people who are intellectually engaged online seem to crave the physical presence of others as well as the right to refresh their anatomical position with greater frequency. Varied spatial types, integrated circulation and lines of visibility between spaces are essential elements of the revised plan's goals.

To develop a detailed list of program requirements I reviewed the plans of three Fablab spaces, one in Tampa Bay, one in San Jose and one in Providence, RI. I expanded this database to include information gleaned from the Whole Buildings Catalogue of design types. (See Appendix)

Precedent Studies

Columbia College Media Production Center

As a final stage of program development, I gathered and reviewed a set of architectural precedents that seems relevant to the challenges of 1 Bigelow Street's existing condition. Precedents explored during this phase of design included, among others, Columbia College Media Production Center by Gang Studios in Chicago, and Allied Works adaptation of a 1908 warehouse into a contemporary office space for Wieden & Kennedy, a Portland advertising firm. In each project similar tensions were at play between the program and the existing architecture's structural constraints.

Furthermore, both of the designs express the same desire as this project to animate the existing space in way that accommodates a creative and diverse community of users.

Figure 15. Columbia College Media Production Center (Studio Gang Architects)

Jeanie Gang's work at Media Production Center uses the analogy of a digital video production process to define a series of linear spaces containing varied scales of closed volumes connected by a series of ramps. Horizontal slices run crossways through the plan creating visual viewing lines or, in film parlance, "frames" between the different spaces. The combined effect retains some of the openness of the original industrial warehouse but with a more useful spatial sequencing or narrative flow. Gang's treatment of the facade, a colorful sequence of glass panels wrapping the day lit main entry area, accomplishes two important things. It broadcasts liveliness to the street and it repeats the concept of selective framing or montage that occurs in plan throughout the building.

Figure 16. CCMPC Plan, from Studio Gang Architects website

Wieden + Kennedy Advertising Agency

Allied Works Wieden + Kennedy strategy is different, but shares some qualities. Like Diamond Water, the existing building in Portland is column dense and structurally overbuilt for its contemporary need. Rather than gut the entire building, Allied Works chooses to embrace the dense field condition and use it as a starting point for a subtractive strategy. The client's work emphasizes communication. Allied Works grabs onto this conceptually and expresses communication by creating vertical fissures that build relationships between different zones of the building. Rather than play to the street in a linear manner, as Gang has done, Allied chooses a conservative exterior treatment respectful of the building's traditional masonry facade, and a modernist's exploration of concrete and exposed wood on the interior. The combination works to imply creativity and open-mindedness but with a degree of restraint.

At the center of the Wieden + Kennedy's plan an atrium space acts as a kind of well, or boring, pulling all the creative energies of the upper floors down to a generous meeting point. This vertical space dominates the building like the cross point of a crucifix plan. Smaller vertical incisions (removals of floor plate) occur on each of the floors creating echoes of the vertical connections engendered by the center core. These cuts create avenues for visibility between spaces and opportunities for varied means of circulation. Where Gang's strategy becomes legible in plan, Allied Works strategy is legible in both plan and section. It takes a materially dense box of people, activity, columns and floor plates and inserts a powerful vertical shaft and series of punctures that introduce light, air, and cross-floor visibility.

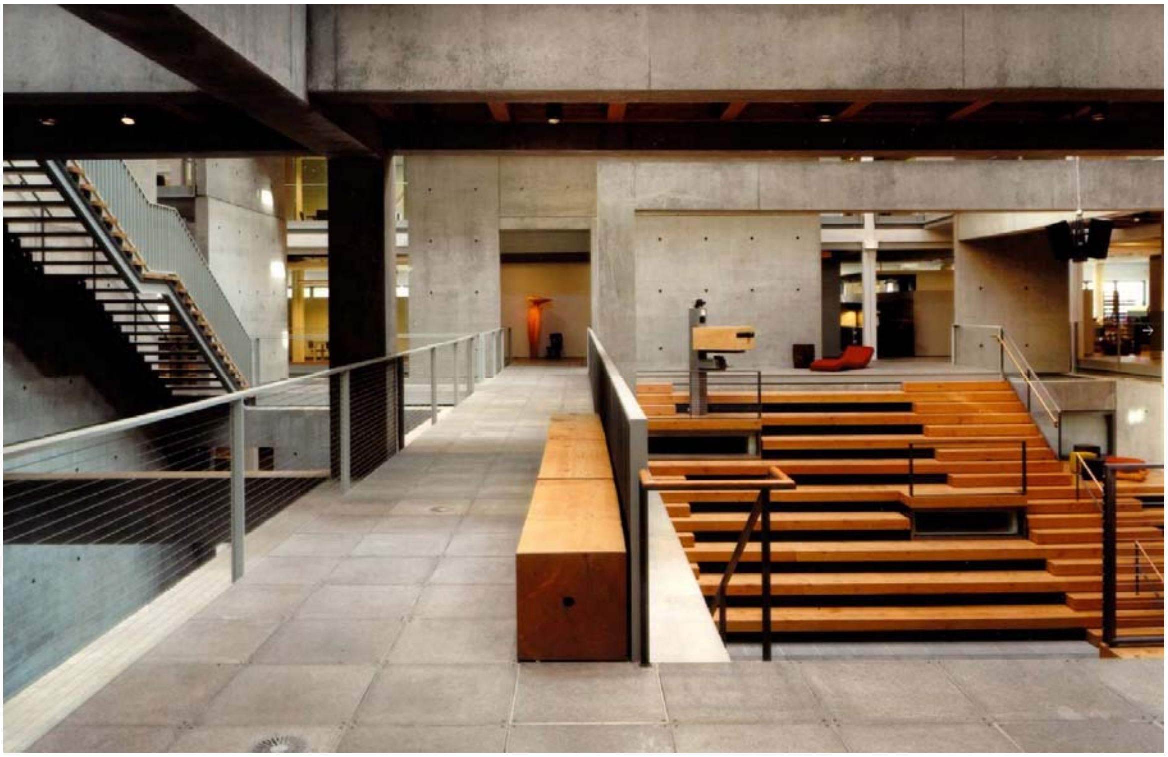


Figure 17. Wieden + Kennedy Interior, Allied Works Architecture

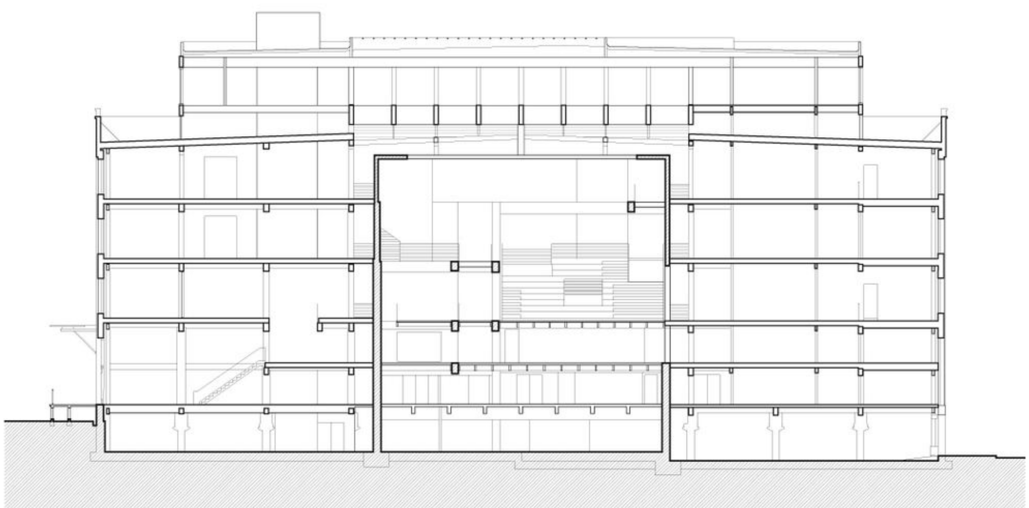


Figure 18. Section Wieden + Kennedy, Allied Works Architecture

Of these two strategies, the approach at Wieden + Kennedy is more applicable to the situation at 1 Bigelow Street. 1 Bigelow shares a similar field condition to Wieden & Kennedy and the decision of what to remove to liberate the building from its columns is important, as is the technique of connecting spaces through vertical cuts and paths. But while Gang's plan is a little less related, the choices the architects made by studying the technology and language of film making, and the way this language carries through consistently from facade to plan inspires me to continue to evolve the analogy of the building as information processor.

Conceptual Design

Computing the Flux of the Real

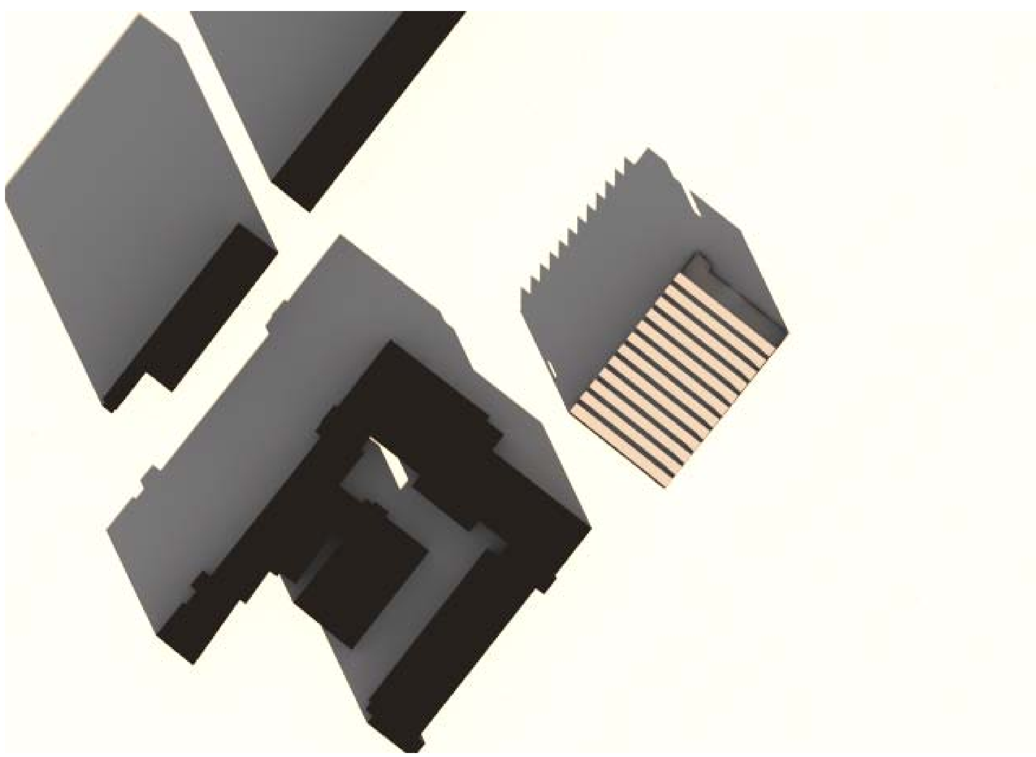
Architecture plays an important job mediating our relationship to our environment. This thesis proposes that the manner in which architecture has done this has shifted over time as technology and cultural norms have changed. Where the building comes into contact with the canal the architect of the 19th and early 20th century placed a 2 foot thick masonry wall with generous apertures. In the years before climate control systems this was the sum total of the climate control system. The wall acted as a heat sink moderating temperature variations, while the glazing system provided necessary light and fresh air.

The age of air conditioning, steel frames and curtain walls moved away from this strategy and towards a system of mechanically regulated volumes wrapped in layered enclosures or curtain walls. Adapting the old mills to the new technology meant blacking out the windows and installing cheap, unpleasant air handling units. It wasn't glamorous but the machines that replaced the workers in the original mill didn't complain. Gradually many of these buildings were converted to warehouses, perhaps because no one visiting such spaces could imagine working in them eight hours a day.

The design strategy for the adaptation of 1 Bigelow seeks to impose a new architecture to the site capable of doing a better job of managing the flow of heat, light, human presence and memory within the building. These are among the factors that architectural theorist Elizabeth Grosz calls "the flux of the real."[6] This strategy is heavily predicated on a personal assumption of mine, based in part on Grosz' work, that workers in the digital age, even more perhaps than workers in the 19th century, have a thirst for homes and workplaces that support our connection to place. By this I mean simply that as we are increasingly preoccupied with our virtual selves, our need for architecture that responds to local conditions increases. Lost in cyberspace we need buildings that document the sun's movement to maintain our sense of local time; that shift interior temperatures to maintain our relationship to seasonal time; and that provide access to external views and preserve aged building materials to maintain a connection to our collective memory and local environment. These, and our inherent social need for human fellowship are the functional qualities of architecture that keep us grounded.

Minding the Gap

My design process begins with a series of studies of the solar path over the course of the day to see how the building might "compute" the passage of time to its occupants.   I construct digital and physical models and carry out a virtual environmental analysis to develop a better understanding of the building's relationship to the sun and the seasons.   This analysis leads me to imagine imposing a wall within 23 feet of the existing south and east walls. 23 feet is the extent of shadow play from the first and second floor glazing system with floor plates removed.



10am, December 15th   Figure 19. A frame from a light study by the author

This imposed wall, a bit like the core of the Wieden + Kennedy Building, immediately generates a host of possibilities and questions. Rather than an atrium the wall suggests a building-within-a-building strategy. Such a strategy makes sense because it creates a logical way of inserting clustered spaces into the void of the existing building. It also creates a gap between the inner and outer spaces. An interstitial space of this kind is a rare luxury in a building but in the case of Holyoke, a city with acres of underutilized industrial square footage, this luxury is affordable. The project offers an interesting opportunity to explore the value of in-between spaces.

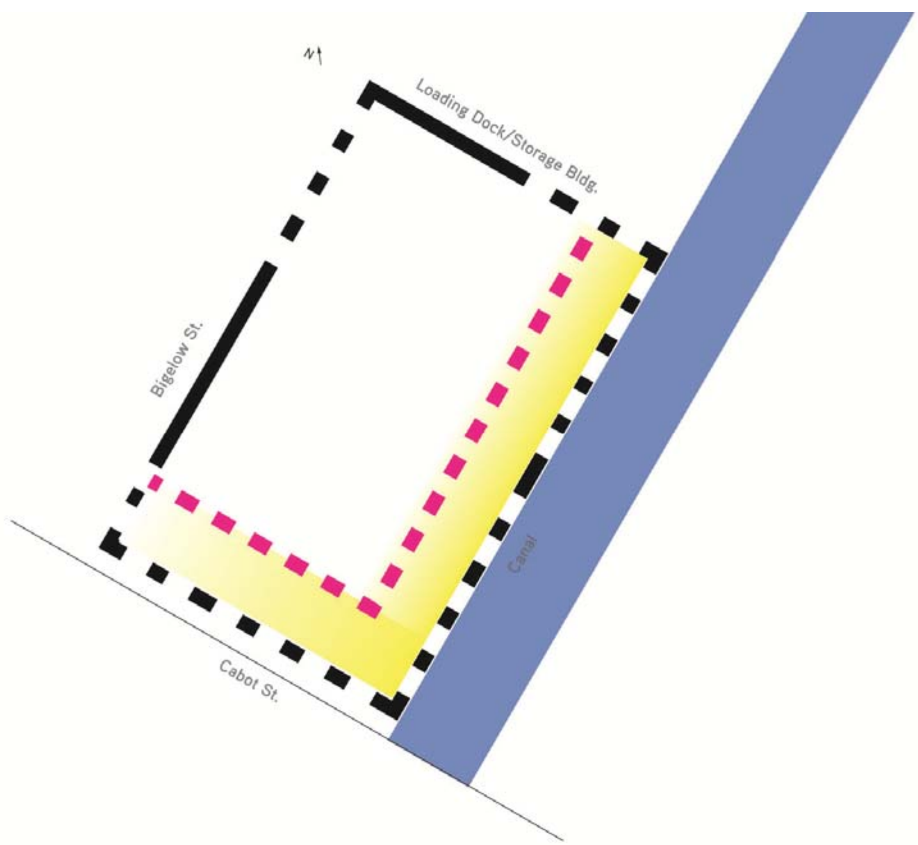


Figure 20. Diagram by author

One advantage of this gap is that it creates a generous amount of potential public space, something Holyoke's original city plan is desperately short of. The gap also serves not just one computational function, but several. It creates a viewing area for the observation of direct light and shadow; it thermally buffers the interior volumes; and it create a vertical shafts in which lines of sight and circulation can be organized to establish connections between floors. As the gap develops, it becomes clear that variety within the gap is something to strive for. Like an urban street, spaces of different size and qualities need to be created to provide texture and a sense of opportunity to people moving through the space.

The gap originates at the canal, the point where the site's ephemeral qualities are most palpable. It ends at the west side of the building where the utilities and existing core create an opposing sense of material firmness or darkness. The site's grade and the presence of the Mastex building to the west supports this reading of the western edge of the building as the more anchored. Being a pragmatist I decide to support the building's existing logic, and I place the new core elements on the West side of the building while choosing to maintain the original loading dock to the north as the primary entry point for fabrication materials. The loading dock dictates the eventual position of the largest workspace in the plan, a 2 story, conditioned wood, metal and plastics fabrication space.

For some time I explore the idea that the inserted wall that encases the inner building might have an anti-orthogonal quality. I use parametric design tools to explore sculpting the wall and imagine re-using the city's ocean of brick ruble to construct a new, updated interior masonry wall. But there is an artificiality to this design idea that never resolves itself despite countless digital and physical models. Such a wall is too functionally static despite its dramatic shape.

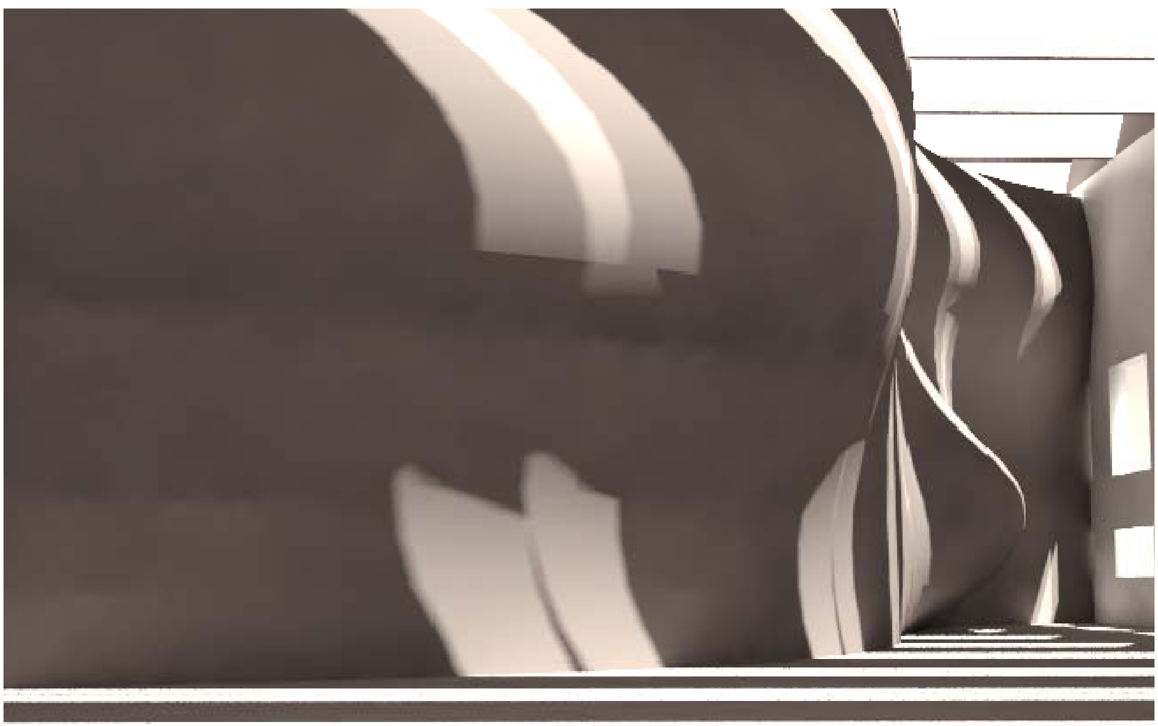


Figure 21. Digital rendering of study model, by author

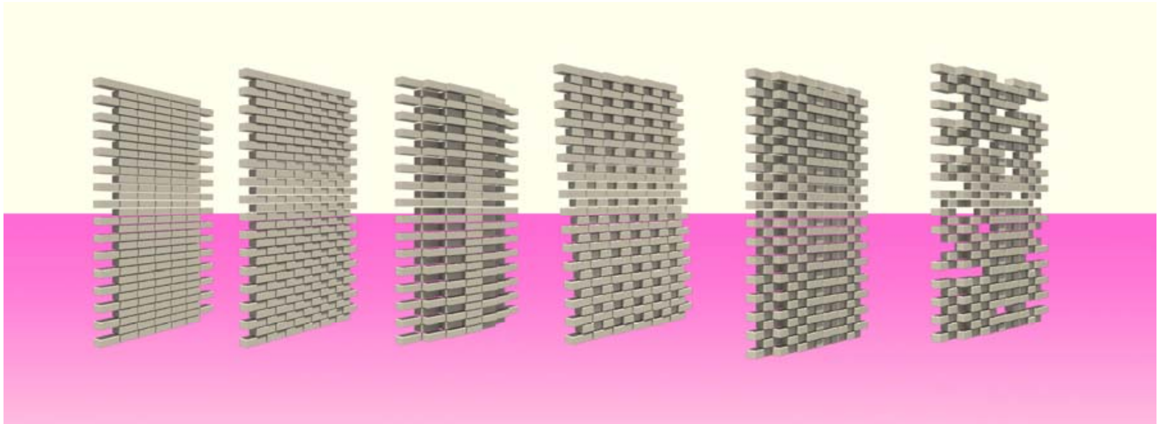


Figure 22. Renderings from a series of studies by the author

Eventually I notice that there is an axis between the buildings "core" area and "the gap" that runs along the canal. This axis is parallel to the turbine tunnels that run beneath the building. This is one of those moments when you choose as a designer to believe in a cosmic harmony that only you are aware of, though you hope it is somehow going to echo in the design at least unconsciously. I decided to abandon the complex curve in favor of the simple, orthogonal plan arising from the position of the turbine tunnel and the canals. It may just be a convenient justification, but it seems to lead to a more rational result. Working out the plan suddenly gets a lot easier. The trajectory from core-to-canal establishes the force of primary circulation and eventually results in a dramatic thrust that moves through the new volumes and ends just feet from the charming old brick wall.

Treating people like water in a turbine, I work to funnel the circulation down through the heart of the building. The new cluster spaces and core are organized around the funnel in two towers, an education tower and a fabrication tower.   A series of bridges and walkways extend from core to the towers so that the design begins to reflect an inverted consistency in plan and section.

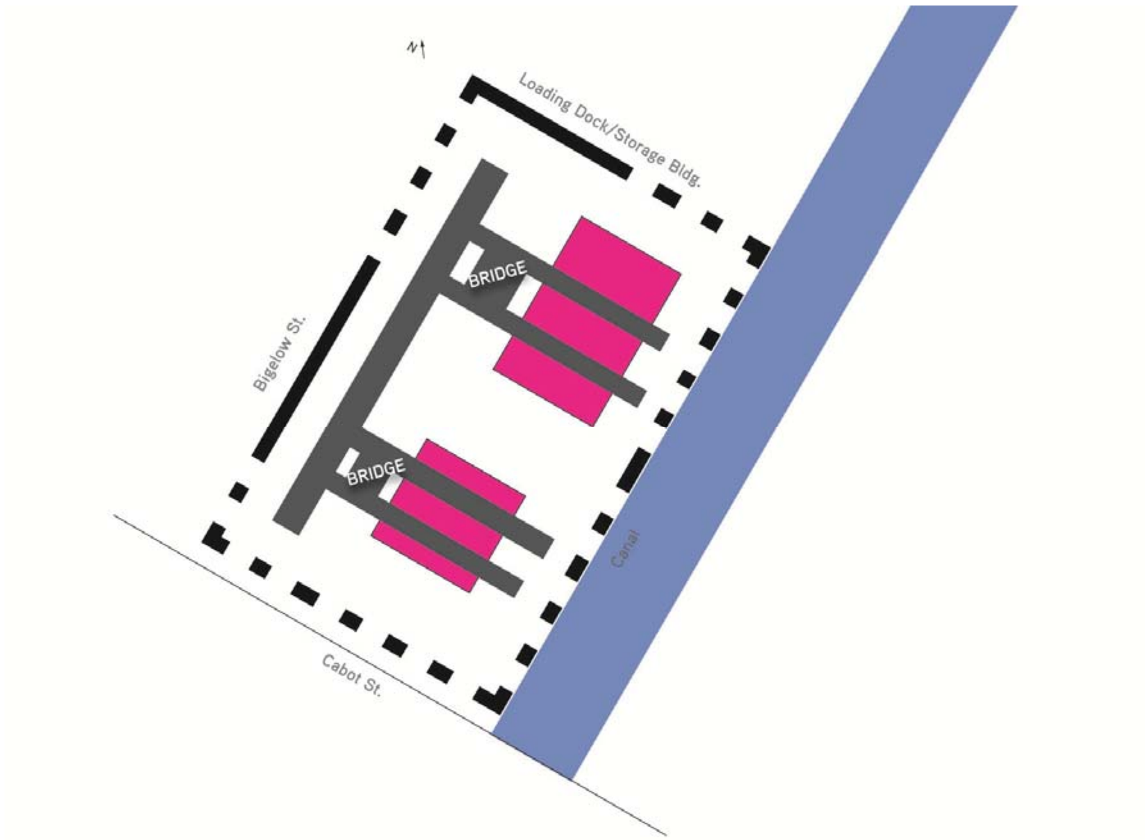


Figure 23. Diagram by author

The Gap's Inner Gap

Still the gap demands more of me.   The value of this whole thesis process is that it forces you to own your concept. The concept I've established to guide the design is that "the building computes the flux of the real." While the interstitial space is an effective way of giving vertical breath to the building, the formal decision alone does not complete the investigation. I am still vexed by the materiality of the wall around the inner volumes. It is, in my mind at least, an extension of the gap. The entire space from interior volume to sol air space beyond the masonry shell is an assemblage of assemblages, new and old, static and potentially dynamic.   The next hurdle of design is to figure out what this inner wall is doing functionally, and then to figure out what it is doing materially.

The idea of sharing a space between functional systems is always interesting. Not only does it suggest greater efficiency, it invites the possibility of creative collision. The large vertical nature of the gap makes this a significant thermodynamic opportunity. Oriented as it is towards the south and southeast, it is an easy argument to make that the southern portion of the gap can function as a passive heating space for the entire void.   The sun heats the two foot thick exterior wall and the concrete floor. The slow release of this heat throughout the day provides an energy transfer that can be accelerated by a system of fans and dampers that pull the warmed air up in alignment with the natural convection current around the imposed volumes.   This gap space around the volumes creates a thermal buffer, reducing the temperature differential between conditioned and unconditioned space.

A hydronic system seems the logical cooling option because it can share the same vertical space where warm air rises. In the summer, a reverse convection current cools the air in the wall, which drops it down to the concrete floor. Hydronic cooling of the interstitial space can be accomplished by running chilled water down a series of horizontally arrayed pipes on the outside of the inserted volumes. Another array of pipes within the closed spaces would cool the interior.

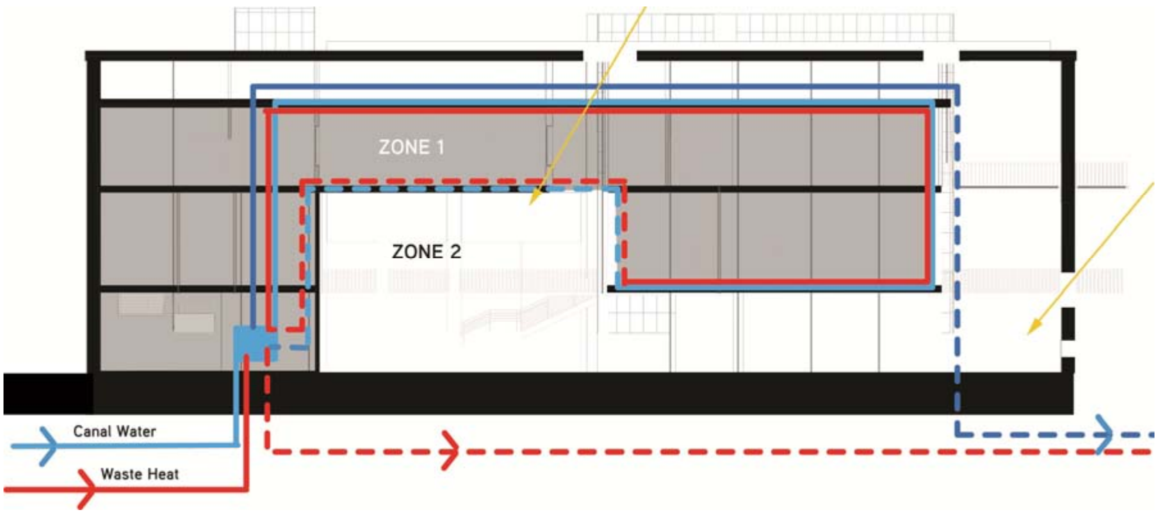


Figure 24. Heating and cooling diagram by author

Conveniently, the site provides a ready supply of chilled water. At its warmest, First Canal registers a seasonal high temperature range between 13 and 25 degrees celsius. Even 25 degrees is sufficient to meet the building's summer cooling load.[7] The idea of assembling this cooling and venting system within the margin of this inner wall strikes me as entirely feasible. I explore the idea of the inner wall binding to an orthogonal arrangement of existing structural columns in such a way as to create a second gap, roughly 18" wide, between an interior curtain wall and an exterior curtain wall. The shaft between these curtain walls act as a giant duct pulling heated and cooled air through the building vertically.

Next I approach the design of the inner wall of the inner gap of the inner volume. Again I use the computer analogy as the starting point. What information is this layer of the system processing? Primarily it is processing views and light and regulating the movement of energy out of the conditioned spaces. But at different points along the wall the need for views, light and insulation vary. One would think that the value of a unit-based curtain wall system, the dominant wall system of commercial buildings today, is the capacity to vary the panels that make up the wall as conditions demand, but often this potential is ignored. I decide to explore a simple curtain wall system into which panels of different opacities and insulating values can be installed, imagining that such a wall might encourage the hands-on engagement of occupants. In winter the interior panels can be switched to insulating aero gel panels that allow in light while retaining heat. In summer a desire for greater sense of shielding can lead to a change in arithmetic and a larger number of opaque panels. Perhaps the entire system can be strategically dissolved where occupants desire more sense of connection to the public space beyond the volumes.

The same logic is applied to the outer wall with one exception. I see no reason to install opaque panels here at all. The outer wall serves no insulating or privacy value. Instead it offers a screening of the mechanical systems within the wall cavity. A system of light emitting perforated screens or translucent panels makes the most sense as a material for the exterior layer of the double curtain wall system.

A problem in this design keeps cropping up. The "wall" was meant to capture the passage of time by harvesting shadows. While the margin between exterior masonry wall and the imposed volumes does create a venue for the observation of shadows, the curtain wall itself lacks the texture it needs to create shadows. With this thought in mind I explore the idea of setting back the exterior of the volume's outer wall so that the I-beam (and added C-beams on the alternate axis) can break the monotony of the curtain wall. Pleased with this result I finish the wall's conceptual design with a reconsideration of sensing and performance technologies.

Designing for Awareness

I have slyly managed to keep open the possibility of using the double curtain wall system as a stage for the exploration of sensing technologies and their usefulness. As a last step in this painfully truncated design process I address the idea that generated the design concept in the first place, sensing technologies and their inclusion in architecture. The detailed design of a system of sensors, DMX controllers and fixtures is beyond the scope of this project, but the general outline of the possibilities of such a system are worth discussion.

As a building dedicated to design and prototyping, the Turbine Center should enable occupants to explore the environmental systems on which they depend. I imagine the wall as a kind of visual dashboard revealing the dynamic forces acting on and within the building. The sensing system is not particularly complicated. It includes a series of motion, thermodynamic or carbon dioxide sensors; software that interpolates data into lighting cues; and programmable lighting fixtures that respond to scripted cues. All of these elements can be sandwiched within the wall system such that the wall can visually communicate the building's metrics to the occupants and to the world beyond through the play of light within the exterior walls of the new volumes.

Imagine the hot summer evening when the hydronic system kicks in. Temperature sensors relay data to a CPU that interpolates the temperature information into a series of lighting cues. The cues are sent to a series of programmable LED flood lights in the wall cavity mounted at the floor and ceiling. The lights present an orchestrated performance of blue and orange color washes descending along the vertical surface. The image communicates the gradual shift of temperature as the space cools. It is easy to imagine that the color shift alone might enhance the physiological effect of the cooling system.

This idea brings us back to the precedent studies discussed earlier of Berkowska and Lozano-Hemmer. "Smart" technologies and propaganda about smart technologies are all growing in popularity, at least in trade journals. Architects are feeling the pressure to include them in their designs. The downside of these technologies is that they typically promote the "dumbing" down of the occupant. They don't encourage the occupant to interact with the physical environment intuitively. They automate systems and fetishize information through handheld gadgets, establishing even greater distance between humans and their environment. The Cisco Systems Smart Homes is one example of the use of sensing technology in this way. Developed for a prototype community in Manila known as the Greenfield District, Cisco's Smart Home allows residents to raise and lower their thermostat, adjust the shades and change the light levels of their apartment from their workplace or their car by way of their smart phone.[8] This is supposed to encourage energy efficiency, but by disconnecting physical experience from cognitive experience it seems to do the opposite. A more useful deployment of the technology would aim to bring people greater cognitive awareness of their environment. Making smarter occupants seems at least as critical as making smarter buildings.

In the space of time available for this project it is not possible for me to design all the elements of the building to a thorough schematic level. Hopefully the major design moves discussed thus far are sufficient to suggest the direction of the final design. A few additional details are important to mention because they show up in the final renderings. In truth they are still works in progress.

The roof of 1 Bigelow Street is an opportunity to extend the design logic of the building as computer analogy to its completion. The existing northern light monitors provide a wonderfully even light to the upper reaches of the space. But the monitors are prone to snow drifts and ice dams. The option exists to repair the current system as is, or to replace it with a new system that collaborates with the inserted volumes.

A new system might consist of targeted light wells that conform to the needs of the new program and interact with the proposed passive cooling system. Or it might capture and route rainfall on the roof through the public space to support the water cycle on which the city depends. And finally, its horizontal space and solar orientation could be explored for their potential to house solar collectors. While the design is already a candidate for Zero Net energy designation, there is no reason not to consider its potential as a net energy producer.

The design decision relating to the public image the building gives to the street also requires some discussion. As mentioned before, the design process is more of a spiral than a straight line. I considered various ways of carrying the design through to the exterior. One idea, for example, looked at puncturing the southeast face of the building with a system of decks that would complete the connection of the plan to the canal. It is still an idea with merit, but ultimately I preferred the gesture of stopping the insertion at a distance from the exterior wall. This felt like an important acknowledgement of the building's history.

On the Cabot Street side of the building I felt the need to erase the existing envelope and broadcast a new presence to the city. This goal is accomplished by removing a portion of the south face of the building. Nibbling off this corner concentrates the message that the building had been changed. The "nibble" creates a window into the heart of the building and establishes two fissures running perpendicular to each other through which pedestrians are invited to enter. The west entrance ramps visitors up into the heart of the turbine while the south entrance draws visitors down into the solar space that runs along the canal creating an indoor extension of the city's canal wall. (See Appendix A for complete architectural boards)

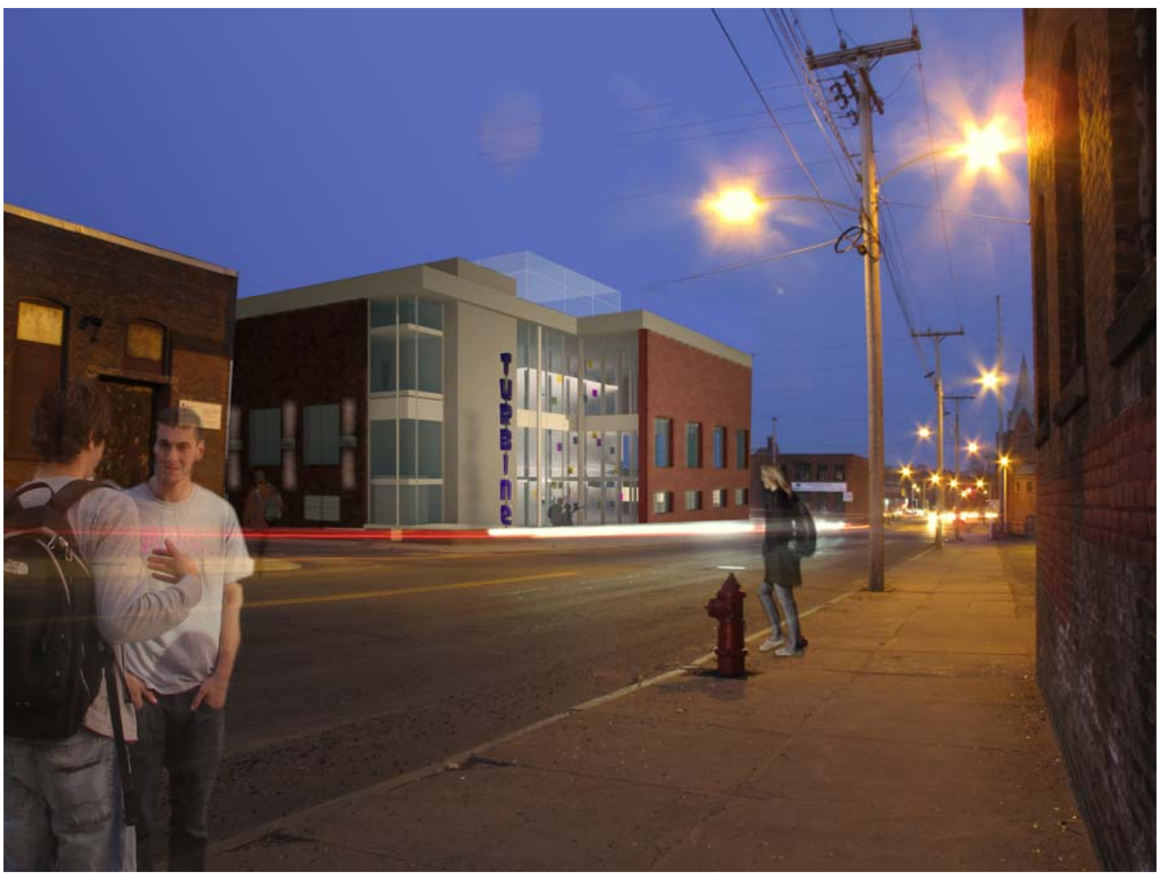


Figure 25. Rendering of model in site context (by author)

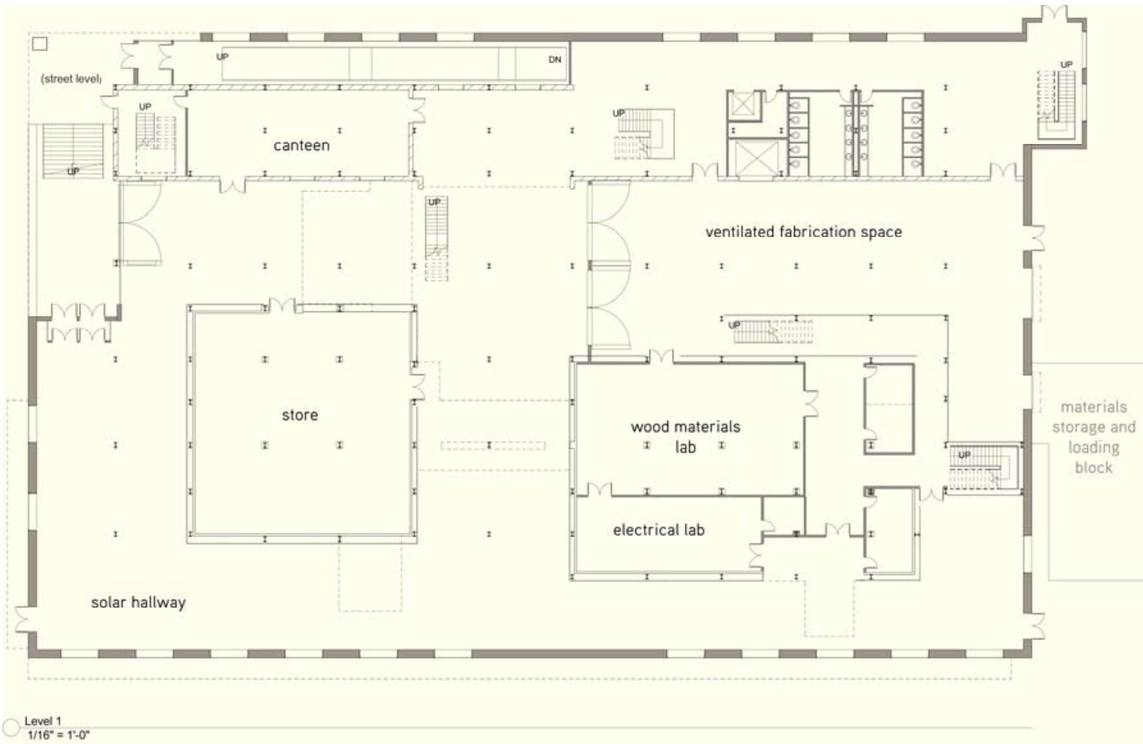


Figure 26. 1st Floor Plan (scaled for publication)

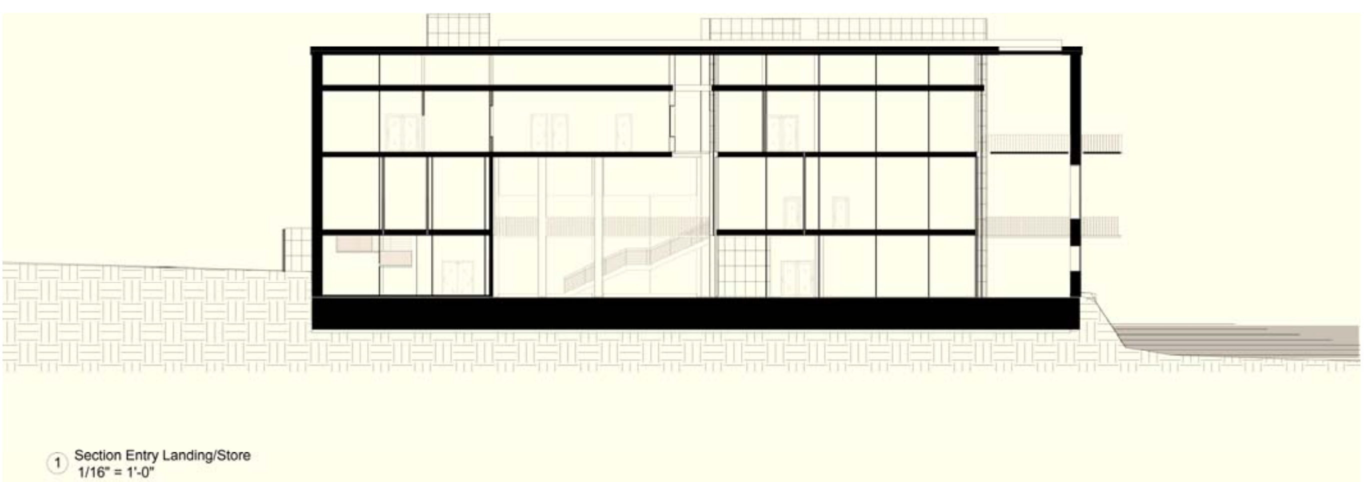
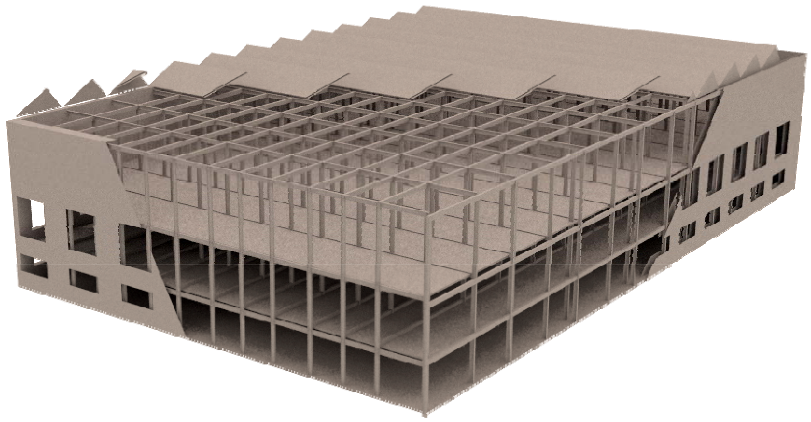
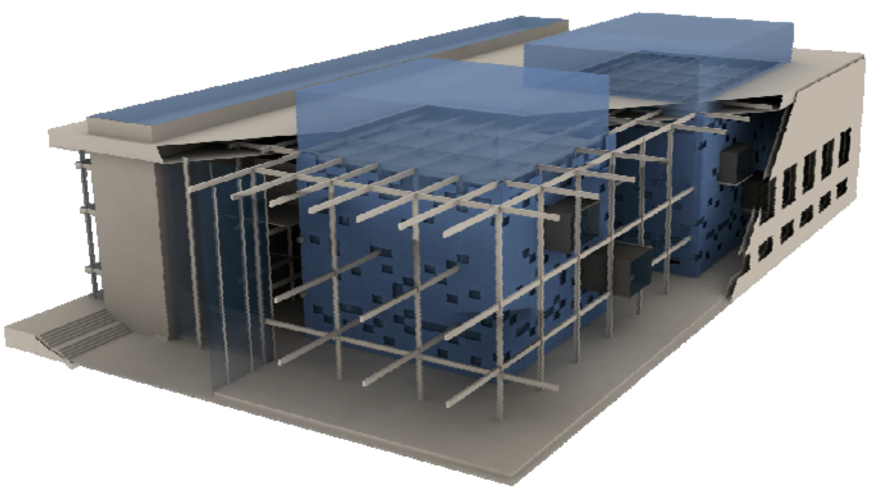


Figure 27. Section from Cabot Street side (scaled for publication)



BEFORE



AFTER (by author)   Figure 28

Conclusions and Possibilities

Carrying out an investigation of this depth has been a gratifying experience. An even more gratifying experience would be seeing any of these ideas translated into reality.

Some ideas are relevant to the city as a whole. While some residents have reacted negatively to any proposed use of the canal for cooling purposes, and while the city recently began work to dismantle its remarkable 100 year old centralized steam heating system, the long term benefits of energy self-sufficiency beg for a reconsideration of both these policies. Shared cooling with canal water and shared heating with waste heat from sources like the MGHPPC could mean significant reduction in energy consumption in the city as a whole. Similarly, the scale of the rooftops and vacant lots, and sheer mass of the older building stock in Holyoke should not be viewed as liabilities but as assets. These are places where the city can look to harvest radiant energy through a variety of old fashioned and new fashioned technologies.

The project also sought to explore building solutions that could be transferred to other buildings. Many of the mills built between 1870 and 1910 share common attributes. The use of exterior masonry walls as a source of passive heating makes sense wherever similar solar exposure exists; and in many places in Holyoke it does exist because of the generous width of the canals and streets. The removal of floor space, while logically inconsistent with many developers attitudes, could add market value to the remaining square footage because of the way it improves connectivity and internal circulation and visibility. And lastly, using digital technologies to strengthen connections between buildings and occupants is an idea whose time has come. The technology is affordable and available. What is needed are building owners and architects willing to experiment to see what the consequences of responsive systems might be.

This project owes a huge debt to the MGHPCC and its director, John Goodhue who generously allowed me to trespass at 1 Bigelow Street and answered all my questions. I kept in touch with John often, and never forgot that at the end of all this it would be his building that would garner public attention, not the virtual building I was designing. For his part, John knew all along that I harbored fantasies, as all graduates students do, of having an impact on the long term plans for Diamond Water. I still do.

Just as I felt it was short sighted for the MGHPCC to overlook the embodied value of the existing mills in Holyoke, I believe it would be equally short sighted to overlook the potential of a more engaged relationship with the community of Holyoke which has such a wealth of history in industrialization. The spark of industrial creativity needs to be rekindled if the United States is going to stop hemorrhaging jobs to other countries. The Turbine Center for Design and Innovation could be a place where experts and citizens collaborate on innovative ideas and the development of new products. The Turbine Center could create a place where the public can connect to the research being carried out at the MGHPCC, and the MGHPCC could support entrepreneurial projects being incubated at the Turbine Center with access to computing power and expertise. In time the two sister buildings could become a model of innovative research, service learning and architectural courage in the heart of a revitalizing industrial city.

Notes

[1] Briggs, David, *Hybrid Masonry Structures*, Troy, NY: Ryan Briggs Associates, undated.

[2] My research into the structural system was validated by a report issued to Mass Development of the GHPCC by Winter Street Associates, an architecture firm specializing in re-use situations. Winter Street Associates investigated the building and reported that while it was structurally sound, the building would require to meet seismic code was necessary.

Meche, Mark & Winter Street Associates, *Re-use Study, High Performance Computing Center: Holyoke, MA*. Mass Development and Holyoke Gas and Electric, Salem, MA, May, 2010.

[3] Adrion, Rick, *Summary Report on the Workshop on Educational Opportunities Associated with a Green High Performance Computing Facility,* Commonwealth Information Technology Initiative, Holyoke, MA, April 15, 2010.

[4] Gershenfeld, Neil, FAB: The Coming Revolution on Your Desktop, Ch. 1, *How to Make Anything*, Basic Books:New York, NY, 2005, Ch.1.

[5]Constance Green's story of Holyoke's history reports that for a period of time the Farr Alpaca Company went so far to honor worker's rights as to attempt to treat each $100 of earned labor wages as equivalent to $100 of share holder investment. They also included workers in the design of the building at the Bigelow buildings. She claims workers tested paint colors for the mill walls to determine which color produced the least eye strain. For a small research stipend I would be happy to spend another semester in Lowell, MA verifying these facts at the archives of the Farr Alpaca Company.

[6] Grosz, Elizabeth, *Architecture from the Outside*, Cambridge, MA: MIT Press. 2001, p. 180.

[7] Federal Energy Regulatory Commission, *Holyoke Hydroelectric Report*, City of Holyoke, MA: HGE, 1997.

[8] Twin Oaks, The Greenfield District Smart+Home Prototype by Cisco Systems, http://www.twinoaksplace.com.ph/about_top.html.

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