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RE|Fab : How the 10% Investment Tax Credit Can Aid in the Creation of a Prefabricated System for the Rehabilitation of Non-Designated Historic Structures

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Abstract

Historically known as "the Workshop of the World", Philadelphia was home to numerous industries that served as financial anchors for the neighborhoods surrounding them. However, due to a loss of industry these anchors have become dangerous, attractors of unsavory activity, and impediments to growth and safety. In order to reconnect the frayed social and economic fabrics that exist surrounding these buildings, a balance must be created between the building's historic significance and the contemporary needs and potentials of the surrounding area. Although, many of these vacant buildings are old enough to be considered historic most are not historically designated. While there are numerous incentives available to 'preserve' buildings that are historically designated, it is the non-designated buildings that often offer more contemporary design flexibility. In order to bring these buildings back to life, the quantitative requirements of the 10% Investment Tax Credit (ITC) for the rehabilitation of existing structures will be used as the spring board for the design. In addition, strategies that emphasize rapid, cost effective and flexible retrofit will be emphasized and techniques of prefabrication and rapid deployment will be explored. This thesis project explores how the implementation of a prefabricated, mass customizable, construction system into the rehabilitation of an existing building can help address issues of vacancy within the city. Can the creation of a prefabricated frame and panel system capable of being deployed within a structurally sound existing building begin to restitch the building to the neighborhood and the neighborhood to the city?

Keywords

Historic Preservation; Tax Credit

Disciplines

Architecture | Historic Preservation and Conservation

Comments

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Nakita Ann Johnson

A THESIS

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MASTER OF SCIENCE IN HISTORIC PRESERVATION
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____
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Lecturer in Historic Preservation

____
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DEDICATION

To Grandma Byrd for showing me everything can be reused;

To Grandpa Byrd for teaching me to keep it simple;

To Glenn for seeking the ‘greater glory’;

To Melissa for leading the way;

To LJ for being patient

And

To mom for giving me all the love I could handle.

This thesis has been a process of figuring out the intersections of architecture and preservation, both in the field and administratively at PennDesign. This work would not have been possible without the guidance of numerous people who helped me navigate the intricacies of this process.

First I have to thank my advisors, David Hollenberg and Brian Phillips for agreeing to drudge these unchartered waters with me. Their insight, positive attitude, and encouragement helped push me through the rough patches and gain a better understanding of my views on the intersections between preservation and architecture. Without their support and guidance this project would not have been possible.

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"Historic preservation can – and should – be an important component of any effort to promote sustainable development. The conservation and improvement of our existing built resources, including re-use of historic and older buildings, greening the existing building stock, and reinvestment in older and historic communities, is crucial to combating climate change."

-The National Trust for Historic Preservation's stance on Sustainability

PREMISE

According to the Brookings Institute there is approximately 300 billion square feet of existing built space in the United States. Architecture 2030 predicts that of this built space, more than 82 billion square feet will be demolished by 2030.[1] In addition, it is predicted that by 2050 more than 60% of the world's population will be living in cities.[2] The combination of these statistics creates a very unsettling picture. If the majority of the space that will be demolished in cities is structurally sound, then space for potential housing will be demolished before it is needed most. The sheer amount of non-biodegradable waste this demolition would send to our landfills should be reason enough to reevaluate how to incorporate existing buildings – including those seen as historic[3] - into new programmatic uses and designs. Since the operation of buildings produce approximately 43% of carbon dioxide and consume 72% of all electricity in the United States[4], finding ways to sustainably retrofit and adaptively reuse these existing buildings will be crucial to

[1] "Climate Change, Global Warming, and the Built Environment - The 2030 Challenge." *Climate Change, Global Warming, and the Built Environment - Architecture 2030*. Web. 12 Jan. 2010. <http://www.architecture2030.org/2030_challenge/index.html>.

[2] "Urbanization: Facts and Figures". Habitat Backgrounder. Wed. 11 Oct. 2009 <www.unhabitat.org>.

[3] To be considered for historic designation in the United States, a building or structure must be at least 50 years old and satisfy at least one of the four designation criteria. *National Register of Historical Places*. Web. 12 Jul. 2010. <http://www.nationalregisterofhistoricplaces.com/faq.html>.

[4] "USGBC: Green Building Research." *USGBC: U.S. Green Building Council*. Web. 13 Aug. 2009. <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718>.

reducing the negative impact buildings have on the environment.

As of 2000 there were more than 28,000 vacant buildings in the city of Philadelphia.[5] Many of these buildings are vacant and dilapidating light industrial structures and exist in a variety of conditions – from intact shells and envelopes to detailed interior layouts. Although the majority of these light industrial buildings are not historically designated, these buildings should still be promoted by preservationists as viable adaptive reuse projects. The need to find compatible programmatic uses for these structures that can be implemented in a relatively short amount of time is crucial to prevent the majority of them from being demolished and replaced by new construction – destroying urban fabric and sending massive amounts of waste to landfills.

One device used to entice developers to reuse non-designated structures is the 10% Investment Tax Credit (ITC). However, this tax credit as currently structured is only for non-residential, non-historically designated structures that were put in service prior to 1936. Since preservation in the United States generally exists on a sliding scale of 50 years from the current date, the rigidity of the 1936 requirement is quite harmful to many non-designated buildings that were constructed after 1936 and will be constructed in the future. Fortunately the Community Restoration and Revitalization Act (CRRA) recently introduced in the House of Representatives, seeks to expand and promote the use of the 10% ITC for the rehabilitation of non-designated structures. If passed, the CRRA would create a way for all non-designated buildings (including residential properties) older than 50 years of age to receive tax credits to supplement the cost of rehabilitation.

The ITC, unlike the Historic Rehabilitation Tax Credit (HRTC), is a quantitative instead of qualitative tax credit that does not have a formal design review process

[5] Philadelphia NIS Neighborhood Report on Fairhill. <http://cml.upenn.edu/nbase/nbProfileRequest.asp>.

and can be claimed on the owner's income tax for the year the building is placed in service. The quantitative approach of this tax credit (which will be discussed further in Chapter 1) has interesting design implications and is the basis for the design portion of this thesis, which will seek to evaluate the applicability of using prefabrication as a construction technique in the rehabilitation of existing structures.

Proposal

This thesis seeks to exist at the intersection of historic preservation, sustainability, housing, and prefabricated design, and will explore ways to bring together the related parts of each of these topics to create an alternative method of dealing with the rehabilitation of non-historically designated buildings for mixed-use purposes. In order to get a holistic view of the various ways in which issues of vacancy and adaptive reuse may be resolved, this author will evaluate the existing preservation policies for rehabilitation and opportunities for expanded policy impact while simultaneously looking to enrich these policies through the examination of the potential intersections with other fields. By exploring the existing and potential overlaps that exist between these fields it is the author's hope that the outlines of an alternative approach to intervening on existing structures will arise.

To test the design implications of the various intersections, vacancy in Philadelphia and preservation rehabilitation policies were chosen as points of departure for this thesis. Philadelphia's neighborhood fabric is characterized by numerous vacant buildings and tracts of land, especially in neighborhoods where light industrial buildings were centrally located. These buildings were once productive contributors to the neighborhood and the city at large; however, due to a loss of industry many have become dangerous attractors of unsavory activity, and are impediments to growth and safety. The design portion of this thesis will propose that these buildings can be put back into service in ways that will reconnect the frayed social and economic fabrics of their surrounding neighborhoods. This will be accomplished by adapting their inherent physical qualities to align with contemporary needs and potentials. Construction strategies that emphasize rapid, cost effective and flexible retrofit will be emphasized, and techniques of prefabrication and rapid deployment will be explored to test their applicability. The implementation of a prefabricated construction system would become a kit-of-parts for use by Philadelphia developers, allowing many existing buildings to be put back into use while simultaneously re-stitching parts of the community together and diverting massive amounts of demolition debris from the landfill.

Conclusion & Organization

The rehabilitation of the existing and historic building stock is an environmentally, financially, and culturally responsible act. In addition to the environmental implications of adaptive reuse and retrofit, there are numerous positive financial and social reasons to reuse existing and historic structures. Financially, reusing much of a building's infrastructure – from its connection to the power and plumbing grid to its proximity to public transportation – can have a positive impact on a developer's bottom-line. In addition, by recognizing that these existing and historic structures were part of a network of systems and amenities that had a relationship to how people lived, worked, and learned, adaptive reuse can have positive social implications and be a catalyst for neighborhood revitalization.

The various benefits of adaptive reuse have lead this author to believe that the numerous vacant light industrial buildings within Philadelphia should be adaptively reused in a sustainable manner. These often non-descript buildings are often the backbone of an area and deserve to be viewed as viable rehabilitation projects when they fall into disrepair. Due to their open floor plates, high ceilings, and extraordinary structural capacity, the majority of these vacant light industrial buildings could support the retrofit of almost any program and will be the main building typology focused on for the design portion of this thesis.

In order to explore many of the aspects, opportunities, and design implications for reuse, this thesis is organized into four chapters with supplemental appendices. Chapter One analyzes the rules and regulations of the four areas of interest to find potential intersections. Chapter Two examines the intersections that do and do not exist between preservation, affordable housing, prefabrication and sustainability to highlight areas of potential symbiosis. Chapter Three describes and analyzes the opportunities for expanded impact contingent on the approval and implementation of the Community Restoration and Revitalization Act (CRRA). Chapter Four illustrates the ranges in design that could result by the implementation of a flexible construction system capable of adjusting to the needs of the building and surrounding area in North Philadelphia. Finally, the various appendices are included to share the basis of knowledge this thesis was founded upon, and contain a review of relevant literature, influential design case studies, and graphic documentation for the proposed design of the selected site.

The Historic Rehabilitation Tax Credit (HRTC) is "the most significant single incentive for historic preservation and the production of housing"[1]

- David and Barbara Listokin,
Historic Preservation and Affordable Housing:
Leveraging Old Resources for New Opportunities

When rehabilitating an existing or historic structure there are various rules and guidelines that need to be followed - depending on the designation of the building and the programmatic requirements of the rehabilitation. The interplay of the existing structure with the new programmatic options is important to consider since there are numerous use and program options that could be implemented into an existing structure (i.e. community center, affordable housing, markets, retail space, etc.) Understanding the rules and regulations for rehabilitating these structures in addition to the potential overlap of requirements for the programmatic interventions will illuminate opportunities as well as challenges for the rehabilitation.

Based on the needs of the city of Philadelphia, this author decided to explore the specifics of historic tax credits, affordable housing, sustainability, and prefabrication. By understanding the individual rules and regulations of these separate agendas, opportunities and challenges for overlap will become apparent. The conceptual overlaps and the financial opportunities based on the programmatic interventions will play key roles in the economic viability of the rehabilitation project.

HISTORIC PRESERVATION & TAX CREDITS

In the United States, any structure over 50 years old, demonstrating significance and retaining sufficient physical integrity by itself or contributing to

[1] David Listokin and Barbara Listokin, "Historic Preservation and Affordable Housing: Leveraging Old Resources for New Opportunities," Housing Facts and Findings 3.2 (2001)

a historic district can be considered for historic designation at the national level (i.e. listing on the National Register of Historic Places).[2] The median year of construction for buildings within the city of Philadelphia is 1945 – meaning that more than half of the buildings in the city would be eligible for historic designation based on age alone. A building's significance, however, is attached to one or more of four National Register criteria: whether or not the building was associated "with events, activities, or developments that were important in the past", "with the lives of people who were important in the past", "with significant architectural history, landscape history, or engineering achievements", or with "potential to yield information through archeological investigation about our past".[3] Although a nomination to the National Register for Historic Places does not guarantee that the building will remain as it appeared historically, nor does it mandate that an owner retain the building. It does create guidelines and procedures that an owner must follow in order to receive federal tax credits to rehabilitate a listed income-producing property.

To aid in the rehabilitation of existing and historic buildings, tax credits were introduced with the Economic Recovery Tax Act (ERTA) of 1981. This Act introduced a three-tier investment tax credit – where each tier was divided by the age range of the building and the percentage of funding available to be received.[4] The range of buildings and percentage of available funding for each of the tiers was reduced in 1986 and is currently set to 10% for non-residential, non-historic properties and 20% for the rehabilitation of a designated building that is or will become income-producing. These two tax credits, referred to herein as the 10% Investment Tax Credit (ITC) and the 20% Historic Rehabilitation Tax Credit (HRTC)

[2] "National Register of Historic Places Fundamentals -- National Register of Historic Places Official Website--Part of the National Park Service." *U.S. National Park Service - Experience Your America*. Web. 17 Jul. 2009. <http://www.nps.gov/nr/national_register_fundamentals.htm>.

[3] Ibid

[4] David Listokin, Barbara Listokin, and Michael Lahr, "The Contributions of Historic Preservation to Housing and Economic Development," Housing Policy Debate 9.3 (1998): 446.

respectively, are the main financial incentives for rehabilitating existing or historic buildings. The ITC refers specifically to existing buildings that were put in service prior to 1936 and that are NOT designated historic. [5] The HRTC, however, is solely for certified historic structures and can provide a tax credit worth 20% of the Qualified Rehabilitation Expenditure (QRE) of the project.[6]

The federal tax credit programs have been “extremely successful in attracting capital to historic areas in cities and towns throughout the country.”[7] These programs are credited to “more than 35,600 projects nationwide and leveraging over $50 billion in private investment”.[8] In addition, it is estimated that the implementation of the credits have created more than 67,000 jobs dealing with the rehabilitation of various buildings. The eligibility of the owner to receive the ITC or HRTC depends on the historic designation and location of the project.

The 10% Investment Tax Credit (ITC)

As currently structured, the 10% ITC is only applicable to non-designated, non-residential structures that were placed in service prior to 1936. In order to be eligible for this credit, the rehabilitation must be a substantial rehab of at least $5,000 and the structure must not have been relocated from its original site.

[5] “TPS Tax Incentives.” *U.S. National Park Service - Experience Your America*. Web. 10 Mar. 2010. <http://www.nps.gov/history/hps/tps/tax/brochure1.htm>.

[6] Qualified Rehabilitation Expenditures (QREs) that are eligible for inclusion in a tax credit include: work done on the building, Architecture/Engineering fees, site survey fees, legal expenses, development fees, other construction related costs. QREs that cannot be included in a tax credit include: building acquisition, furnishings, new additions that expand the existing building, new building construction, and site work such as parking lots, sidewalks, landscaping. “Glossary - Rehabilitation Tax Credit Guide.” *NTCIC Is the Leader in Syndicating Federal Historic Tax Credits and New Markets Tax Credits*. Web. 27 Feb. 2010. <http://www.ntcicfunds.com/taxcreditguide/glossary.html>.

[7] Ibid.

[8] “The Community Restoration and Revitalization Act: Eight Proposed Amendments to the Federal Rehabilitation Tax Credit.” *PreservationNation Homepage - National Trust for Historic Preservation*. Web. 12 Mar. 2010. <http://www.preservationnation.org/issues/rehabilitation-tax-credits/federal/proposed-amendments.html>.

Although there is no formal application for this tax credit, the building rehabilitation must meet quantitative building retention requirements: 50% of exterior walls must remain exterior walls, 75% of exterior walls must remain in place, and 75% of the interior structure must be retained.[9] In addition, the property must be owned by the same owner and remain an income-producing property for at least five years after the building is placed in service. However, there is no formal application process for this tax credit, nor is there a formal design review process. The owner of the structure simply has to claim 10% of the construction cost on IRS Form 3468 for the tax year in which the building was placed in service.

The 20% Historic Rehabilitation Tax Credit (HRTC)

The Historic Rehabilitation Tax Credit is jointly administered by the Internal Revenue Service (IRS), the State Historic Preservation Office (SHPO), and the Secretary of the Interior through the National Park Service (NPS).[10] This tax credit can only be used on a designated historic structure that is income-producing or will be rehabilitated into one (i.e. rental apartments, retail, etc.). The extent to which the rehabilitation guidelines apply are based on the condition of the building at the start of the project; taking into account non-original modifications and conditions to ensure that the owners of the building are not reconstructing 'original' fabric that no longer exists. Like the ITC, there is no cap on the amount of funding that can be received from the HRTC, since it is based on the percentage of the construction cost of the project.[11]

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[9] Ibid, "TPS Tax Incentives."

[10] Ibid, "TPS Tax Incentives."

[11] "TPS Tax Incentives." *U.S. National Park Service - Experience Your America*. Web. 10 Mar. 2010. <http://www.nps.gov/history/hps/tps/tax/brochure1.htm>.

The main guidelines followed when rehabilitating a historic structure to receive the HRTC are the Secretary of the Interior's Standards for the Treatment of Historic Properties, namely the Standards for Rehabilitation.[12] Rehabilitation is "the process of returning a building or buildings to a state of utility, through repair or alteration, which makes possible an efficient use while preserving those portions and features of the building and its site and environment which are significant to its historic, architectural, and cultural values."[13] These Standards were developed in 1978 and have been edited twice since their inception – once in 1983 and again in 1995.[14] In order to receive the HRTC funding, the entire project must meet the Rehabilitation standards.

The process of applying for the HRTC involves three parts – an Evaluation of Significance, a Description of Rehabilitation, and a Request for Certification of Completed Work – Parts 1, 2, and 3 respectively.[15] The application fee varies for each project, as it is based on the project's construction cost. The application requires various components - from appropriate historic photographs to architectural plans in order to document the property both before and after the rehabilitation. In order to receive the maximum amount of tax credits on a project, it is important that the Description of the Rehabilitation is completed prior to the start of any work, thoroughly documents the building as found, and correctly shows the work planned to be undertaken in the rehabilitation. In addition, the work must be completed within 24 months or phased over 60 months in order to receive the tax credit.[16]

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[12] There are four standards for the Treatment of Historic Properties – preservation, restoration, rehabilitation, and reconstruction. Ibid, "TPS Standards and Guidelines."

[13] "Incentives!" *U.S. National Park Service - Experience Your America*. Web. 10 Feb. 2010. <http://www.nps.gov/hps/tps/tax/incentives/standards_1.htm>.

[14] Ibid, "TPS Tax Incentives."

[15] If a building is already individually listed on the National Register of Historic Places, then Part 1 of the application process is not required. <http://www.nps.gov/history/hps/tps/tax/brochure1.htm>.

[16] "Incentives!" *U.S. National Park Service - Experience Your America*. Web. 10 Feb. 2010.

Although the tax credit cannot be claimed until the rehabilitation work has been completed and certified by the NPS and SHPO, upon certification the tax credit can be deducted “dollar for dollar” from a person’s federal income tax liability.[17] In order to keep the tax credit, however, for a period of five years after the building is placed in service the rehabilitated property must be owned by the same owner, maintained as an income-producing property, and the rehabilitation work must remain unaltered.[18] Coordination between the owner/developer and the SHPO is paramount to the success of a project receiving the HRTC since the SHPO is the mediator between the project and the NPS. Although the SHPO handles the direct connection with the owner – and may visit the property to verify that the work is being completed as stated – all final certifications are made by the NPS.[19] While there are varying levels of historic designation in the United States (i.e. local designation, national designation, historic landmark designation, or world heritage site) the main source of funding for the majority of building rehabilitations is received in the form of tax credits via the ITC or HRTC.

Both the ITC and the HRTC play important roles in the rehabilitation of existing and historic structures. However, due to the higher financial incentive and level of preservation required, the HRTC often gets promoted more than the ITC by the preservation community. Although the HRTC requires a higher level of qualitative preservation, this author is more interested in the design implications of the quantitative approach found in the ITC. The quantitative approach of the ITC offers the ability to combine preservation policy and building rehabilitations with contemporary design in a less restrictive manner than the HRTC.

<http://www.nps.gov/hps/tps/tax/incentives/essentials_5.htm>.

[17] David Listokin, Barbara Listokin, and Michael Lahr, “The Contributions of Historic Preservation to Housing and Economic Development,” Housing Policy Debate 9.3 (1998): 446.

[18] Ibid, “TPS Tax Incentives.”

[19] “Incentives!” *U.S. National Park Service - Experience Your America*. Web. 10 Feb. 2010. <http://www.nps.gov/hps/tps/tax/incentives/review_3.htm>.

Affordable Housing

Affordable housing, as defined by Department of Housing and Urban Development (HUD), is housing that costs less than 30% of the household's income. In Philadelphia, more than 79% of the population spends 30% or more of their income on housing (Figure 1). It has been estimated that there is a shortage of over 60,000 affordable housing units within the city of Philadelphia.[20] Due to the lack of affordable housing in Philadelphia and the surplus of vacant existing structures in the city, this author chose to explore the regulations for the implementation of affordable housing.

In an effort to provide housing for as many people as possible, HUD currently promotes the use of three different programs – The HOME Program, the SHOP program, and the Homeownership Zone.[21] Each of these programs takes a different approach to the creation of affordable housing, but all seek to create more vibrant communities through their implementation. The HOME program expands affording housing by providing grants to States and local governments to distribute as seen fit. The SHOP program encourages non-profit organizations to get involved in the process by purchasing sites or infrastructure to rehabilitate with volunteer sweat equity. The Homeownership Zone provides funding for communities to reclaim the vacant or dilapidated buildings within their neighborhood and to create newly constructed neighborhoods of single-family homes based on New Urbanist principles.[22] Both the HOME and the SHOP programs are trying to address the discrepancy between needed affordable housing and excess abandoned structures

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[20] Ibid, "Affordable Housing – CPD – HUD".

[21] "Affordable Housing - CPD - HUD." Web. 4 Aug. 2009. <http://www.hud.gov/offices/cpd/affordablehousing/>.

[22] New Urbanist principles encourage the development of "pedestrian-friendly environments, a mix of incomes and compatible uses, defined neighborhood boundaries and access to jobs and mass transit." "Affordable Housing - CPD - HUD." Web. 14 Mar. 2010. <http://www.hud.gov/offices/cpd/affordablehousing/>.

by creating various policies that could be implemented without direct reliance on the HRTC & ITC. The Homeownership Zone, however, seeks to remove dilapidated buildings and replace them with single-family housing.

Fortunately, in addition to the national HUD programs there are various governmental agencies that are invested in affordable housing within the city. The most prominent affordable housing agency in Philadelphia – which receives funding from HUD – is the Philadelphia Housing Authority (PHA). PHA is the largest landlord in the state of Pennsylvania and serves a customer base comprising almost exclusively very low and low-income families. PHA houses approximately 81,000 people in the city of Philadelphia and focuses on families making up to 50% of the area median income – approximately 84% of PHA families earn less than $19,000 a year.[23]

PHA administers the 'Housing Choice' Program (formerly Section 8) in which rental assistance is provided to low-income families within privately owned housing by using funds from HUD.[24] In this program, the low-income family signs a lease with the landlord of a privately owned building and then signs a voucher with PHA, who sets the family's obligation and payments.[25] The goal of the 'Housing Choice' Program is to help low-income tenants move toward home ownership while allowing them to choose where to live within mainstream society. Since the affordable housing units are rented from privately owned buildings throughout the city, it helps prevent low-income families from being clustered together in a remote area, while promoting private investment into affordable housing.[26] Within Philadelphia, the Redevelopment Authority and the Pennsylvania Housing Finance Agency are

[23] "Excellence in Affordable Housing." Philadelphia Housing Authority. <http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/PhillyHousingAuthority.pdf>

[24] "PHA - FAQ's." *Philadelphia Housing Authority*. Web. 11 Oct. 2009. <http://www.pha.phila.gov/housing%5CHousing_Choice%5CFAQs.html>.

[25] Ibid, "PHA - FAQ's."

[26] Ibid

the two prominent regulatory agencies that determine the design guidelines for affordable housing units. Although these guidelines are not site specific, they do stipulate minimum room sizes for affordable housing units (Figure 2).

Although the general definition of affordable housing does not explicitly state that housing is subsidized, the term generally has that connotation. Subsidized housing not only has a stigma attached to it, but it also generally has had an unattractive substandard architectural form as well. Historically, affordable housing structures have been constructed with cheap materials in high density to keep construction prices down and low-income persons isolated from the rest of the city. However, to create more economically diverse neighborhoods, increase the number of affordable units, and decrease pockets of poverty, many municipalities are requiring the inclusion of a percentage of affordable housing within every newly constructed or rehabilitated housing complex. By expanding the affordable housing options into the private realm, the government is less involved in the direct production of affordable housing and low-income families are less isolated from the rest of the society. This often leads to the creation of mixed income neighborhoods, which are more successful and often times have more access to job opportunities for lower income families.

Prefabrication

Prefabrication is not a new construction technique. With multiple iterations and examples reaching as far back as the late 1880s (Figure 3), this approach to construction has been explored numerous times to address the need to house the most amount of people with the least amount of material. As a building system, prefabrication can be manufactured, modular, panelized, or component based and has the potential to be mass customized (Figure 4). Due to the massive amounts of vacancy throughout the city of Philadelphia and the numerous prefabrication manufacturers that exist in the state of Pennsylvania, prefabricated construction techniques are beginning to be employed by designers as a lower cost construction strategy to address vacant lots and infill properties around the city.

Some of the often cited construction advantages claimed by proponents of prefabricated systems include the reduction in transportation miles of the materials to the site and the decreased on-site assembly time. In addition, it is often argued that prefabricated construction results in better building performance since components, panels, and modules are produced within a weatherproofed factory and the system is less vulnerable to moisture infiltration. The process is considered to be more sustainable than stick building due to the materials used and the controllability of the construction process which results in less construction waste. In addition, prefabricated components are designed with assembly in mind, and can thus be disassembled easier than stick built construction to be potentially reused or recycled.

Unlike mobile homes, which are monitored and permitted by the Department of Housing and Urban Development (HUD), modular and panelized homes must conform to local building codes.[27] Although various communities may have design requirements for new home construction, modular and prefabricated homes – unlike mobile homes – cannot be "excluded from financing or any communities".[28] In addition, due to the stress on the building materials sustained during the shipping process, prefabricated materials are required to meet more stringent building codes than stick-built housing. When taking into account the financial incentives for prefabrication, economies of scale and transportation to the site are paramount. Economies of scale matter in the implementation of prefabricated components,

[27] *LivingHomes*. Web. 18 Apr. 2010. <http://www.livinghomes.net/faq.html>.
[28] Ibid

as the manufacturing system works best when it can produce multiple variations using the same mechanism.

One of the issues with prefabrication can be the transportation of the element to the site. The transportation restrictions refer to the size of highway lanes but can also be effected by the size of the roads surrounding the site. As the width of the truck bed increases – up to a maximum of 15'9" in the state of Pennsylvania – it becomes more expensive to transport materials due to the need to having a driving escort in front of the truck.

While the process of chunking – assembling multiple pieces of a whole into chunks offsite – has taken over the majority of industrialized processes, building manufacture has been slow to adopt this method of construction.[29] The use of fully outfitted prefabricated modules in new construction creates the biggest issue with local labor unions and is one of the bigger issues preventing prefabrication from being implemented as the dominant building system. The disproportionate amount of pay that occurs between prefabricated workers and local union workers has often been an issue due to the cheaper labor that can be found at prefabrication plants. In addition, when prefabricated modules are used in new construction, local union workers have less work to do onsite since the materials arrive ready to be assembled, resulting in less onsite construction time and hence less pay for local union labor workers. Finding a way to make the implementation of prefabrication methods a viable building model for local labor union workers will be a major determining factor in whether or not the building process is able to follow the lead of many other industrialized processes. One compromise could potentially be the use of prefabricated panels instead of modules, that would require more assembly onsite than prefabricated modules.

[29] Kieran, Stephen, and James Timberlake. *Refabricating Architecture*. New York: McGraw-Hill, 2004.

Sustainability

Perhaps the most accepted definition of sustainability comes from the 1987 Brundtland Commission, which defined sustainability as 'meeting the needs of the present generation without compromising the ability of the future generations to meet their own needs'.[30] Currently, the triple bottom line of sustainability exists in the balancing of social, economic, and environmental equality. In order to create a project that will be successful and able to endure, all three aspects of sustainability must be taken into consideration. The creation of jobs in an area needs to be balanced with social equity issues and the environmental effects on an area. Sustainability is a systemic way of thinking about how the processes that make up our daily existence are interconnected and affect the environment around us. This is a key concept that has implications affecting various systems around the globe and should be incorporated into every level of a rehabilitation project.

One of the major proponents of reducing the negative impacts of buildings on the environment is the United States Green Building Council (USGBC). Since 1998 the USGBC has been promoting the adoption of its Leadership in Energy and Environmental Design (LEED) program in the creation and rehabilitation of buildings. The system was developed to encourage architects, owners, and developers to be more conscious in the choices made with the natural resources that were used in creating and operating our buildings. Each LEED product is divided into categories containing prerequisites and credits with specific design requirements that need to be attained in order to obtain points. The more points a project earns, the higher the LEED certification. Although each of the LEED

[30] "Report of the World Commission on Environment and Development: Our Common Future - A/42/427 Annex - UN Documents: Gathering a Body of Global Agreements." *A/RES/3/217 A - Universal Declaration of Human Rights - UN Documents Cooperation Circles*. Web. 10 Jul. 2009. <http://www.un-documents.net/wced-ocf.htm>.

credits within the different LEED products focuses on program and material components specific to that product, the general categories include: sustainable sites, water efficiency, and indoor environmental quality. In addition LEED has added categories for Innovation in Design and most recently a Regional Priority category, recognizing that sustainable technologies and implementation will vary from region to region. Levels of LEED certification include certified, silver, gold and platinum – with platinum being the highest attainable level.

The reception of LEED by the building industry has been explosive. The program has evolved from one LEED product (LEED for New Construction and Major Renovations) to many and now encompasses a range of building types – homes, commercial interiors, core & shell, schools, healthcare, retail, and existing buildings.[31] The program has grown exponentially and is one of the most recognized building labeling programs in the country. By showing developers and owners that incorporating sustainable practices into building construction can save energy and offer a better return on their investment, the USGBC has been able to effect change in the building industry. The program has gone through multiple revisions since its inception and is designed to be continually revised and updated as the technologies improve.

The implementation of LEED has changed the way in which buildings are being conceived and constructed. The effectiveness of LEED has led to many of its design principles being written into building codes and regulations. More designers are striving to include sustainable methods in their designs, owners are requesting buildings that are sustainably designed, and developers are developing

[31] LEED for existing buildings (LEED-EB) does not apply to vacant and dilapidated structures. LEED-EB is for buildings which have functioning HVAC systems but seek to improve the energy efficiency. Vacant buildings or structures that undertake the replacement of their HVAC system fall into the LEED for New Construction and Major Renovations (LEED-NC) category. *United States Green Building Council*. Web. 18 Apr. 2010. <http://www.usgbc.com>.

LEED projects to fill the market need. Although the LEED certification process is currently optional, the implementation of LEED design guidelines can and should be applied as a baseline of building efficiency in rehabilitations and new construction.

Conclusion

In many post industrial cities, but Philadelphia in particular, there is a surplus of dilapidating light industrial warehouses sitting at the core of residential neighborhoods. The sustainable adaptive reuse of these existing, vacant and dilapidating buildings is needed at a systematic level to prevent these buildings from being sent to the landfill. The need for the financial incentives to match the type of program chosen for the rehabilitation of the project is apparent as the financial implications will continue to affect the quantity of buildings that are adaptively reused.

Due to the lack of affordable housing in Philadelphia and the surplus of light industrial building, affordable housing seems like a perfect fit for many of these structures. However, in areas experiencing massive vacancy or decline, revenue generating and mixed-use programs should be considered to ensure that low-income households are not clustered in deteriorated areas of the city. In addition, the recent implementation of prefabricated construction technologies within Philadelphia presents the opportunity for the implementation of prefabrication into the rehabilitation of existing structures. With any rehabilitation, the implementation of sustainable principles will be required to ensure that the amount of energy consumed in the operations of buildings can be reduced. By understanding the rules and regulations involving the rehabilitation of existing and historic structures, affordable housing, prefabrication and sustainability, various opportunities for overlaps and intersections have been discovered and will be explored.

"

Two major challenges we face today are the enormous environmental impact of buildings and the growing divide between rich and poor in this country. These issues are becoming increasing interconnected and require a synthesized response. People must collaborate across these disciplines not just because collaboration is a good idea but because there is really no other way to begin to address them. We must all join the design activism movement… and focus our attention, a little less on our own comfort and a little more on what will positively impact all societies. "

-John Quale, "Last Lecture" presentation at the University of Virginia, 4/30/2009

The rehabilitation of an existing or historic building has the potential to be programmatically interesting, financially viable, and completely adaptable. Strong overlaps exist between historic preservation and affordable housing, affordable housing and prefabricated design, prefabricated design and sustainability, and sustainability and historic preservation (Figure 5). These overlaps will be explored to highlight the intersections that currently exist in an effort to understand the potential of overlaps that could exist in the future. With each of these intersections there are advantages for symbiotic development that has the potential to be maximized for the reuse of existing buildings in Philadelphia. The exploration of these intersections will provide the basis for collaboration in the building reuse and guide the design of this authors test site in North Philadelphia which will be discussed in Chapter 4.

Existing Intersections

Historic preservation and affordable housing intersections

Due to the surplus of existing buildings and the lack of affordable housing, there are many proponents of implementing affordable housing into existing buildings. Affordable housing, generally defined as housing that requires the expenditure of less than 30% of a household's annual income, has become an increased need for many families in urban areas. As stated by Samuel Davis in the Architecture of Affordable Housing:

> "Who needs affordable housing? Not just the homeless, and not just those living at or below the poverty line. All sorts of people with incomes above the poverty line still cannot afford market rate housing: single parents, seniors, twenty-year-olds fresh on the job market, and the new unemployed are probably the largest groups."[1]

This need for housing, coupled with the surplus of existing vacant buildings, presents a powerful opportunity for reuse within Philadelphia. The intersection of affordable housing and historic preservation is not a new phenomenon as many historic properties have been reused for affordable housing, and there are numerous statistics supporting the reuse:[2]

- "32% of households below the poverty line live in older & historic homes
- 31% of homeowners whose household income is less than $20k year live in older & historic neighborhoods
- 34% of renters whose household income is less than $20k/year live in older or historic homes
- 31% of black homeowners & 24% of historic homeowners live in older and historic homes
- 29% of elderly homeowners live in older and historic homes
- 53% of all owner occupied older and historic homes have monthly costs
- 48% of tenant occupied older and historic homes rent for less than $500/ month"

Each of these statistics represents a significant portion of the population potentially benefitting from the reuse of these structures on a daily basis. Enlarging the focus to the community level creates a similar picture of viable older and historic

[1] Davis, Sam. *The Architecture of Affordable Housing*. Berkeley: Univ Of California, 1997. Print. pg, 2.

[2] Rypkema, Donovan. "*Historic Preservation and Affordable Housing: The Missed Connection".* National Trust for Historic Preservation. Aug. 2002. Pg 5.

neighborhoods:

- 40% of residents in older and historic neighborhoods are within 5 miles to work
- 2/3 of older and historic neighborhoods have an elementary school within one mile (less than 40% of new construction does)
- 60% of houses in older and historic neighborhoods have shopping within one mile (40% of new construction does)
- public transportation is available to residents in nearly 60% of older & historic neighborhoods whereas ¾ of new housing has no public transportation available nearby
- 40% of residents in older and historic neighborhoods are within 5 miles to work[3]

The Advisory Council on Historic Preservation (ACHP) is an independent Federal agency, created by the 1966 National Historic Preservation Act, which "promotes the preservation, enhancement, and productive use of our national historic resources, and advises the President and Congress on national historic preservation policy".[4] The ACHP supports the use of historic structures for affordable housing and has compiled sample design guidelines for the implementation of such work. These samples are taken from New Haven, CT and Greensboro, NC and suggest that the Secretary's Standards be adhered to "when feasible", but not at the expense of putting the project in service.[5]

In addition to the tax credits for rehabilitation described in Chapter 1, there are financial incentives available for owners who are interested in rehabilitating their designated historic structures to affordable housing. These incentives come in the form of additional tax credits which are applicable to the owner's income tax. One of the more prominent incentives is the Low Income Housing Tax Credit (LIHTC) which was created as a component of the 1986 Tax Reform Act intended

[3] Ibid, pg. 6

[4] "ACHP | About ACHP | General Information." *Advisory Council on Historic Preservation: Preserving America's Heritage*. Web. 13 Feb. 2010. <http://www.achp.gov/aboutachp.html>.

[5] "ACHP | Samples: Affordable Housing Alternative Design Guidelines." *Advisory Council on Historic Preservation: Preserving America's Heritage*. Web. 26 Apr. 2010. <http://www.achp.gov/altdesignsamples.html>.

to attract private money to invest in developing affordable housing. This incentive provides tax credits that can be used to offset one's income tax in exchange for a monetary investment in low-income housing.[6] The tax credit can be claimed annually over a ten year period and is monitored by the IRS and state housing agencies.[7] Although there is an allowable financial overlap between the HRTC and the Low-Income Housing Tax Credit (LIHTC), there are numerous administrative hurdles in combining the two.

Since the LIHTC is for the construction of all affordable housing units, not just rehabilitated ones, rehabilitation projects must compete with new construction projects for funding. Unlike the HRTC and ITC, which are based on percentages of the construction cost, the LIHTC comes from a fixed pool of money awarded by the state to private and non-profit developers who must compete to attain the tax credit for their individual projects – HUD is not involved in the distribution of LIHTC monies. Money is distributed to the states based on population and $1.25 is allotted per capita.[8]

Each state ranks the projects to receive funding base on their Qualified Allocation Plan (QAP), which reflects each states affordable-housing priorities.[9] In addition, the amount of funding available through the LIHTC depends on whether or not the project also receives funding from the federal government. If a project is not subsidized by the federal government then the LIHTC is 9% per year for a period of ten years. If the project will receive federal subsidies – tax-exempt bonds or below market Federal loans – the project is eligible for a 4% tax credit

[6] "TPS Tax Incentives." *U.S. National Park Service - Experience Your America*. Web. 10 Mar. 2010. <http://www.nps.gov/history/hps/tps/tax/brochure1.htm>.

[7] Charles Orlebeke, "The Evolution of Low-Income Housing Policy 1949-1999," Housing Policy Debate 11.2 (2000): 489-520, p. 491

[8] David and Barbara Listokin. "Barriers to the Rehabilitation of Affordable Housing: Volume I Finding and Analysis". U.S. Department of Housing and Urban Development, Office of Policy Development and Research. 2001 http://www.huduser.org/Publications/PDF/brahvol1.pdf, pg 31

[9] Ibid, 74

over a period of 10 years. In order to receive the tax credit the units must be rent restricted and occupied by individuals with income below the Average Median Income (AMI).

Although the LIHTC is capable of being combined with the ITC and HRTC, the primary focus of each of these tax credits is slightly varied and their combination involves various financial, regulatory, and design complexities. The goal of the HRTC is preservation not affordable housing, whereas the goal of the ITC is the retention of building fabric, and the goal of LIHTC is the development of low-income housing. While each of these tax credits strives for different goals, the potential for overlap - between the LIHTC and the HRTC or the LIHTC and the ITC exists - and if needed can be utilized by owners to maximize their financial incentive.

Affordable housing and prefabricated design

Prefabrication as a construction technique has been effectively used in the creation of new affordable manufactured housing – mobile homes – and high end private residences for many years. Not solely relegated to manufactured housing or single family construction, prefabrication has started to be used in the construction of hotels and dormitories and has the potential to be 15-20% less expensive than traditional stick built construction.[10] It is often looked to as an alternative building system when constructing housing due to the highly repetitive units and modules that can be reproduced quickly and effectively. Due to the climate controlled atmosphere of the factories which do not expose prefabricated materials to precipitation, prefabricated components have the potential to be of a higher quality construction than their stick built counterparts.[11]

[10] *LivingHomes*. Web. 18 Apr. 2010. <http://www.livinghomes.net/faq.html>.

[11] Ibid

While prefabrication as a construction technique for affordable housing is used most dominantly in the United States for mobile home construction, in other countries around the world – Sweden in particular - prefabricated housing has taken over the affordable housing market. A company named Skanska, in partnership with IKEA, has created a series of affordable housing units and complexes (Figure 6). Their system, BoKlok (pronounced Boo Klook) "provides space-saving, functional and high quality housing at a price that enables as many people as possible to afford a stylish and comfortable home."[12] The BoKlok housing system was started at a housing fair in Sweden in 1996 and the first four residences were completed in 1997 in Helsignborg, Stockholm, Ovebro, and Sundsvall, respectively. In total, 4000 apartments in over 100 locations and five different countries have been constructed using this system. The goals of the company are to use prefabrication to be "the customer's friends", create "pleasant homes", "good housing", and "low price with a meaning".[13] The BoKlok system offers low-destiny housing laid out in a neighborhood friendly way. The housing system is currently available in Sweden, Denmark, Norway, Finland, and Great Britain.

This successful use of prefabrication for affordable housing in Sweden demonstrates that the technology exists. But the implementation is lacking in United States. While there are various prefabricated manufacturers in the United States who are trying to push the market for prefabricated housing, much of their focus is on market rate housing instead of affordable housing. The expansion of prefabrication to the affordable housing market is an opportunity with potential to be affordable and effective for both developers and residents.

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[12] "BoKlok UK - About BoKlok." *BoKlok*. Web. 29 Mar. 2010. <http://www.boklok.com/UK/About-BoKlok/>.

[13] Ibid.

Prefabrication and Sustainability

Sustainability refers to the environmental, social, and financial aspects of an issue and strives to achieve a balance between all three. Prefabricated elements can exist in a variety of shapes, sizes, and configurations allowing for maximum flexibility. From an environmental standpoint, prefabricated construction is a superior choice to stick built construction due to the decreases in construction waste, miles travelled for the materials to get to the site, and site disturbance. From a social standpoint the construction of prefabricated components employs a constant stream of workers who work at the centralized factory. By having the components constructed in one factory and then shipped to the site, there is a decrease in the number of miles traveled, as the workers are not moving from site to site and the materials are travelling to the site together instead of individually. From an economic standpoint it offers decreased construction costs. Additionally, as prefabricated components are designed, their assembly and disassembly are considered, allowing for better removal and potential reuse of these elements. The creation of sustainably designed standardized pieces that aggregate together to create a whole is one method of sustainability that will be explored in Chapter 4.

Although there are many advantages to using a prefabrication system, proponents of stick-built construction will argue that the implementation of a prefabricated system does not help the local economy as the local union workers have less to construct onsite and therefore make less money. However, the cost savings of prefabrication to the owners – which is the ultimate determination of whether or not existing buildings will get reused or demolished – provide evidence that prefabrication is a method to pursue for the rehabilitation of existing structures. As a way to mitigate negative issues on local economy, a prefabrication manufacturing plant could be implemented in one of the vacant light industrial buildings and local labor workers could be trained in the manufacturing process to ensure that the prefabricated components are manufactured locally and help boost the local economy.

Sustainability and historic preservation

Instead of viewing historic buildings solely through the lens of their past significance, preservationists are starting to take into account the environmental, social, and financial impacts of historic buildings and how their retention or demolition affects the built environment. The retention and rehabilitation of dilapidated historic and existing structures can breathe new life into an area without destroying the urban fabric that contributes to the character of the neighborhood. Furthermore, the number of local jobs created due to the rehabilitation of an existing structure – from construction to post occupancy jobs – gives credence to the economic sustainability implications of adaptive reuse. As such, preservation through adaptive reuse has the potential to balance the triple bottom line objectives of sustainability.

There is a common misconception that all historic buildings are energy hogs. However, a 2003 study on the Commercial Building Energy Consumption from the U.S. Energy Information Administration found that buildings constructed prior to 1920 are more energy efficient than buildings constructed at any other time in the 20^{th} century (Figure 6). This is probably due to the fact that buildings built prior to 1920 were more likely to be situated on their site to take advantage of natural ventilation and heat gain, due to their being constructed prior to the creation of the air conditioner, have higher ceilings for better ventilation, and bigger operable windows to allow more daylight and fresh air into the building.

A sustainable ('green') building relies heavily on the following basic tenets of design: site selection, water conservation, energy reduction, material choice, indoor environmental quality, and renewable energy selection. In general, the core of energy efficiency and savings comes down to how well the building is designed to take advantage of its climate through insulation, material choices and siting. Since the operation and maintenance of buildings accounts for 30% of the green house gases that are contributing to global warming, the need to design retrofits in a way that reduces operating energy is crucial.

The United States Green Building Council's (USGBC) Leadership in Energy Efficiency and Design (LEED) standards – in addition to numerous other green standards – have helped push buildings constructed after the year 2000 to become more energy efficient. While this progress towards higher efficiency in new buildings is helping designers be more conscious of their design decisions, the number of existing structures needing to be rehabilitated will continue to far outweigh the number of newly constructed high performing buildings.

There are multiple advantages to reusing historic buildings, from their existing connection to infrastructure (transportation, utilities, etc.) to their inherent structural qualities. In addition, each building has an amount of inherent embodied energy - energy required to extract, transport, and construct all of the materials in the building. While the amount of embodied energy is important, the energy saved from the 'avoided impacts' of demolition are equally if not more relevant. Avoided impacts of demolition refer to the amount of carbon dioxide that would be released during the demolition of the existing structure.[14] When a historic building is demolished and replaced with a more 'green' building of similar size, studies show that it can take approximately 25 years for the energy savings of the new building to balance out with the energy needed to demolish the historic building.[15]

[14] "TPS Tax Incentives."

[15] "Sustainability by the Numbers." *PreservationNation Homepage - National Trust for Historic Preserva-*

Having a more holistic view of the life cycle of the building materials will help change how existing and historic buildings are reused.

At a time when natural resources, housing needs, and economic sustainability are competing with each other any unconsidered decision to demolish any existing or historic structure that is a viable, structurally sound adaptive reuse prospect would be irresponsible on multiple levels. Most of the time "the greenest building is the one already built,"[16] and it is these buildings that often create the cultural fabric of the city.

Potential Intersections

Historic Preservation & Prefabricated Design

The ability to find ways to rehabilitate existing vacant warehouses faster than typical stick built construction stems from the notion that the longer a building sits vacant, the more it deteriorates, welcomes unsavory activity, and negatively effects the neighborhood it is located within. The implementation of the quantitative requirements of the 10% ITC allows for the removal of the 4th exterior wall, presenting an opportunity for easy insertion of prefabricated elements. The faster these buildings are put back into service, the sooner the neighborhood will start to experience the positive effects of adaptive reuse. Similar to the way in which LEED was accepted, widely implemented, and has positively changed the way in which buildings are currently designed and constructed, there exists the same potential for a mentality shift in the use of prefabricated systems within existing structures. The potential of this interaction inspired the design portion of this thesis and is explored in Chapter 4.

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tion. Web. 10 Feb. 2010. <http://www.preservationnation.org/issues/sustainability/sustainability-numbers.html>.

[16] *Welcome to the May T. Watts Appreciation Society Embodied Energy Page*. Web. 11 Oct. 2009. <http://www.thegreenestbuilding.org/>.

Capitalizing on the speed, economy, and flexibility of prefabricated systems, the mass production of these components could aid in curbing the massive vacancy and dilapidation issues facing Philadelphia. The creation of a flexible system of panels coupled with the coordination between local laborers and prefabrication workers could result in a readily accessible system of deployment. Each of the prefabricated elements – components, panels, modules – could lend themselves to different implementations within and around the building. Components can range from storage units to kitchen cabinets, do not have to be permanently fixed in place, and have the ability to be located anywhere within the existing building. Panelized walls tend to be more permanent installations within an existing building and have the potential to create partitions within the existing building. Both prefabricated component pieces and panelized systems have the potential to fit within the walls of the existing building without altering the exterior drastically. Although modular construction presents the opportunity to quickly insert full rooms into an existing structure, shipping a panelized system is more cost effective as the shipment can be packaged tighter - when shipping modules, the majority of shipping costs is due to the shipping of air.

The use of prefabricated panels in existing buildings may have the potential to allow for the faster rehabilitation of structures, providing needed space back to the neighborhood while maintaining the urban fabric. Each panel has the potential to serve a different purpose and would be able to respond to the needs of the site and the program. By utilizing the existing structure of a building through the implementation of the quantitative requirements of the ITC, there is the possibility of using prefabricated construction to achieve faster construction results. The implementation of a contrasting construction system into the rehabilitation of an industrial building would be able to take advantage of the open floor plates and existing structure faster and more efficiently than stick-built construction. The process of using prefabricated components within an existing building has the potential to become a new construction method involving mass customized parts which could be implemented at a city wide scale on buildings experiencing similar deterioration and vacancy.

Conclusion

Having a holistic view of all of the intersections that exist within all of these fields shapes the view of vacancy and dilapidation into a more manageable issue and allows for a more inclusive way of thinking about the options for adaptive reuse projects. Although all existing structures are not capable of or worth saving, the social, cultural, and environmental opportunities and implications for the potential reuse of existing structures is significant enough to warrant the examination of the reuse of a project on a case by case basis. The potential for the reuse of these light industrial buildings, using the quantitative requirements of the ITC, present the opportunity to implement a prefabricated system capable of rehabilitating an existing building quickly and with the help of local laborers. The details of this new prefabricated system are the main focus of the design portion of this thesis and are discussed in Chapter 4.

> *"A truly* mind boggling statistic*, there are enough empty homes in the USA to house the whole UK population! And in case you thought that was shocking, we have enough empty homes in England alone to house the whole population of the Republic of Ireland."*
>
> *-http://www.emptyhomes.com, 8/30/2009*

Viewing the issues of vacancy, dilapidation, affordable housing and sustainable reuse simultaneously creates a broader view of rehabilitation issues and helps illuminate the opportunities for collaboration. In addition to recognizing opportunities for collaboration with other fields, there is a need for a policy change within the preservation field to expand the reach of the rehabilitation of non-designated existing structures. Although Historic Preservation as a means of adaptively reusing properties has been a proven model for economic development, as currently structured, some of the provisions in the financial incentives for the rehabilitation of existing, non-historic structures lack the flexibility needed to encourage the sustainable reuse of the majority of the building stock that is more than 50 years old, but built after 1936.

As discussed in Chapter 1, the 10% Investment Tax Credit (ITC) currently applies "only to non-historic buildings first placed in service before 1936 and rehabilitated for non-residential uses."[1] A project's eligibility for the 10% tax credit is based on its lack and ineligiblity for historic designation and the quantity of the building that will remain after the rehabilitation is complete. Unlike the Historic Rehabilitation Tax Credit (HRTC), which is awarded based on qualitative measures, the ITC is a solely quantitative approach. As a review, in order to receive the 10% ITC, the building must adhere to the following quantitative guidelines:[2]

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[1] "TPS Tax Incentives." *U.S. National Park Service - Experience Your America*. Web. 10 Mar. 2010. <http://www.nps.gov/history/hps/tps/tax/brochure1.htm>.

[2] Ibid

- "at least 50% of the building's external walls existing at the time the rehabilitation began must remain in place as external walls at the work's conclusion, and
- at least 75% of the building's existing external walls must remain in place as either external or internal walls, and
- at least 75% of the building's internal structural framework must remain in place."[3]

This credit's emphasis on the quantitative aspect of the building to remain and the lack of a formal review process allows for more contemporary design freedom than the HRTC. Since the work does not have to be reviewed by the State Historic Preservation Office (SHPO) and there is no formal application process, there is an added level of ease to achieve the tax credit.

Although the law in the United States requires that for a building to be considered for historic designation it must be 50 years old (or demonstrate significance of the recent past), the wording on the ITC established a solid in-service date requirement – prior to 1936. Unfortunately, this date is becoming a hindrance to the rehabilitation of existing structures that are more than 50 years old but were constructed after 1936. Since the HRTC functions on a sliding time scale of 50 years, it seems that the ITC should be able to follow suit. In addition, although there is no formal review requirement for the ITC, this author believes there should be a documentation process and database of completed rehabilitation projects that implemented the use of this tax credit, in order to begin to change the perception of designers and the general public about the possibilities of adaptive reuse within existing buildings.

[3] Ibid

Expanded Impact

In an effort to expand the impact and applicability of the rehabilitation policies and update the federal tax credits, Senators Blanche Lincoln, a Democrat from Arkansas, and Olympia Snowe, a Republican from Maine, introduced the Community Restoration and Revitalization Act (CRRA) to the House of Representatives on October 1, 2009. The Act was developed by the National Trust for Historic Preservation in collaboration with the Historic Tax Credit Coalition and the Natural Resources Defense Fund (NRDC), and is numerically known as H.R. 3715 and S. 1743. This bi-partisan Act is intended to create amendments to the IRS Code of 1986 and expand the federal rehabilitation tax credits (ITC and HRTC) rehabilitation credits for existing and historic buildings respectively.[4] The proposed amendments in this Act address a variety of items that would improve the applicability and implementation of the ITC and HRTC. Below are the salient points of the various sections of the Act and what they hope to accomplish, as reviewed by the Public Policy Department at the National Trust for Historic Preservation.[5]

> **"Section 2: Enabling Smaller Rehabilitation Projects**
> *Increase the federal historic tax credit from 20% to 30% for "small projects" with $7.5 million or less in qualified rehabilitation expenditures.*
>
> **Section 3: Providing Downtown Housing in Historic Buildings**
> *Permit the 10% non-historic credit for older buildings to be used for rehabilitating residential rental property.*
>
> **Section 4: Using a Practical Definition for "Older Building"**
> *Use the common definition of an older building as one that is at least 50 years old in determining eligibility for the 10% non-historic rehabilitation credit.*

[4] Ibid

[5] *PreservationNation Homepage - National Trust for Historic Preservation*. Web. 12 Mar. 2010. <http://www.preservationnation.org>

Section 5: Rehabilitating Qualified Non-Profit and Public Historic Buildings. *Allow for certain leasing arrangements with non-profits and other tax-exempt entities that are now precluded.*

Section 6: Facilitating Smaller Projects through Transferability *Allow for the transfer of historic tax credits to another taxpayer for projects under $5 million qualified rehabilitation costs.*

Section 9: Encouraging Moderate Rehabilitation through Reducing the Substantial Rehabilitation Requirements. *Allow the tax credit to be claimed at 50% of the adjusted basis[6] instead of 100%.*

Sections 8 & 10: Making Historic Buildings as Energy-Efficient as They Can Be. *Encourage building owners who are rehabilitating historic buildings to achieve substantial energy savings and allow graduated increases in the credit based on the scale of energy efficiencies achieved.*

Section 11: Allowing State Historic Tax Credits to Work More Effectively with the Federal Credit. *Specify that state historic tax credits should not be considered federal income for tax purposes."*

Design Implications of CRRA Amendments

While all of the amendments of this act would dramatically improve the effectiveness of the ITC and HRTC, Sections 3, 4, 8, and 10 have strong design implications for the rehabilitation of non-designated structures. These design implications would vary in their physical manifestation but each one would play a vital role in expanding the impact of policy for rehabilitation. The following section is an analysis of how the implementation of the various sections of the proposed

[6] The adjusted basis of a project is calculated by added the subtracting the cost of the land and depreciation from the purchase price and improvements made to the building. Currently historic tax credits can only be claimed if the property being rehabilitated meets the substantial rehabilitation requirements during a 24-month period. Although the period may be selected by the taxpayer, the rehabilitation expenditures must exceed $5,000 of the adjusted basis. Ibid.

CRRA would impact the intersections discussed in Chapter 2.

Affordable Housing & Historic Preservation

Although a strong connection already exists between affordable housing and historic preservation, the implementation of ***Section 3: "Providing Downtown Housing in Historic Buildings"*** would expand this connection to allow for all non-historically designated housing structures to also receive funding under the ITC. This eligibility would provide some financial assistance to non-designated building owners to maintain and/or rehabilitate the structure in a sustainable way. This amendment further recognizes the inherent value of all structures, not just public income-producing properties. Furthermore, the implementation of this policy would aid in increasing the number of available housing units – both market rate and affordable – and would further strengthen the role of preservation in community development.

Historic Preservation & Prefabrication

Although not explicitly stated in the Act, providing funding for buildings older than 50 years of age and placed in service after 1936 would help soften the financial burden for owners who invest in prefabricated systems. Again, since the ITC is applied quantitatively and not qualitatively, the potential for hybrid construction techniques will be more accepted in the implementation of this credit. The provision to include these structures would allow owners and developers of buildings to have incentive to reuse portions of the building instead of demolishing it. The implementation of prefabricated components into the eligible structure would allow the building to be placed in service faster than stick built construction and allow the owner to claim the tax credit sooner.

The implementation of ***Section 4: "Using a Practical Definition for "Older Building"*** is a section that could potentially have the most impact on the existing buildings. By changing the wording of the act to allow any non-designated building that is 50 years or older to be eligible for this tax credit, more owners will be able to receive the 10% tax incentive, potentially encouraging more adaptive reuse projects.

Acknowledging that preservation exists on a sliding scale will be beneficial for owners and design professionals. Owners will benefit from the tax incentives, whereas design professionals will benefit from the ability to use these buildings as a hybrid of new and old design. The expansion of this act to include post-1936 buildings will also expand the playing field for preservationists by allowing them to contribute their expertise to the reuse of buildings constructed between 1936 - 1960. In addition, considering the amount of buildings that will continue to be constructed now and in the future, having the 10% ITC operate on a sliding scale for buildings constructed at least 50 years prior to the current date will create the frame work for the rehabilitation of future buildings.

Both ***Sections 8 & 10: "Making Historic Buildings as Energy-Efficient as They Can Be"*** address the need to reconcile the amount of energy consumed by the operations of buildings. To continue to argue for the rehabilitation of existing structures, these structures will need to continually be sustainably retrofitted to improve their energy efficiency so as to prove that they are capable of being higher energy performing structures. Energy saving goals presented in sections 8 & 10 would range from 30%-50% and would determine how much additional financing the project could receive. This incentive would provide a boost in the tax credit "up to an additional $2 - $5 [per square foot] depending on the range of energy savings".[7]

[7] «The Community Restoration and Revitalization Act: Eight Proposed Amendments to the Federal Rehabilitation Tax Credit.» *PreservationNation Homepage - National Trust for Historic Preser-*

The energy credit would not be allowed to exceed 50% of the rehabilitation cost and the energy improvements would be calculated and monitored by coordinated efforts between the Environmental Protection Agency (EPA) and the Department of Energy (DOE). Additionally, Section 10 of this Act would allow for the combination of the ITC with the Renewable Energy Tax Credit (RETC) – creating a financial incentive and overlap for projects that incorporate renewable energies onsite.

Conclusion

The rehabilitation of the existing and historic building stock is an environmentally and culturally responsible act. In areas where there has been massive deterioration of building stock due to industry and job loss, redevelopment can be used as a way to assist in the reinstatement of the neighborhood as a whole. The recognition of the environmental impacts that existing buildings have on the building environment and creating incentives for the reuse of all buildings that are 50 years old – regardless of their historic designation – will save many buildings from being demolished and sent to the landfill.

The passing and adoption of the CRRA would have the potential to create a positive rehabilitation boom affecting a wide range of existing buildings by increasing the financial incentive to rehabilitate. The approval of this bill will help prevent structurally sound, non-designated historic buildings from being sent to the landfill. Promoting the amendments to the 10% ITC will allow preservation as a field to have a bigger impact on existing structures. In addition, by allowing existing buildings to be eligible for funding based on a 50 year sliding timeline from the current date, a precedent will be set allowing tax credits to be awarded to all non-designated buildings that approach their 50th birthday. However, promoting

vation. Web. 12 Mar. 2010. <http://www.preservationnation.org/issues/rehabilitation-tax-credits/federal/proposed-amendments.html>.

the use of the 10% ITC and spreading information about it will ensure that non-designated structures are not demolished due to a lack of funding.

"To maintain the sense of connection that people have with the built fabric of a place; to extend the urban meaning into the present, without demeaning the past or casting a forward shadow on continuing life in that place, is the building art of a civilization."

-Alison Smithson, "City Centre Full of Holes"
Architectural Association (Great Britain) – AAQ, 2-3/1977

Philadelphia's neighborhood fabric is characterized by numerous vacant buildings and tracts of land. These buildings were once productive contributors to the neighborhood and the city at large, however, due to a loss of industry they have become dangerous, attractors of unsavory activity, and are impediments to growth and safety. The goal of the presented design is to demonstrate an approach to put these buildings back in service in a way that will reconnect the frayed social and economic fabrics of their surrounding neighborhoods. This will be accomplished by balancing their historic significance with their adaption to contemporary needs and potentials. In order to bring these buildings back to life, strategies that emphasize rapid, cost effective and flexible retrofit will be emphasized and techniques of prefabrication and rapid deployment will be explored. The implementation of a prefabricated construction system could become a kit-of-parts for use by Philadelphia neighborhoods, allowing many existing buildings to be put back into use while simultaneously re-stitching parts of the community together and diverting massive amounts of demolition debris from the landfill.

BACKGROUND

Light industrial buildings in Philadelphia

To highlight the systemic issue of vacancy in Philadelphia, this author chose to look at buildings left over from the once robust textile industry within Philadelphia. Philadelphia, which was once the "Workshop of the World" is currently home to over

59,000 vacant properties (Figure 8).[1] The majority of the vacant industrial buildings are reminders of the city's extraordinary industrial past. Many of these buildings range from 2-4 stories and are brick-faced facades with concrete construction systems. Historically, industrial buildings were built in conjunction with a residential neighborhood with worker housing for the workers.

When vibrant, these buildings acted as an anchor for the neighborhood, drawing people to live and work in the area. However, once the industry left these buildings the residents soon followed since there lacked the financial incentive for them to remain. The longer an industrial building remains vacant the more it physically deteriorates, welcomes squatters, vagrancy, and various other unregulated and potentially illegal activities. Hence, a vacant industrial building within a neighborhood is typically the beginning of decline that will lead to vacant residences within that same neighborhood. Buildings do not exist in a vacuum and vacant buildings present a multitude of impacts on an area. The number of vacant buildings and disinvestment in communities is a systemic phenomenon that is rarely isolated to one building. It seems that one vacant building begets another vacant building. As vacant residences increase so does the vacancy in commercial properties. This interconnected dependency of industry, residential uses, and commercial use is important to understanding how to affect change within an area. In a city facing depopulation issues, managing the rising number of vacant structures is important to sustaining the number of remaining residents and buildings in the city.

[1] *Workshop of the World - Philadelphia*. 12 Dec. 2009. <http://www.workshopoftheworld.com/>.

Premise

When dealing with an existing or historic structure, there are numerous options in deciding how the building should be adaptively reused. The reuse of these industrial buildings has the potential to drive the redevelopment of the entire area. By reinstituting a revenue-generating component into the area, it begins to act as a magnet to attract new activities and residents. In addition, by analyzing financial strengths and weaknesses of the neighborhood and recognizing that each neighborhood may have multiple needs, there is great potential to implement a multiplicity of uses into the structure.

In order to get these vacant industrial buildings back online quickly, the option explored in this thesis is the applicability of the implementation of a prefabrication panel system for existing structures. This kit-of-parts is designed to minimize on site construction but maximize end-user flexibility (Figure C4). Using the modeling and fabrication technology available today, this system would be able to mass customize panels allowing this system to be deployed within a variety of vacant warehouse structures. In addition to the financial advantages of using a prefabricated panel system, these systems are quite sustainable as they are constructed using less material than traditional stick built applications and are inherently designed for deconstruction, which would allow the panels to be removed and reinstalled in other locations.

Site Selection

In an effort to design and evaluate the reuse of a non-designated historic structure through the application of a flexible prefabricated construction system, this author has chosen a test site for the implementation of a new rehabilitation project. Although there are numerous vacant and dilapidating light industrial buildings within Philadelphia, this author wanted to find a light industrial building that was located in an area with high vacancy in order to relate the existing building to the surrounding sites and phase in different program to the area. The selected site to test these ideas is located at the intersection of 11th Street and Indiana Ave in the Fairhill neighborhood in northern Philadelphia (Figure 9).

Constructed as a local depot for the Bell Telephone Company circa 1940 (Figure 10), this corner building is approximately 50,000 square feet and is bounded by an empty lot on the west, and a small park with tennis courts and community swimming pool to the south. The area of intervention encompasses both the building and the empty lot to the west – which will be used as necessary to fulfill the programmatic requirements. Chosen for its dilapidated state, proximity to residential structures, and vacant land, this building will serve as a prototype of ways to reuse similar industrial buildings throughout Philadelphia.

The various physical gaps in the urban fabric within the Fairhill neighborhood prevent the neighborhood from reading as a whole (Figure 9). Similar to the lacunae (an empty space or missing part; a gap, a void) seen in various pieces of art, the gaps of the Fairhill neighborhood that are created by vacant lots and buildings prevent the neighborhood from being viewed cohesively. However, unlike voids in art, voids within the physical fabric of a neighborhood have lasting effects on the residents of that neighborhood and can become places for unsafe and unsavory activity. This author believes that it is possible to fill in the voids of the neighborhood with new program and phase in housing stock that is compatible with the existing context. This infill would still act as lacunae of sorts and allow the remnants of the historic neighborhood to be understood in contrast to the infill.

The design tackles the historic center of the neighborhood – in the case of Fairhill, the site of the old Bell Telephone building – as the starting point for a redevelopment intended to fan out to stitch the neighborhood back together.

To understand what types of program would work within the neighborhood, research was conducted on the demographics of the surrounding neighborhood. The majority of employed persons in the Fairhill neighborhood are in service jobs, commute 20 minutes or more to work, and make 50% less income than other Philadelphians. The neighborhood has a 25% unemployment rate and those who are unemployed participate heavily in the informal economy (babysitting, auto repairs, etc.). Although the neighborhood is fairly culturally diverse, it is financially homogenous. The median housing income is roughly $14,500 and most households are made up of single incomes and spend more of their income on housing than most other Philadelphians. In addition, because many of the residents that live in the neighborhood stay for many years there are many intergenerational connections[2]. As seen from the 2000 census, the Fairhill neighborhood has a higher rate of industrial properties, vacant properties, and demolished properties than the rest of Philadelphia. The number of vacant and dilapidating properties coupled with the fact that the majority of the housing and building stock was built before 1939 makes this neighborhood a prime testing bed for a design intervention.

Program: Site & Phasing

The site is currently zoned for G2 but the neighboring blocks are zoned for R10 with the corner lots being zoned C2.[3] The proximity of the various zoning codes

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[2] "Fairhill People & Fairhill Demographics - Zillow Local Info." *Real Estate, Homes for Sale & Real Estate Values - Zillow*. Web. 19 Apr. 2010. <http://www.zillow.com/local-info/PA-Philadelphia/Fairhill-people/r_271175/>.

[3] The zoning code "seeks to protect public health, safety, and welfare by regulating the use of land and controlling the type, size, and height of buildings." As such, a G2 zone is for General Industrial buildings (i.e. light or heavy manufacturing and distribution uses). The R10 zone is Residential (i.e. typical Philadelphia row homes). Finally, the C2 zone is Mixed-use Commercial (i.e. restaurants, catering,and single family or duplex dwellings). "Zoning Classifications | Zoning Matters." *Zoning Matters | The Official Website of the Philadelphia Zoning Code Commission | Zoning Matters*. Web. 19 Apr. 2010. <http://www.zoningmatters.org/facts/districts>.

in this area gives credence to the possibility of allowing a multitude of programs to potentially exist on and around the site. Since the structure is extant, there is the added advantage that it is already tied into the transportation infrastructure and utility grid, eliminating the need to construct new roads or lay new piping.

Although the building (Figures 11a-11d) is currently being used by Maxicom, a metal bending manufacturer that specializes in distribution systems, it is not fully conditioned. The owner has blocked in many of the windows on the second floor with concrete masonry units (CMU) to prevent the neighborhood children from throwing more rocks through the openings. In addition, the majority of the historic interior partitions have been removed and only a few of the historic partitions remain. The lack of numerous interior partitions coupled with the blocked-in windows provide the opportunity for a dramatic rehabilitation.

In order to address the issues of vacancy within this neighborhood, this author created a phasing strategy for the implementation of the selected programs. The need for a phasing strategy for this area affected the ways in which this author thought about the construction sequence and implementation, encouraging the utilization of a prefabricated system capable of being adapted over time.

Phase one of the design results in the installation of windows back into the openings, planting the numerous vacant land surrounding the building, the installation of a market, produce training centers, and energy producing technology within the building (Figure C14). This system was chosen because community gardens are not only a great source of local food, but can also offer job training skills, and help unify a community. The goods that are sold at the market are grown and harvested on the vacant land surrounding the building by local residents. The market spaces inside the building would be located on the ground floor whereas the produce training centers would be located on the top floor. The goal of phase one is to reestablish the neighborhood as a vibrant community in the hopes of attracting more business opportunities and residents to the area.

Phase two of the design would introduce retail, business incubators, housing, and begin to encourage the infill of the various vacant lots with housing. The business incubators would help those in the community who are already participating in the informal economy learn how to grow their business. In addition, these incubators would be a space where residents would learn how to start their own business and have access to various financial opportunities. In both phases, the revenue generating component of the neighborhood resides within the existing building and provides job training opportunities for the residents of the neighborhood.

The site at 11th & Indiana is designed to be reinstated as an anchor for the neighborhood. The building will provide socio-cultural programs in addition to a being financial generator. The various programs will be phased into the building and will be able to use the same prefabricated kit-of-parts for each program. The purpose of the phasing this site is to reconnect the community amenities to the community, prior to bringing new residents to the area. To maintain the historic appearance of the building and to adhere to the requirements of the ITC, this author has chosen to alter solely on the western exterior wall, leaving the other three facades intact.

Panel System Intervention : Kit-of-Parts

The prefabricated frame and panel system for this thesis has been designed to attach to the existing building in efforts to minimize onsite construction time and quickly reinstate a revenue generating component back into the neighborhood. The frame system is customizable and would be designed to accommodate a ceiling height up to 15’. In addition, the frame system allows for the changing of spatial layouts based on the programmatic needs of the building and site. The goods that are sold at the market are grown and harvested on the vacant land surrounding the building by local residents. The hard and soft system requirements and the temporality of the program will determine the type of panel needed for implementation (Figure C19). Once the desired programs are established, a kit of parts is created for the owner to allow for maximum flexibility. The system consists of five separate elements: a transformer conduit, utility frame, lateral support frame, interchangeable panels – both horizontal and vertical, bathroom and kitchen pods - and a façade system. In addition, all of these systems would tie into the thermally insulating addition, reducing the required operating energy of the building (Figure C11).

Transformer Conduit (Figure C5)

The transformer conduit is designed to be installed on the underside of the beams on each floor and is the power connection for all of the frames that will be inserted into the building. The transformer conduit is the lynchpin in this system and acts like a surge protector of sorts, connecting the frames to the green technologies and municipal utility grid.

Main Frame (Figure C5)

The utility frame is an aluminum frame constructed of 6" square aluminum portions with vertical members offset every 12' and separated by 1' insertions of lighting or power panels. This framing system is connected via the lateral support frame and is the structure which the panels hang from.

Lateral Support Frame (Figure C5

The lateral support frame connects the utility frames to each other, providing lateral support to the system. In addition, these frames provide the support for the horizontal panels should a program require more acoustic privacy.

Interchangeable Panels (Figure C9-C10)

The interchangeable panels arrive onsite fully finished and ready to be installed in the utility frames. These panels can be fabric, solid, planting medium, or numerous other finishes and can provide visual, acoustic, and/or thermal separation from the rest of the building.

Bathroom and Kitchen Pods (Figure C7)

In order to keep the construction time to a minimum and prevent the need to drill holes through the building for plumbing stacks, bathroom and kitchen pods would be employed. These pods would have raised floors to accommodate the required slope of the sanitary and sewage drains into and out of the building (Figure C22).

Thermal Insulating Attachment (Figure C18-C20)

The thermal insulating attachment designed as a three story greenhouse that gets attached to the western wall to enclose the structure. The western facade of this attachment is a solidly glazed wall allowing the most sunlight into the space. The eastern wall of this addition, however, is composed of operable panels allowing the occupants to control the amount of heat and sunlight entering their space.

The implementation of this thermal attachment capitalizes on passive solar techniques helping to lower the amount of heating required for the building, hence reducing energy consumption and operating costs. This attachment includes its own vertical circulation system and would be able to be altered as the programmatic needs of the building changed. In addition this attachment is capable of collecting and harvesting rainwater for reuse in the building. By designing the panel system to rely heavily on green technologies instead of needing to plug into the municipal grid, there is an added layer of self-sufficiency and adaptability to the system.

Advantages of the system

Similar to the construction of a new prefabricated house, the time savings are realized when site work is able to be conducted at the same time as the panels are being manufactured. In the case of a rehabilitation project, local union workers would remove any debris, remediate environmental hazards (asbestos, mold, etc.), demolish portions of the building according to the design specifications, and make the building weather-tight for the reception of the panel system. While this work is being conducted onsite, the various panel systems would be fabricated and prepared to be shipped to the site. Unlike stick-built construction where the plumbing, power, and HVAC systems would be installed by different trades on a staggered schedule, this panel and frame system arrives onsite with utilities embedded and ready to be utilized. Once on site the local union workers would work with the prefabrication manufacturer to install the panels as specified. The implementation of this prefabricated system could be mutually beneficial to local labor union workers and prefabrication workers as each building would need to be prepared for the installation of the prefabricated frame and panels.

The existing structural capacity of the structure is one of the advantages that make this system work. When adaptively reusing this stable structure the need for the interior walls to possess high structural capacity drastically decreases. The ability to insert non-load bearing frames and panels into the existing building allows for the potential implementation of a lighter weight system. Of all of the prefabricated technologies – panels, modules, components – the panel system was chosen to allow for the most flexibility around within the site.

Manifestation of the Intersections in the Design

10% ITC implications on the design

The use of the 10% ITC quantitative guidelines in this design instead of Secretary for the Interior Standards of Rehabilitation is a result of the lack of historic designation of the building and the desired end product. Allowable removal of percentages of the building led to the implementation of a new construction technique. The goal of this project was to quickly rehabilitate an existing building to flexible programmatic uses for a neighborhood. The HRTC's stipulation that the rehabilitation work remain unaltered for at least 5 years after the building is placed in service would prevent the panels within the building from being altered as needed. In addition to the lack of flexibility in the layout of the building after the rehabilitation process, the added time (although imaginary for this project) and unlikelihood given its overall integrity trying to get this structure listed on the National Register for Historic Places in order to be eligible for the HRTC would have slowed the rehabilitation process.

While this author values the National Register process and the level of preservation required in the rehabilitation of HRTC projects, the recognition that every existing building – old enough to be consider historic – will not meet the requirements for National Register designation was the driving impetus behind the desire to explore the design implications of the ITC. It is these non-designated buildings which are in the most danger of being demolished due to neglect caused by their perceived financial and historic worthlessness. By utilizing the 10% ITC, rehabilitation work can begin when the owner is ready without the need for approval from the SHPO.

Affordable Housing implications on design

While the research exists to highlight the compatibility of affordable housing in existing buildings, due to the location and circumstances of the chosen site this author did not feel that affordable housing would be an appropriate Phase One insertion into the existing structure. The potential for affordable housing to be introduced on the second floor of structure could potentially become a more valid design approach in phase two of the design, after the area begins to have other programs draw activity to the site.

Sustainability implications on design

The design of the entire frame and panel system would be sustainable. From the frame materials to the implementation of energy generating technologies, the panels are designed for disassembly and can be reused in other areas of the building. While the system was not designed to earn any specific LEED certification, the design incorporates many LEED principles to reduce the amount of energy consumed by the building and maximize the buildings energy performance.

Conclusion & Analysis

In a city like Philadelphia, where the majority of the buildings were constructed prior to 1945, the need to find ways to adaptively and sustainably retrofit existing and historic structures is going to continue to grow in coming years. Designers must think collaboratively and outside the box for ways to solve issues of growing vacancy. The ability to phase a site to allow for organic growth and expansion is critical in a city like Philadelphia where the population has been on a steady decline but is slowly starting to increase. By implementing smaller scaled, flexible interventions into existing sites there is the potential to design to accommodate future alterations.

By using the existing quantitative requirements of the ITC, this preservation policy allows for the insertion of a prefabrication system by stipulating that only 75% of the exterior wall remain in place. The removal of this fourth wall opens up the building to easily receive the prefabricated components. The implementation of prefabricated construction into a building that has been prepared to receive the system by local workers is a way to encourage a new model of building and prevent the demolition of non-historically designated structures. Developed to act as a kit-of-parts, this frame and panel system is designed to provide flexibility for the evolving programmatic needs of the building.

The inclusion of prefabricated panels into the existing building creates an interesting dialogue between the two construction types but also provides phasing flexibility and the ability for the current building layout to adopt over time. Due to the amount of similar vacancy that exists throughout the city of Philadelphia and the mass-customization available with this system, the implementation of this prefabricated system would have the potential to be implemented at a variety of sites around the city creating a network of rehabilitated structures. The reuse of the existing building as both structure and enclosure for the prefabricated system will save many existing structures from being demolished while simultaneously preserving the urban fabric and reinstating a revenue generating component into the neighborhood. By retaining the north, south, and east facades of the building, the surrounding neighborhood continues to have a visual connection to its past without sacrificing the functional, revenue generating aspects of its future.

The rehabilitation of the existing and historic building stock is an environmentally, financially, and culturally responsible act. The rehabilitation of non-historically designated structures, in particular light industrial buildings, should be promoted and supported, as many of these buildings were once the backbone of thriving neighborhoods. In areas where there has been massive deterioration of building stock due to industry and job loss, redevelopment of these buildings can be used as a way to reinstate the neighborhood as a whole.

Within Philadelphia, the abundance of abandoned light industrial buildings located within residential neighborhoods around the city presents an opportunity to be rehabilitated to income-producing centers for the viability of existing neighborhoods. Although these buildings are a part of Philadelphia's history, their dilapidated state encourages vandalism and can lead to an unsafe (or a perceived unsafe) area for both visitors and local residents. The adaptive reuse of these buildings should be implemented to improve the quality of life for the local residents. While not all existing structures – historically designated or not - are worthy of being saved, the financial, environmental, and social impact potential of the ones that are structurally sound should be heavily considered prior to demolition.

In many post industrial cities there is a surplus of dilapidating existing building stock along with a lack of affordable housing. Although housing may not be the only program that could get retrofitted into these building types, the potential of a combination of housing or mixed-use space should be considered. By understanding the rules and regulations involving the rehabilitation of existing and historic structures, affordable housing, prefabrication and sustainability, various overlaps and intersections have the opportunity to be employed simultaneously. Having a holistic view of all of the intersections that exist within these fields, shaped the way in which this author thought about how vacancy could be handled and created a different way of thinking about the rehabilitation of existing structures. The direct application of the ITC coupled with the potential of prefabrication led this author to explore the applicability of the two systems working together.

The recognition of the environmental impacts that existing buildings have on the building environment and the creation of incentives for the reuse of all buildings that are 50 years old – regardless of their historic designation – will save many buildings from being demolished and sent to the landfill. The adoption and implementation of the Community Reinvestment and Revitalization Act has the potential to create a positive rehabilitation boom on a wide range of existing buildings by increasing the available financial incentive for eligible structures. Expanding the view of preservation to deal with all existing buildings instead of just historically designated ones could drastically change the impact preservationists have on the built environment. In addition to fixing the wording of the bill to include all buildings more than 50 years old – instead of limiting the ITC to buildings placed in service prior to 1936 – the stipulations about increasing the energy efficiency of existing buildings will play a huge role in improving the operating efficiency of existing structures. The approval of this Act will help prevent structurally sound, non-designated historic buildings from being sent to the landfill. The adoption and promotion of this change to the federal tax credits could dramatically change the affect that preservation as a field has on the built environment, as the field's evolving skills could be applied to the non-designated buildings that would potentially be reused due to the increase in financial incentives.

Prefabrication as a construction technique has the potential to be a powerful tool in the regeneration of neighborhood fabric. The implementation of a prefabricated system into the rehabilitation of existing structures presents the opportunity to put these buildings back in service faster than stick built construction and provide more flexibility to be easily adapted as the needs of the building evolve. In addition, the inclusion of prefabricated panels into the existing building creates an interesting dialogue between the two construction types - that is, between existing heavier construction and new lighter weight construction.

The prefabricated panel system designed for this thesis would allow for the rapid rehabilitation of vacant industrial buildings and create a new construction model for the way in which union workers and prefabrication manufacturers interact. The implementation of the prefabrication system would present an integrated construction option, allowing both prefabrication workers and local labor union workers to be invested in a project. The local union workers would be involved in getting the existing building prepared to receive the prefabrication system and the prefabrication workers would be involved in the production of the system. The design approach implemented for this panel system strove to emphasize flexibility, connectivity, and speed. In addition, due to the amount of similar vacancy that exists throughout the city, the implementation of a prefabricated system would be able to be implemented at a variety of sites. The implementation of the designed prefabrication system for this thesis has found that it will be most applicable to buildings that are structurally sound and have minimal interior wall partitions.

Finally, the only ways in which current and future vacancy issues will be resolved is if professionals continue multi-disciplinary discussions. Issues of vacancy and rehabilitation are interconnected with every facet of city living and will continue to make an impact at various scales – from food production, to job creation, to urban renewal, and infrastructure expansion. Understanding the complexities of the various needs of the stakeholders involved in the rehabilitation process and being willing to approach an old problem in a new way will continue to create more fruitful and holistic design solutions.

17% spend 1/2 of income of housing

21% can afford their homes

22% of owners spend more than 30% of income on housing

40% of renters spend more than 30% of income on housing

Figure 1. Philadelphia Housing Statistics.
(graphic by author, source “Philadelphia’s Housing Challenges:
Why We need a Housing Trust Fund”
www.communitychange.org)

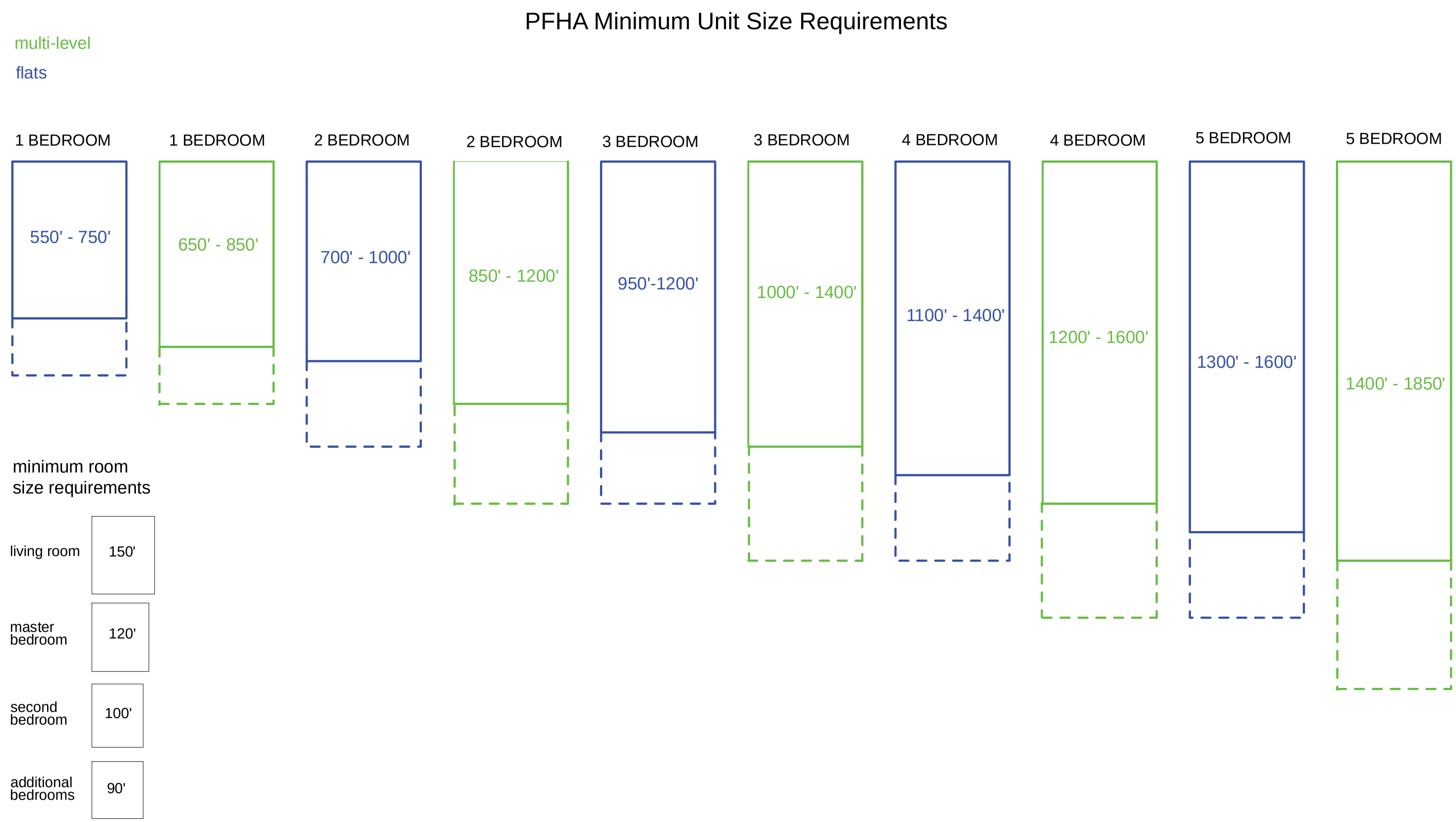
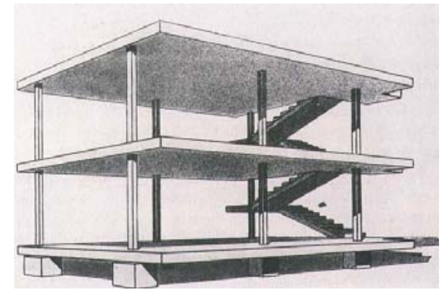


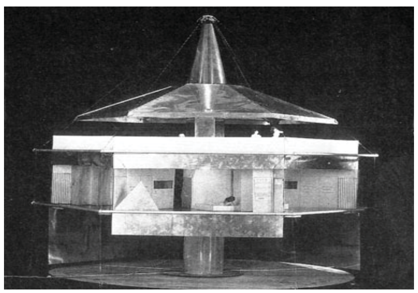
Figure 2. PFHA minimum unit size requirements


1892-1995: Hodgson Houses
http://www.hodgsonhouses.com/Catalogs.htm


1906: Single Pour Concrete System
http://www.moma.org/images/dynamic_content/exhibition_page/23384.jpg

1908: Sear's Catalogue Homes
http://exhibits.mannlib.cornell.edu/prefabhousing/images/large/Sears2.jpg


1914-1915: Maison Dom-ino
http://www.e-flux.com/journal_images/1241483656lecorbu_maisondomino.jpg


1927: Dymaxion House
http://greatdesigners.files.wordpress.com/2008/11/105_3lg.jpg


1944: Wichita House
http://www.wichitaphotos.org/graphics/wschm_R2dymax5.jpg


1948-1950: Lustron Houses
http://www.newberryarchitects.com/LustronprototypeHinsdaleIL.jpg


1948: Prouve's Tropical House
http://www.artloversnewyork.com/zine/wp-content/photos/Jean_Prouve.jpg


1968-78: Futuro House
http://greg.org/archive/futuro_house_wright20.jpg


1968-1972: Nakagin Capsule Tower
http://horsesthink.com/wp-content/uploads/2007/09/nagakin.jpg


1972-1985: Ramot Housing
http://upload.wikimedia.org/wikipedia/commons/7/75/Ramot_polin.jpg

Figure 3. Brief timeline of prefabrication explorations

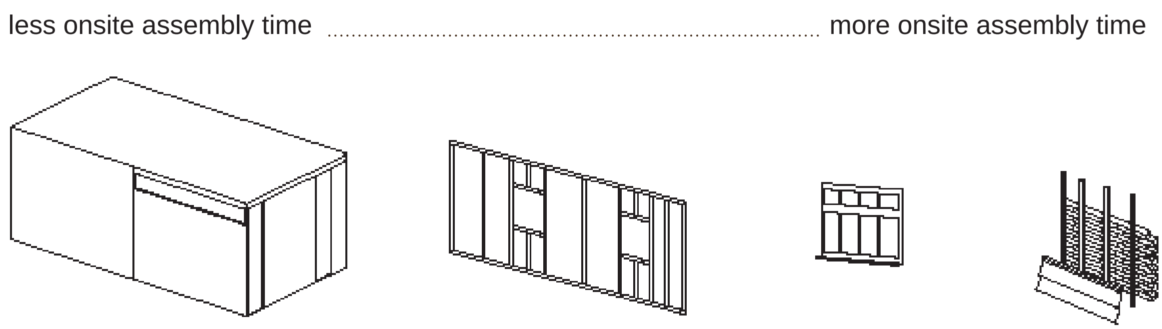


Figure 4. Onsite construction time
(left to right - modular, panelized, component based, ‘stick-built’ construction)

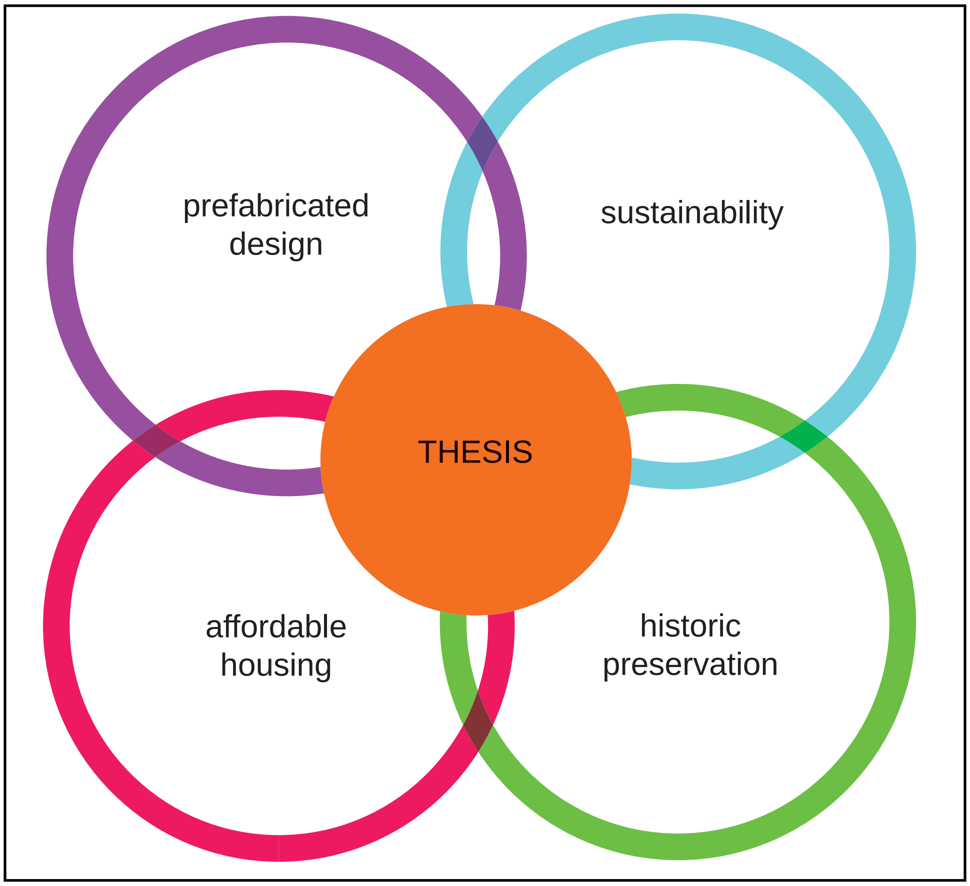


Figure 5. Conceptual overlaps of thesis

Figure 6. BoKlok Houses - St. James, Gateshead

Retrofit Green

Many historic buildings are already energy efficient

Commercial Buildings (non malls):

Date Built	Btu/sq. ft
Before 1920	80,127
1920 – 1945	90,234
1946 – 1959	80,198
1960 – 1969	90,976
1970 – 1979	94,968
1980 – 1989	100,077
1990 – 1999	88,834
2000 – 2003	79,703

Source: U.S. Energy Information Administration, 2003 Commercial Building Energy Consumption Survey

Figure 7. Commercial Building Energy Consumption Study from the Us. Energy Information Administration

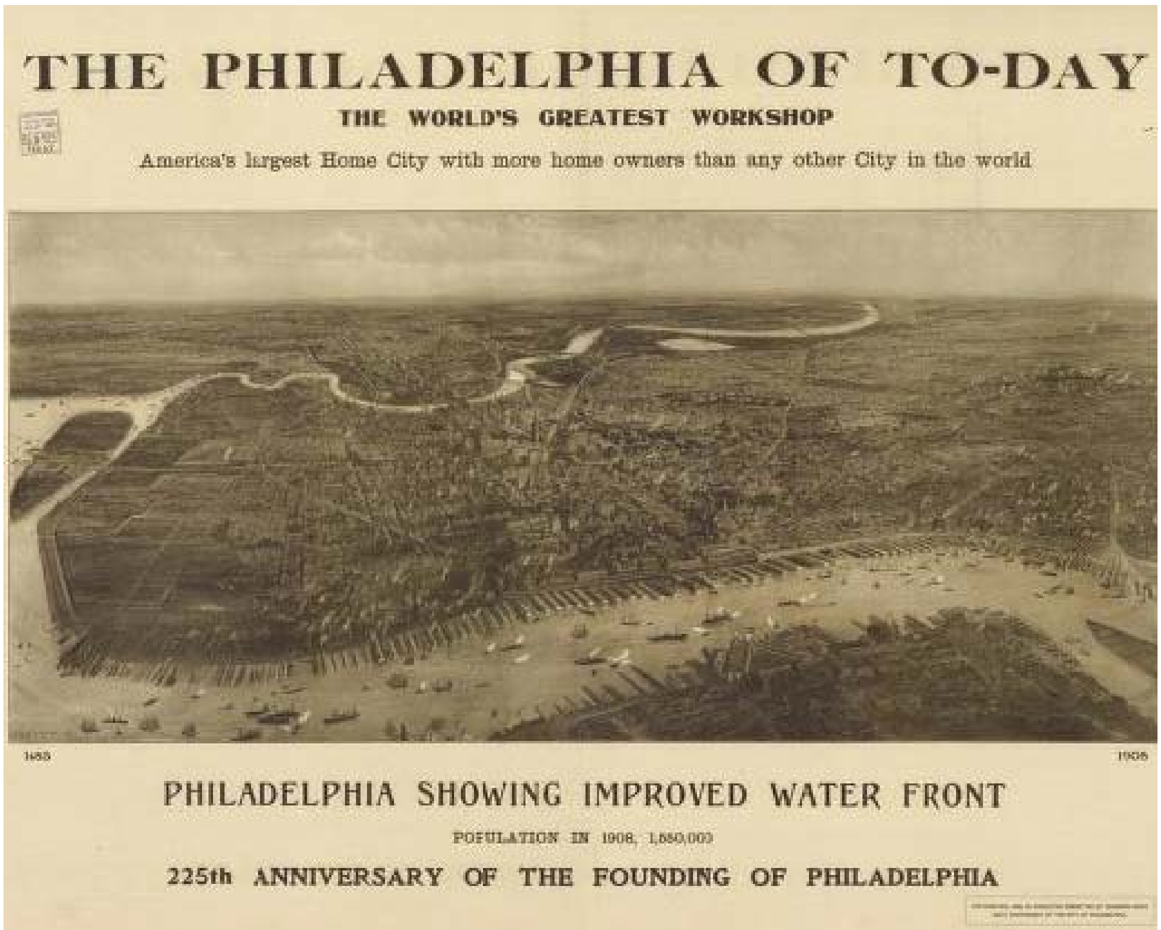


Figure 8. Advertisement for Philadelphia as the “Workshop of the World”

Figure 9. Aerial of Site

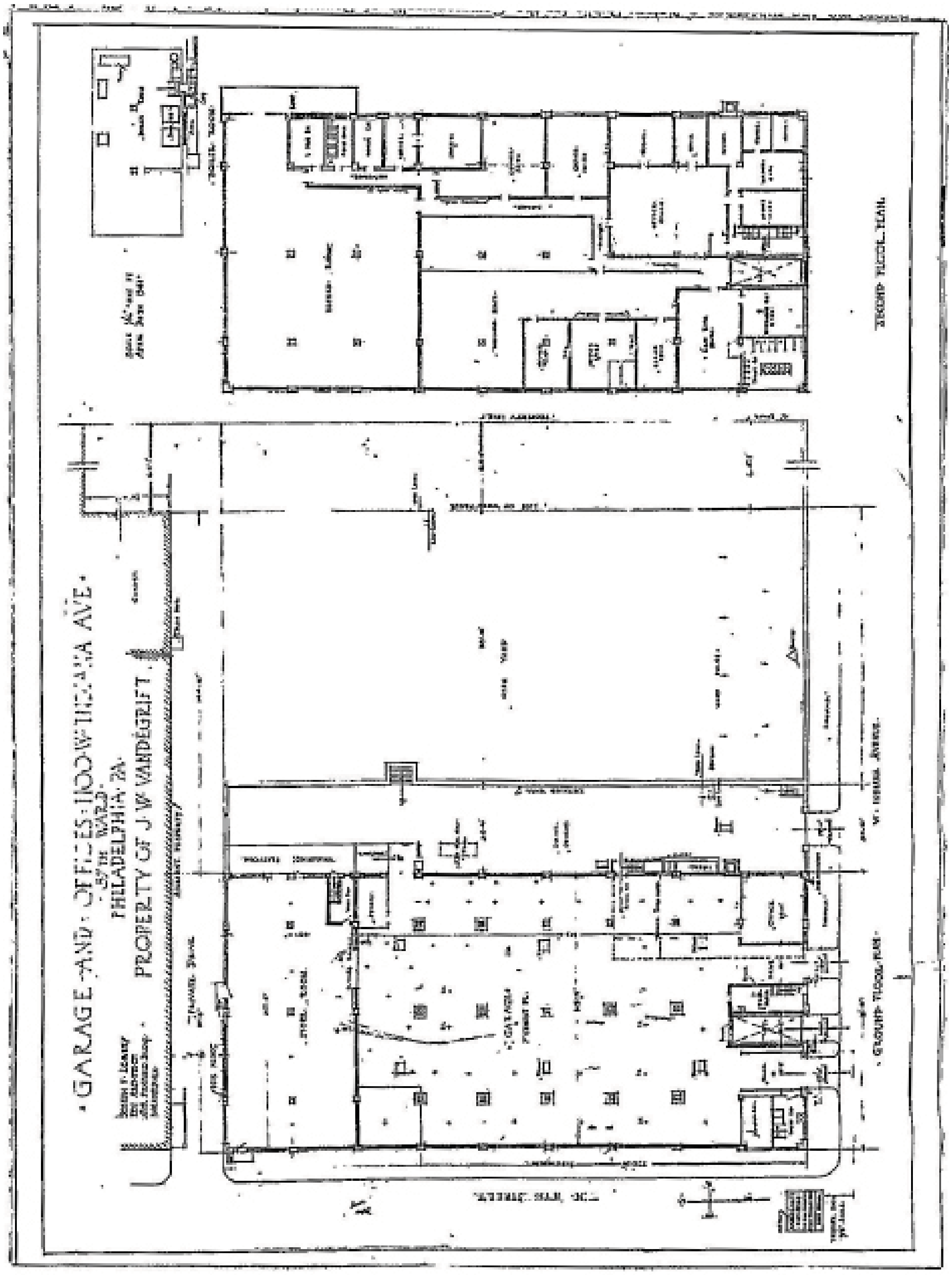


Figure 10. Historic Building Plans

Figure 11a. View of Eastern facade, looking South

Figure 11b. View of Western facade, looking East

Figure 11c. Interior view of second floor

Figure 11d. Interior view of first floor

HOUSING

"BoKlok UK - About BoKlok." *BoKlok*. Web. 29 Mar. 2010. <http://www.boklok.com/UK/About-BoKlok/>.

Davis, Sam. Designing for the Homeless: Architecture That Works. Berkeley: University of California Press, 2004.

Davis, Sam. The Architecture of Affordable Housing. Berkeley: University of California Press, 1997.

Delvac, William F. Affordable Housing Through Historic Preservation a Case Study Guide to Combining the Tax Credits. Washington, DC: U.S. Dept. of the Interior, National Park Service, Preservation Assistance, National Trust for Historic Preservation, 1994.

Glaeser, Edward and Joseph Gyourko. Rethinking Federal Housing Policy : How to make housing plentiful and affordable. Washington, D.C. : The AEI Press, 2008.

Humanity, Architecture For. Design Like You Give a Damn: Architectural Responses to Humanitarian Crises. New York: Metropolis Books, 2006.

Lederman, Jess. Housing America: Mobilizing Bankers, Builders and Communities to Solve the Nation's Affordable Housing Crisis. Chicago, Ill: Probus Pub. Co., 1993.

Listokin, David and Barbara Listokin. "Barriers to the Rehabilitation of Affordable Housing: Volume I Finding and Analysis". U.S. Department of Housing and Urban Development, Office of Policy Development and Research. 2001 http://www.huduser.org/Publications/PDF/brahvol1.pdf

Listokin, David and Barbara Listokin. "Barriers to the Rehabilitation of Affordable Housing: Volume II Case Studies". U.S. Department of Housing and Urban Development, Office of Policy Development and Research. 2001 http://www.huduser.org/Publications/PDF/brahvol2.pdf

Myerson, Deborah. The Business of Affordable Housing : Ten Developer's Perspectives. Washington, D.C.: Urban Land Institute, 2007.

Orlebeke, Charles, "*The Evolution of Low-Income Housing Policy 1949-1999*," Housing Policy Debate 11.2, 2000: 489-520, p. 491

Rypkema, Donovan. "*Historic Preservation and Affordable Housing: The Missed Connection".* National Trust for Historic Preservation. Aug. 2002. Pg 5.

Sard, Barbara and Margy Waller, "Housing Strategies to Strengthen Welfare Policy and Support Working Families," The Brookings Institution Center on Urban and Metropolitan Policy and the Center on Budget and Policy Priorities, Washington, D.C., April 2002 <http://www.brookings.edu/es/urban/publications/sardwallerhousingwelfare.pdf> p. 3.

USA, Global Green. Blueprint for Greening Affordable Housing. New York: Island Press, 2007.

PREFABRICATION

Guy, Brad and Nicholas Ciarimboli. *Design for Disassembly.* Prepared for the City of Seattle, King County. 2006.

Huber, Benedikt and Jean-Claude Steinegger. Jean Prouve Prefabrication: Structures and Elements. London: Pall Mall Press, 1971

Herbers, Jill. Prefab Modern. New York: Harper Design International, 2004

Kieran, Stephen, and James Timberlake. Refabricating Architecture: How Manufacturing Methodologies Are Poised to Transform Building Construction. New York: McGraw-Hill, 2004.

Trulove, James Grayson and Ray Cha. Prefab Now. New York: Collins Design, 2007.

PRESERVATION

"ACHP | About ACHP | General Information." *Advisory Council on Historic Preservation: Preserving America's Heritage*. Web. 13 Feb. 2010. <http://www.achp.gov/aboutachp.html>.

Brand, Stewart. The Clock of the Long Now: Time and Responsibility. New York: Basic Books, 2000.

“Buildings Database: Project Matrix.” Building Technologies Program: Buildings Database. 20 Jun. 2009. <http://eere.buildinggreen.com/mtxview.cfm?CFID=51313659&CFTOKEN=16947976>.

Escherich, Susan. Affordable housing through historic preservation tax credits and the Secretary of the Interior’s standards for historic rehabilitation. Washington, DC: U.S. Dept. of the Interior, National Park Service, Cultural Resources, Preservation Assistance, 1995.

Harris, Samuel Y. Building pathology deterioration, diagnostics, and intervention. New York: Wiley, 2001.

Listokin, David and Barbara Listokin, “Historic Preservation and Affordable Housing: Leveraging Old Resources for New Opportunities,” Housing Facts and Findings 3.2, 2001.

Listokin, David, Barbara Listokin, and Michael Lahr, “The Contributions of Historic Preservation to Housing and Economic Development,” Housing Policy Debate 9.3, 1998.

“Sustainability by the Numbers.” *PreservationNation Homepage - National Trust for Historic Preservation*. Web. 10 Oct. 2010. <http://www.preservationnation.org/issues/sustainability/sustainability-numbers.html>.

“National Register of Historic Places Fundamentals -- National Register of Historic Places Official Website--Part of the National Park Service.” *U.S. National Park Service - Experience Your America*. Web. 17 Jul. 2009. <http://www.nps.gov/nr/national_register_fundamentals.htm>.

“PreservationNation Homepage - National Trust for Historic Preservation”. Web.12 Mar. 2010. http://www.preservationnation.org

“The Community Restoration and Revitalization Act: Eight Proposed Amendments to the Federal Rehabilitation Tax Credit.” *PreservationNation Homepage - National Trust for Historic Preservation*. Web. 12 Mar. 2010. <http://www.preservationnation.org/issues/rehabilitation-tax-credits/federal/proposed-amendments.html>.

“Tools (Listing by Life-Cycle Costing / Assessment Category) | Whole Building Design Guide.” WBDG - The Whole Building Design Guide. 15 Jul. 2009 <http://www.wbdg.org/tools/tools_cat.php?c=3>.

“TPS Tax Incentives.” *U.S. National Park Service - Experience Your America*.

Web. 10 Mar. 2010. <http://www.nps.gov/history/hps/tps/tax/brochure1.htm>.

National Register of Historical Places. Web. 12 Jul. 2010. <http://www.nationalregisterofhistoricplaces.com/faq.html>.

“Glossary - Rehabilitation Tax Credit Guide.” *NTCIC Is the Leader in Syndicating Federal Historic Tax Credits and New Markets Tax Credits*. Web. 27 Feb. 2010. <http://www.ntcicfunds.com/taxcreditguide/glossary.html>.

“Affordable Housing – Community Planning & Development - HUD.” Web. 4 Aug. 2009. <http://www.hud.gov/offices/cpd/affordablehousing/>.

“Excellence in Affordable Housing.” Philadelphia Housing Authority. <http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/PhillyHousingAuthority.pdf>

“PHA - FAQ’s.” *Philadelphia Housing Authority*. Web. 11 Oct. 2009. <http://www.pha.phila.gov/housing%5CHousing_Choice%5CFAQs.html>.

SUSTAINABILITY

“Climate Change, Global Warming, and the Built Environment - The 2030 Challenge.” Climate Change, Global Warming, and the Built Environment - Architecture 2030. 18 May 2009. <http://www.architecture2030.org/2030_challenge>.

Friedman, Thomas L. Hot, Flat, and Crowded: Why We Need a Green Revolution--and How It Can Renew America. New York: Farrar, Straus, and Giroux, 2008

Jones, Van. The Green Collar Economy: How One Solution Can Fix Our Two Biggest Problems. New York: HarperCollins, 2008.

“Report of the World Commission on Environment and Development: Our Common Future - A/42/427 Annex - UN Documents: Gathering a Body of Global Agreements.” *A/RES/3/217 A - Universal Declaration of Human Rights - UN Documents Cooperation Circles*. Web. 10 Jul. 2009. <http://www.un-documents.net/wced-ocf.htm>.

Ritchie, Adam and Randall Thomas. Sustainable Urban Design. London: Taylor & Francis, 2003.

Steele, James. Ecological Architecture: A Critical History. London: Thames & Hudson Ltd, 2005.

Story of Stuff with Annie Leonard. 18 May 2009 <http://www.storyofstuff.com>.

"USGBC: Green Building Research." *USGBC: U.S. Green Building Council*. Web. 13 Aug. 2009. <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718>.

"Welcome to the May T. Watts Appreciation Society Embodied Energy Page". Web. 11 Oct. 2009. <http://www.thegreenestbuilding.org/>.

URBANISM

Braham, William W., Jonathan A. Hale, and John Stanislav. Sadar. Rethinking Technology: a Reader in Architectural Theory. London: Routledge, 2007.

Olsen, Paul. The Textile Industry: An Industry Analysis Approach to Operations Management. Lexington, MA : Lexington Books,1970

"Philadelphia NIS Neighborhood Report on the Fairhill neighborhood." <http://cml.upenn.edu/nbase/nbProfileRequest.asp>.

Scranton, Phillip. Proprietary Capitalism: The Textile Manufacture at Philadelphia, 1800 – 1885. Cambridge : Cambridge University Press, 1983.

Spiller, Neil. Visionary Architecture: Blueprints on the Modern Imagination. London: Thames & Hudson Ltd, 2006.

"Urbanization: Facts and Figures". Habitat Backgrounder. Wed. 11 Oct. 2009 <www.unhabitat.org>.

Workshop of the World - Philadelphia. 12 Dec. 2009. <http://www.workshopoftheworld.com/>.

Due to the varied topics of interest in this thesis a wide range of literature was explored. It was through an understanding of the various topics that the potential opportunities for intersection were highlighted. In an effort to create a concise framework for the basis of understanding that guided this thesis, the relevant literature is divided by topic and discussed below.

PRESERVATION

When dealing with historic buildings it is important to have an understanding of the building's past and the life cycle of its materials to ensure that any new intervention on the building is responsive to these factors. In Stewart Brand's books The Clock of the Long Now: Time and Responsibility and How Buildings Learn, he discusses how the perception of time changes based on the frame of reference the viewer takes and how the timeframe of components within the buildings change. The diagram that Brand presents makes a clear case for the need to design buildings with adaptability in mind to ensure that they can be used after the first tenant moves out. This idea of understanding "the long now" is important when dealing with historic structures since each intervention on the building will effect the hands of time on the structure – a damaging intervention will decrease time to physical decay whereas a positive intervention will increase the time to decay.

In addition to understanding the effect of time on historic buildings, it is also important to evaluate the condition of the materials that compose the building to understand each materials' service life. In Samuel Harris' book Building Pathology Deterioration, Diagnostics, and Intervention, the various causes of building material deterioration are discussed and evaluated. Harris' discussion of deterioration issues – the majority of which are caused by water infiltration – highlight the need to critically observe the building (whether historic or not) prior to any intervention in order to understand its capability. Understanding the materiality of an existing or historic building is important to understanding what types of interventions the building would be capable of supporting. While having an understanding of the needs of the various stakeholders involved in a rehabilitation is important, understanding the physical constraints of each building may be as valuable in understanding how the building will physically need to change.

Affordable Housing

One of the critical works of research regarding the rehabilitation of historic properties to affordable housing is David and Barbara Listokin's two volume report entitled "Barriers to the Rehabilitation of Affordable Housing". Completed for the U.S. Department of Housing and Urban Development, their report explored the various barriers that exist in affordable housing rehabilitation projects and documented them in a series of case studies. The major barriers found were financial as well as the dwindling numbers of skilled craftsman and contractors. In addition, the perception of the difficulty of a rehabilitation on both the owner and developer side continued to be a fundamental issue that needed to be overcome.

Funding for the Low Income Housing Tax Credit (LIHTC) is open to both new construction and rehabilitation projects. Analysis was conducted by the Listokin's to understand how level the playing field is for the competition of the two types of projects. The Qualified Allocation Plan (QAP) rankings are created by giving points to various characteristics for affordable housing. There were ten general point areas and they discovered that of the various QAPs from around the country, the majority of them give higher priority to new construction over rehabilitation, on a scale of 6 points to 4 points respectively.

In his book on The Architecture of Affordable Housing, Sam Davis discusses the need to increase the number of affordable housing units that will instill in the residents a sense of dignity. Encouraging designers and municipalities to move away from historic and stereotypical models of affordable housing, David reintroduces the ideas of human dignity into the equation of affordable housing. He further points out that there is a wide range of people who need affordable housing, from recent graduates to retired citizens.

There is a struggle between developers and clients in creating housing that truly is affordable for the residents but also profitable for the developers. Both The Business of Affordable Housing: Ten Developer's Perspectives and the Blueprint for Greening Affordable Housing focus on finding and analyzing successful affordable housing case studies to understand how previous projects have been successful or unsuccessful. The former focuses on how various developers were successful in creating new affordable housing projects, whereas the latter focuses more on the energy savings that had been realized due to various sustainable upgrades to affordable housing projects. In each of the books, the key financial points of each project were explained, as funding is often one of the major barriers to a project's success.

Sustainability

Although the most accepted definition of sustainability comes from the 1987 Brundtland Commission, the foundations of sustainability were established decades ago. James Steele's book Ecological Architecture, lays the foundation of the history of the ecological movement in architecture, highlighting the major thinkers in the field. Although the creation of the United States Green Building Council's (USGBC) LEED program has helped create an incentive for architects and developers to build high performance buildings, the focus on existing buildings has been largely ignored by the LEED guidelines. While the importance of constructing new buildings that are sustainable and high performing should not be ignored, the reality is that these new buildings will generally make up less than 5% of the total building stock and the number of existing buildings needing sustainable upgrades far outweighs the number of newly constructed buildings. Although the task of upgrading the existing buildings may sound daunting, there is massive potential for job creation, reduced operating energy consumption, and reduced construction debris in landfills.

Van Jones' the Green Collar Economy: How One Solution Can Fix Our Two Biggest Problems, discusses in detail how sustainable upgrades to existing buildings would positively effect the economy. Through his proposals on sustainable building and infrastructure upgrades, Jones' explores how the economy, poverty, and clean energy are all related to each other. Similar to Glaeser and Gyourko, Jones points out that there needs to be a legislation change at the federal government level in order to create the necessary incentives for the local governments to take action in promoting and using sustainable energy.

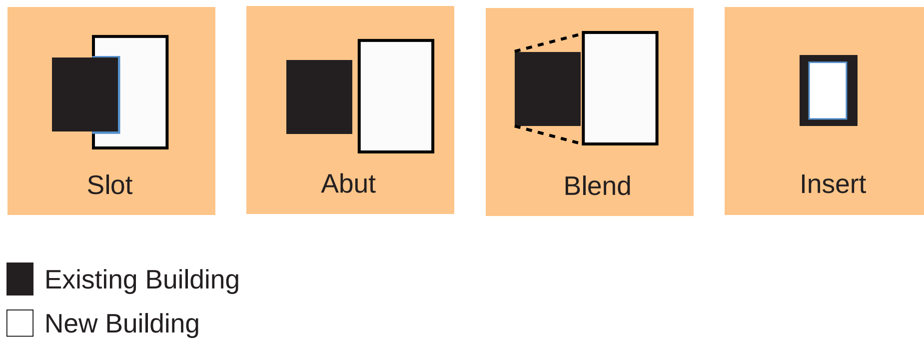
In his book Hot, Flat, and Crowded: Why We Need A Green Revolution – And How It Can Renew America, Thomas Friedman discusses how the adoption of American standards by developing third world countries would result in global catastrophe. Although he is not trying to deny any person the luxuries of the American lifestyle, he is calling for a re-evaluation of how Americans live and the amount of resources we consume. His main point rests on the notion that "business as usual" is no longer acceptable and will result in a shortage of resources needed to provide every person on the planet with the bare necessities of the human condition.

Prefabrication

Explorations into prefabricated construction techniques have existing since the early 1800s (Figure 3). Each technique has focused on various construction techniques, materials, and techniques. Exploring Jill Herbers' PreFab Modern, there has been a real desire for architects and designers to prove that prefabrication can be used for more than mobile home construction. The ability to create interesting aesthetic forms with functional variety through the use of prefabricated construction is captivating more and more designers.

Conclusion

The separate yet intertwined issues of historic preservation, affordable housing, sustainability, and prefabrication were the main impetus for the research of this thesis. Understanding the basic foundations of each field created a base of knowledge upon which this thesis was founded.



In an effort to gain a better understanding of the range of formal and aesthetic implications of adaptive reuse projects, research was conducted to gain an understanding of how new additions are formally added onto existing structures. In addition to studying the formal implications of rehabilitation projects, prefabrication projects were also studied to gain an understanding of the formal varieties typically present in these projects. Throughout the research of rehabilitation and prefabrication projects, an effort was made to find projects that were related to housing in order to keep the common thread consistent.

The evaluation of the formal implications of the rehabilitation case study projects illuminated that there are typically four ways that existing buildings are intervened upon. The rehabilitation portion is slotted, abutted, blended, or inserted into the existing building. This understanding of the typical formal interactions of the addition to the existing structure created a base understanding for the beginning exploration of this author's intervention on the selected site at 11th & Indiana Ave in north Philadelphia. The analysis of the prefabricated case study projects helped this author gain a better understanding of typical construction methods and connection techniques within existing prefabrication projects.

The following projects were reviewed by this author and contributed to the design process and implication of prefabricated panels into the existing structure.

Porter House | SHoP Architects **|** New York, NY

This project is rehabilitation of a 1905 wine warehouse in New York's meatpacking district into a 10-Story Mixed-Use Condominium Building. The new addition to the building rests on the existing structure and was constructed out of zinc and glass panels. The original six-story warehouse consisted of 30,000 square feet and the additional four stories added above added 20,000 square feet, bringing the building to 50,000 square feet of usable space. Constructed in 2003, the top portion of this building "cantilever's eight-feet over the adjoining building, and two partial floors…wrap down on the back of the old six-story structure". To emphasize the verticality of the structure, the architects used a custom fabricated zinc panel system for the floor to ceiling windows. The juxtaposition of the new addition to the old building is distinctive and inspiring. The formal implications of reusing an existing building as the base structure for the newly constructed renovation presents an interesting formal proposition for rehabilitation.

Sources:
http://www.nyc-architecture.com/CHE/CHE-036.htm
http://www.shoparc.com/#/projects/all/porter_house

Garden Street Lofts | SHop Architects | Hoboken, NJ

Renovated in 2008 the Garden Street Lofts project integrates a zinc-clad addition with the renovation of an old coconut processing and storage warehouse. The original warehouse was constructed in 1919 for the processing of coconuts for shredded toppings on Hostess snowball cupcakes. This building was renovated into 30 luxury condominiums and is LEED certified. A five-story 31,600 square foot addition was added to the east site adjacent to the warehouse and two new floors bridge the existing building to the new construction. The formal implications of the design reveal that the process of abutting next to and on top of an existing building as a renovation technique is capable of to creating a cohesive project where the two styles of the building complement each other into a cohesive building.

Source:
http://www.nj.com/hobokennow/index.ssf/2010/02/garden_street_lofts_wins_gold.html

Gasometer B | Coop-Himmelb(l)au | Austria, Vienna

Located in Vienna, Austria, the Gasometers were constructed as part of the city's municipal gas works, Gaswerk Simmering from 1896 to 1899. The gasometers were used until 1984 when the town shifted from town gas to natural gas. A design competition was held to decide the architectural solutions for the buildings and each of the four gasometers were redesigned by a different architect. The one pictured above was designed by Coop Himmelb(l)au and interacts with the existing building via the contrast of adjacency. The renovation of this gasometer provides 360 apartments of varying floor plans both inside the existing structure and outside in the addition. Completed in 2001, this structure incorporates mixed-use elements and rises to a height of 22 stories. The formal implication of this approach to design illustrates that a modern addition containing a drastically different design approach can allow the addition to read completely separate from the existing building creating a sharp dividing line between the two pieces.

Source:
http://www.arcspace.com/architects/coop_himmelblau/gasometer1/index.html

The Music Building | Ann Beha Architects | Philadelphia, PA

Constructed in 1892, the Music Building on the University of Pennsylvania's campus was built as a sister structure to the Morgan Building. Both buildings were originally home to the Foulke and Long Institute, a school and home for orphaned girls and were brought by the University of Pennsylvania in the early 1900s. The buildings became home to the University's Music Department and have gone through various renovation and addition campaigns. Due to growing spatial demands of the Music Department it become clear that more space would be needed to meet the growing needs of the department. Designed as a state of the art facility, the addition to the Music Building includes classrooms, practice rooms, and recording studios. The building was renovated to be LEED Silver and is the first recognized LEED building on UPenn's campus. The formal approach to the design of the addition was to respect the sill lines, material color, and volumetric height of the existing building. Constructed to supplement the existing structure, the Music Building Addition connects to the existing structure in a elegant and unique way.

Source:
http://www.annbeha.com/portfolio-project-details.html?category=academic&id=83

Coral Arts House | NKCDC | Philadelphia, PA

Developed by the New Kensington Community Development Corporation (NKCDC) the Coral Street Arts House is one of the first projects to combine low-income housing with artist live/work space in Philadelphia. Originally constructed in the mid 19th century, the Coral Street building was known as Beatty's Mill and produced cotton and wool yarns. Renovation plans were begun in 1999 and in order to receive federal tax credits, the owners went through the process of getting the building added to the National Register of Historic Places in 2004. The project was renovated into 27 live/work units for artists and provides programmatic gathering space for the local community. The formal approach to the renovation of this project was to preserve the exterior façade of the building and adaptively reuse all of the interior space. In addition to reusing the majority of the hardwood floors in the building, the existing windows were restored and reused in the project.

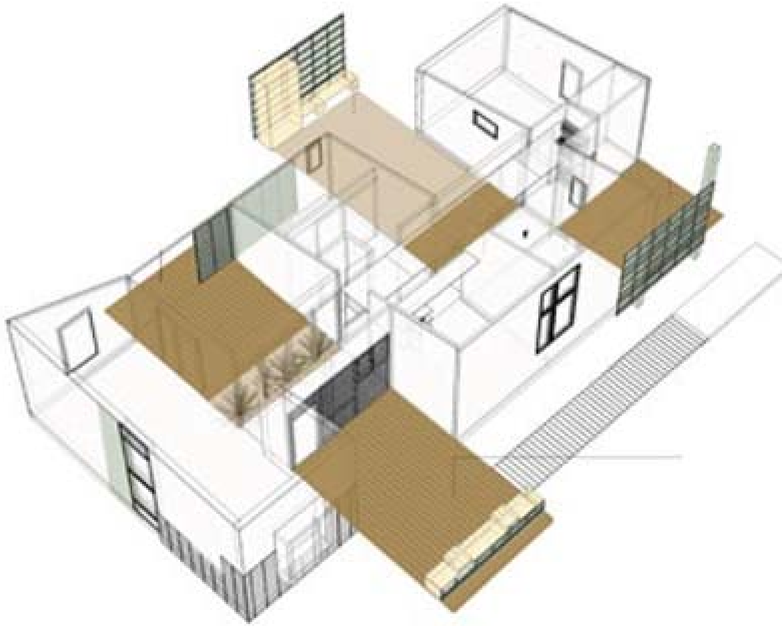
Source:
http://www.nkcdc.org/content.asp?cat=ARTS&varcontentcat=ARTS_CORAL_ST_ART_HOUSE

100k House | Interface Studio Architects **|** Philadelphia, PA

Designed by Interface Studio Architects for Postgreen Homes, this project strove to merge affordable housing and sustainable building techniques. The name of the house refers to the price of its construction and led to a dialogue about how housing can be created more sustainably and affordably. Consisting of two units, the 100k House is both LEED and Energy Star certified and employs a variety of sustainable techniques (including rainwater collection, low-flow and dual flow toilets, compact fluorescent lighting, and the use of structurally insulated panels). The major design approach of the house was to combine construction and sustainability techniques that would allow for a $100,000 construction cost in Philadelphia. The formal approach of construction for this project respected the typical volume of existing row house typologies while giving a new design aesthetic to the exterior façade.

Source:
http://postgreen.com/projects/100khouse/

preHAB House | ARCH 402, Spring 2006 | Gautier, MS



Designed to be a response to relief housing for Habitat for Humanity, the preHAB house was the second house constructed in the ecoMOD housing series at the University of Virginia. The house was designed with sustainable technology, including solar panels, structurally insulated panels (SIPs), and hardiplank siding. The house was designed to the maximum square footage allowable by Habitat for Humanity standards but also strove to create a house that was more spacious than typical habitat houses. Designed to minimize the number of interior partitions, the exterior walls weave to enclose three sides of each room, creating exterior rooms in the spaces between. The interior partitions that were included in the house serve to both delinate the various rooms and provide storage space to the inhabitants. The formal design implications of this house emphasize that by creatively utilizing interior and exterior spaces, it is possible to make a project feel more spacious than the square footage implies.

Source:
www.ecomod.virginia.edu?P2/index.php

Tropical House | Jean Prouve | Brazzaville, Congo

Designed in 1949 as an inexpensive, readily deployable house for France's African colonies, these houses were prefabricated kit-of-parts made of prefabricated folded metal sheets. Prouve considered the climatic implications of the design and created a double roof structure to produce natural ventilation and created a veranda with aluminum sunscreen with sliding metal panels combined with blue glass to block out UV rays. The house was 'flat-packed' and flown to Africa via cargo plane. Although not aesthetically accepted by the local residents, remained in the town of Brazzaville, Congo for 50 years. The formal implications of Prouve's design highlight the ability of standardized pieces to come together quickly and efficiently to form the totality of the house.

Source:
www.tate.org.uk/modern/exhibitions/masiontropicale/default.shtm

This appendix includes images and graphics from the design portion of this thesis for the site located at 11th Street & Indiana Ave in North Philadelphia.

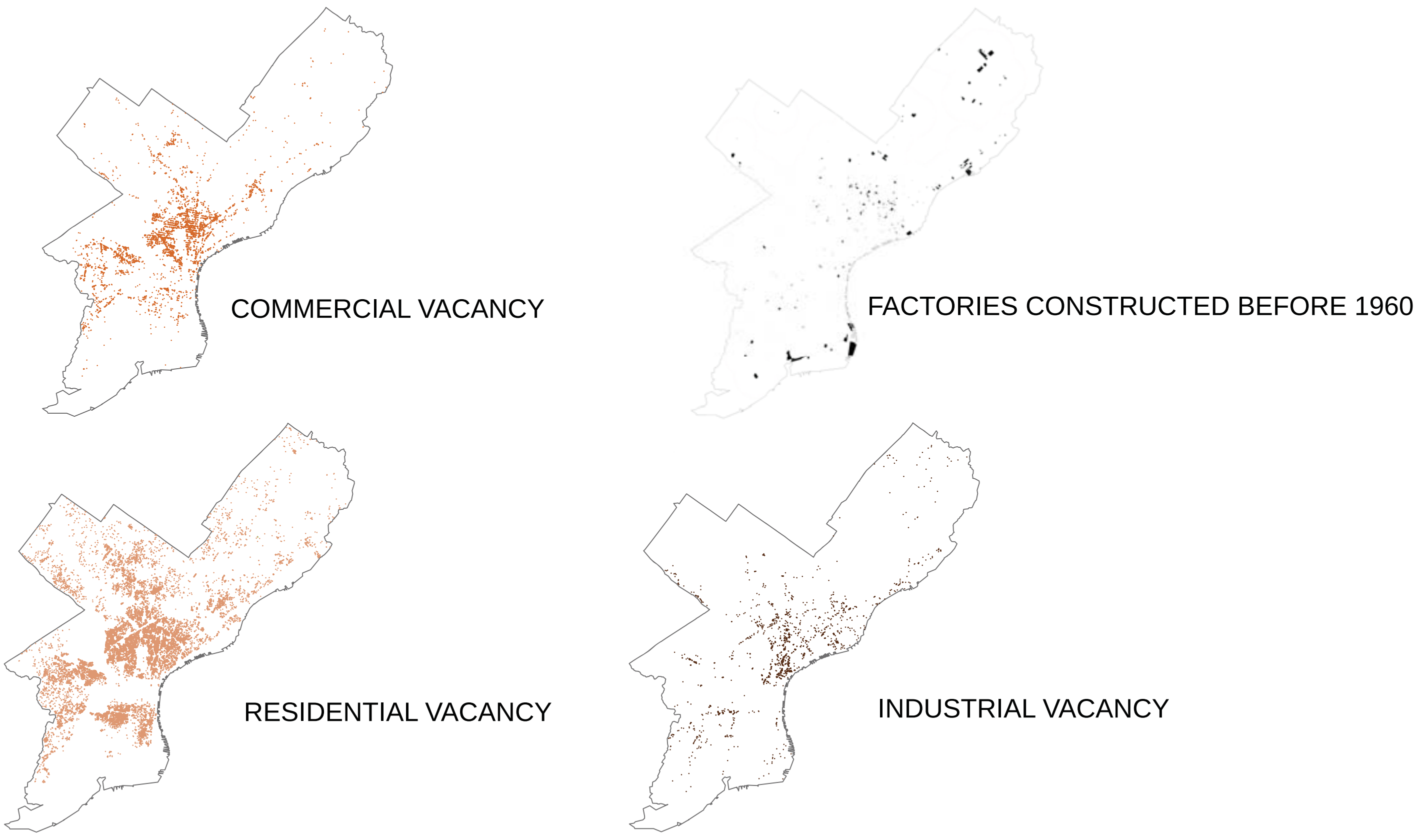


Figure C1. Philadelphia Vacancy & pre-1960 Factory Construction

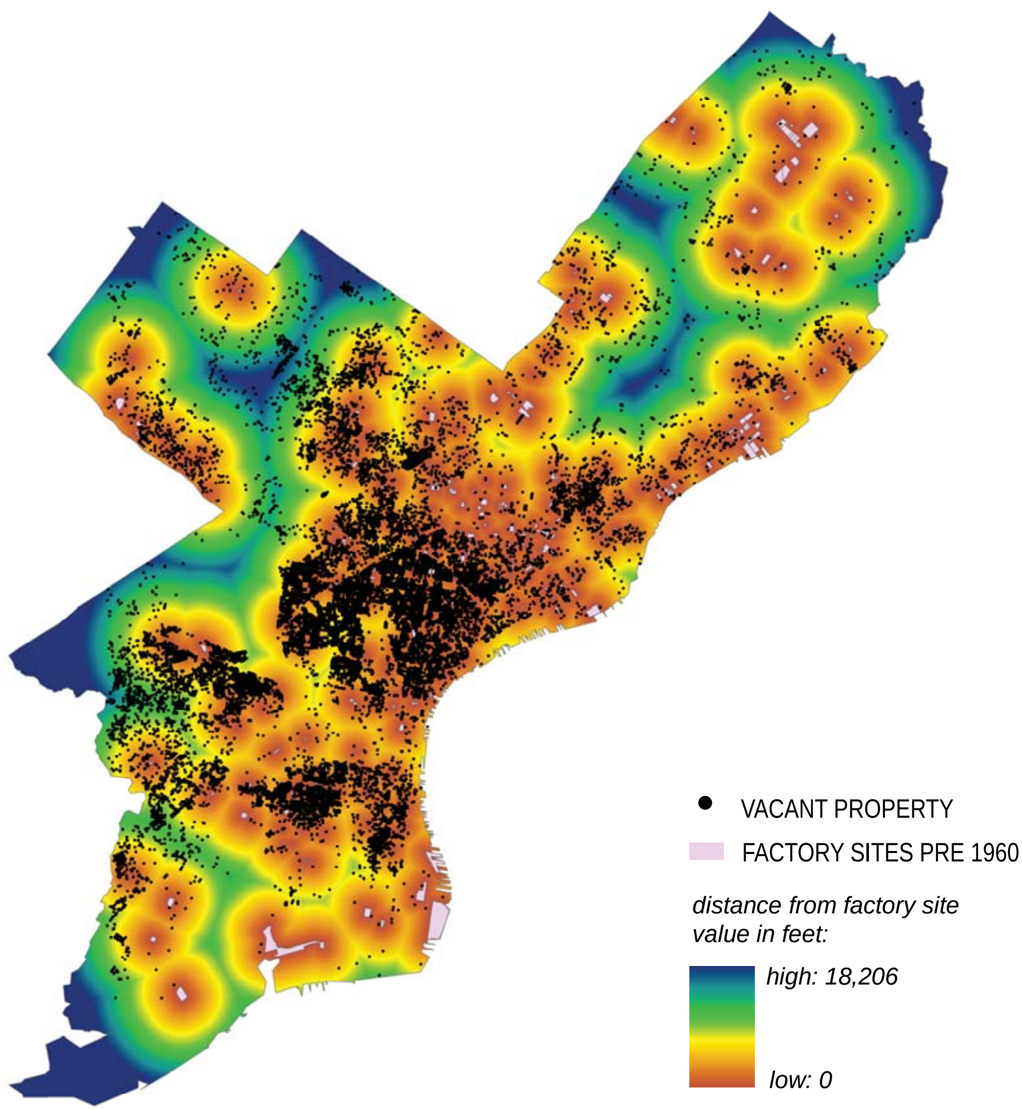


Figure C2. Philadelphia Vacancy & 1960 Factory Construction Overlap

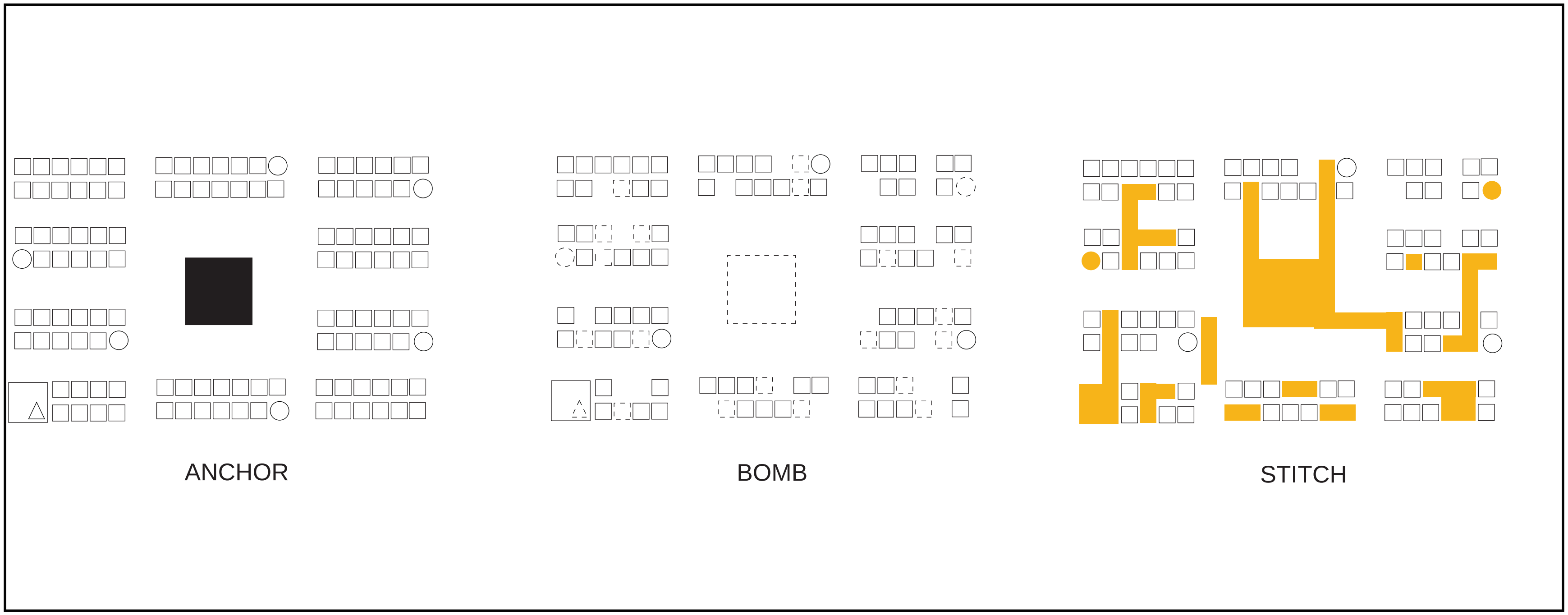


Figure C3. Typical progression of a neighborhood anchored a light industrial building. After the industry leaves and the building becomes vacant it acts more like a bomb, encouraging people to leave the area. This thesis proproses to stitch this network back together

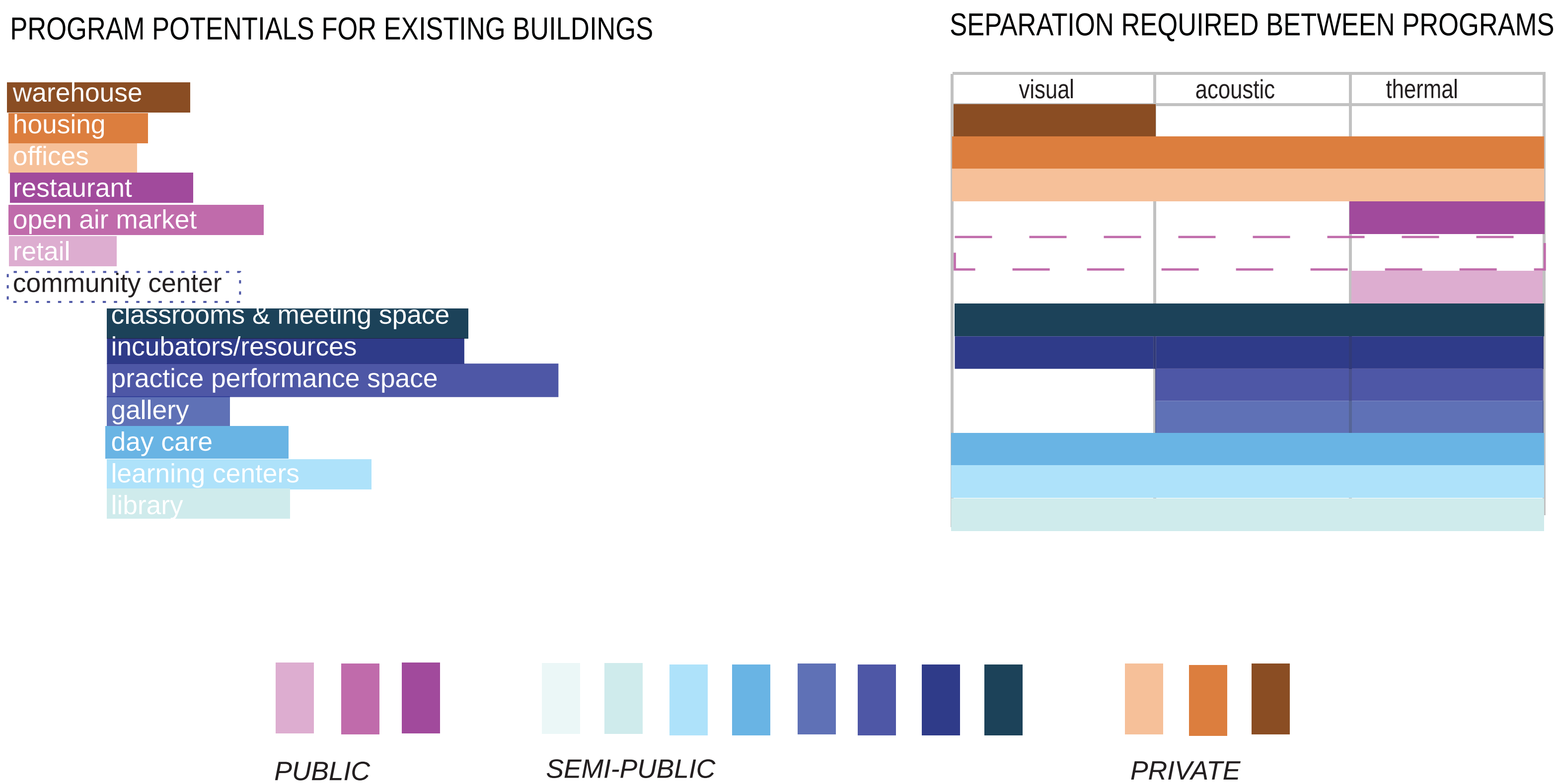


Figure C4. Type of separation required between various programs

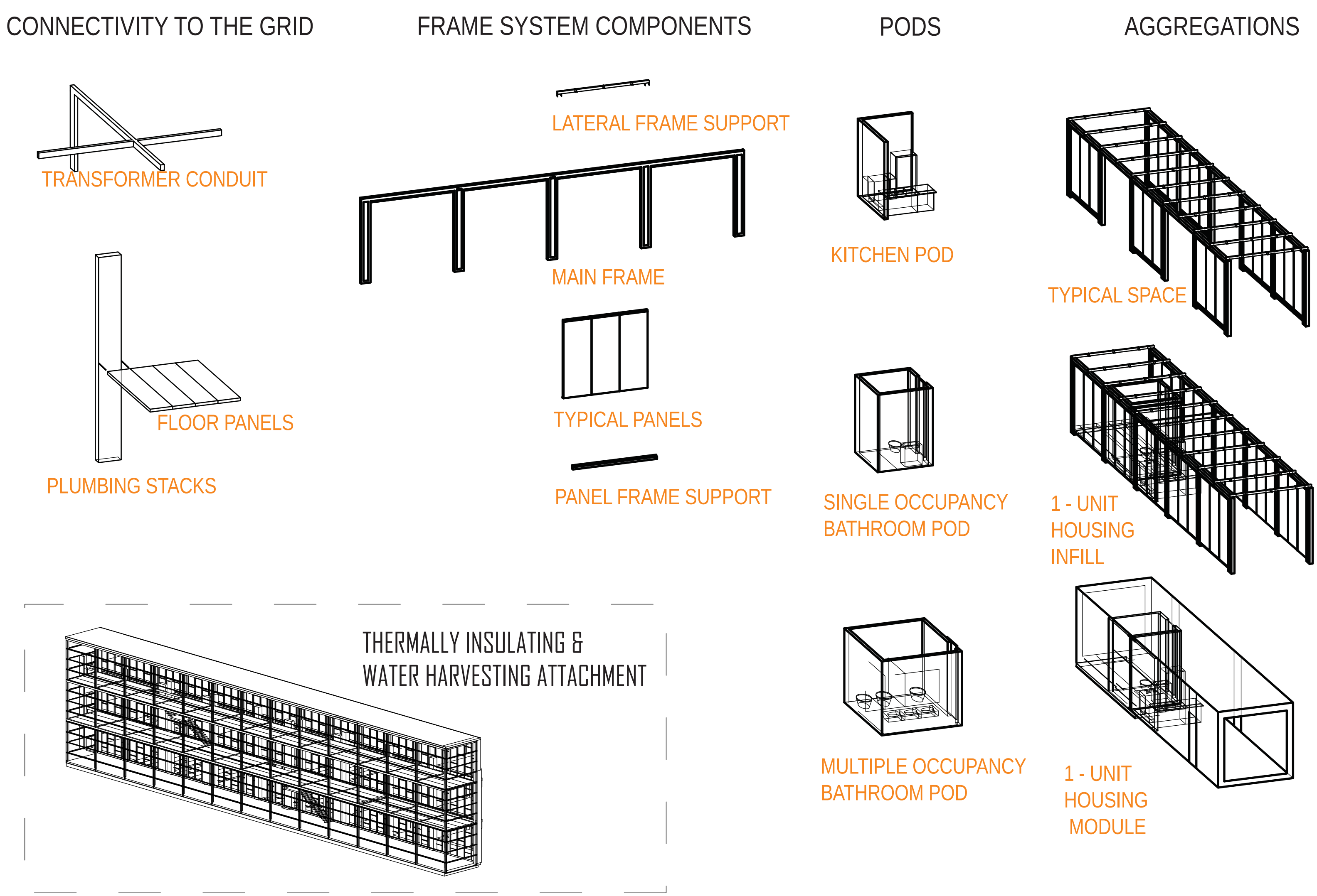


Figure C5. Kit of Parts for prefabricated system

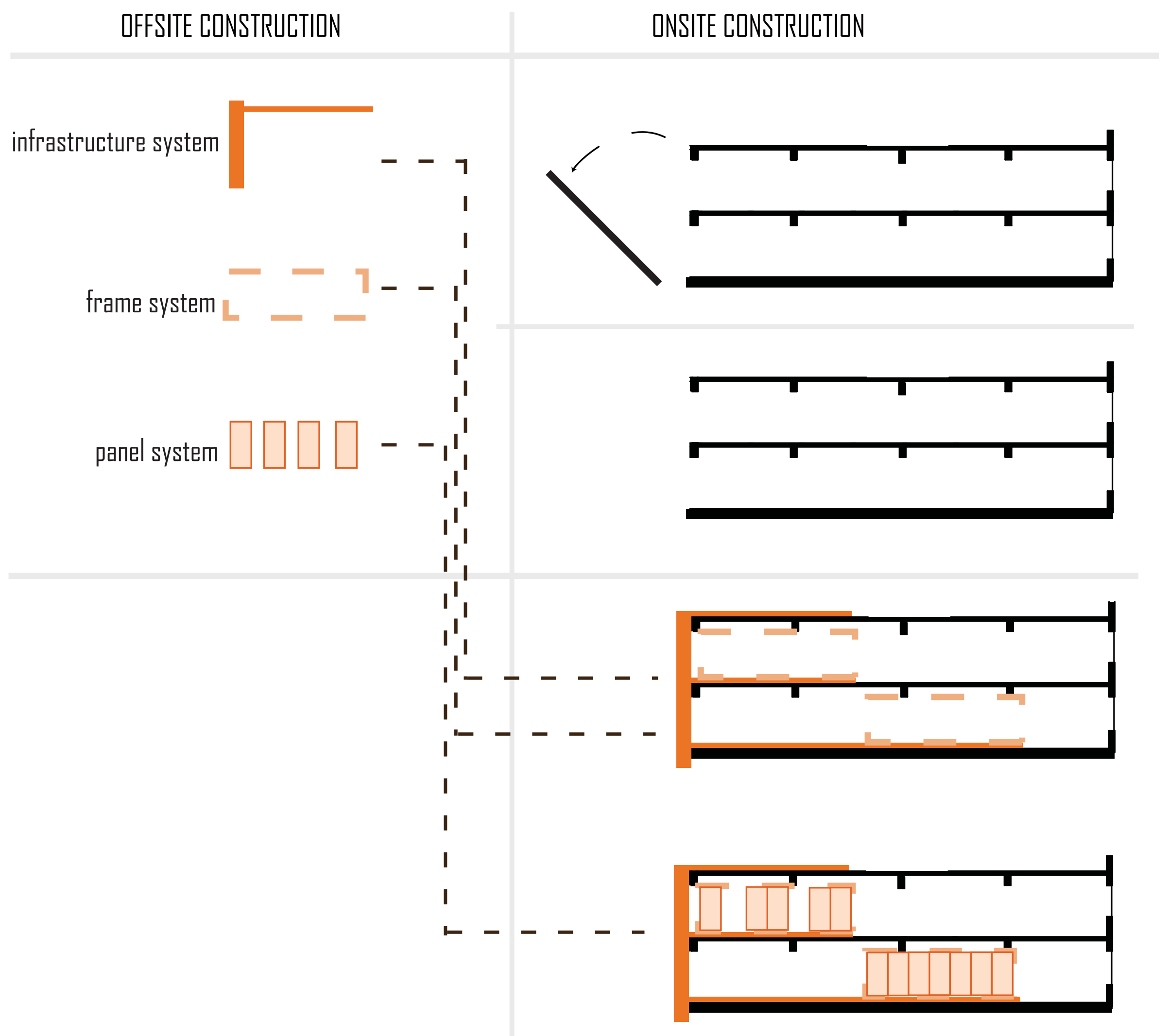


Figure C6. Premise of proposal, using the quantitative requirements of the ITC

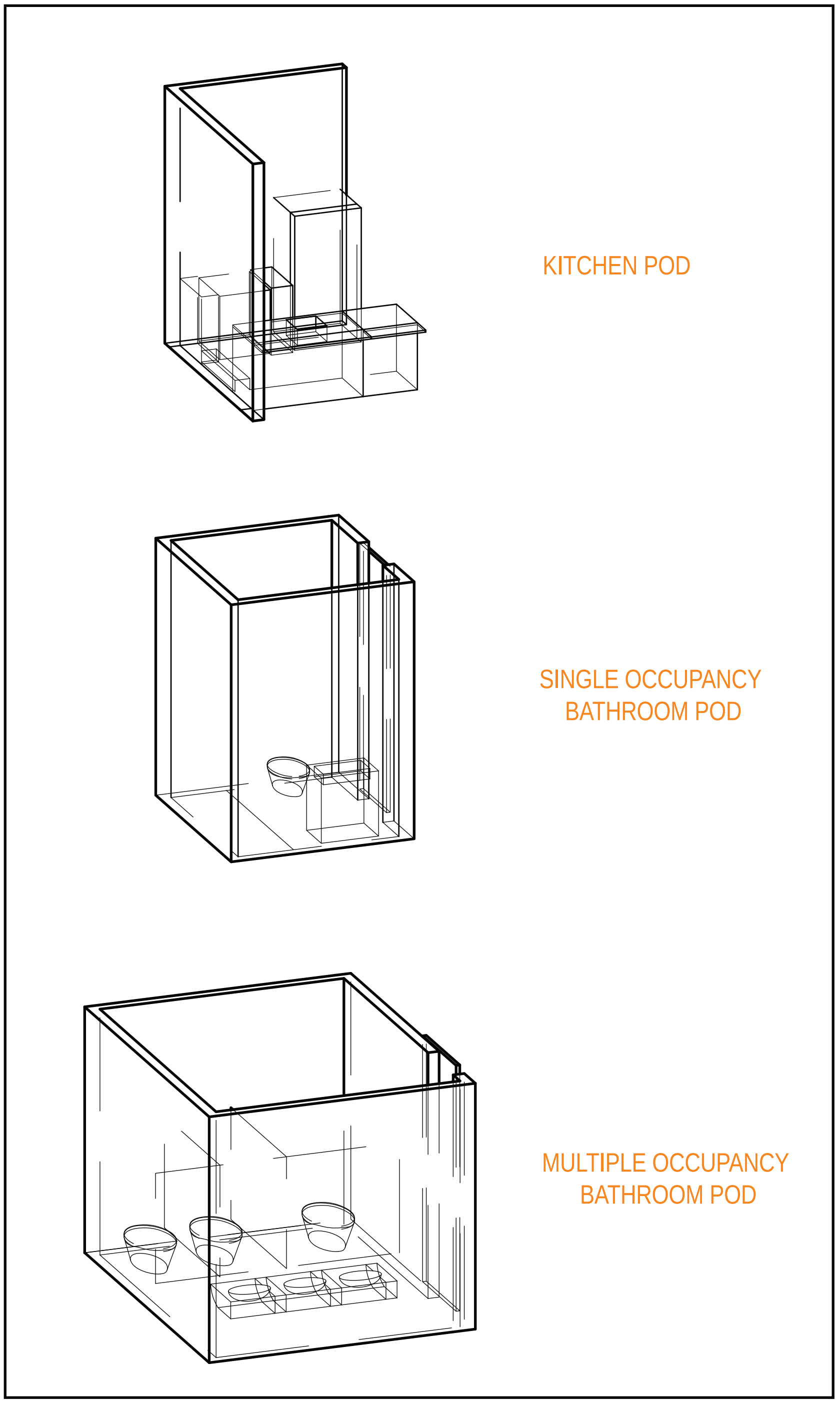


Figure C7. Bathroom Pod Options

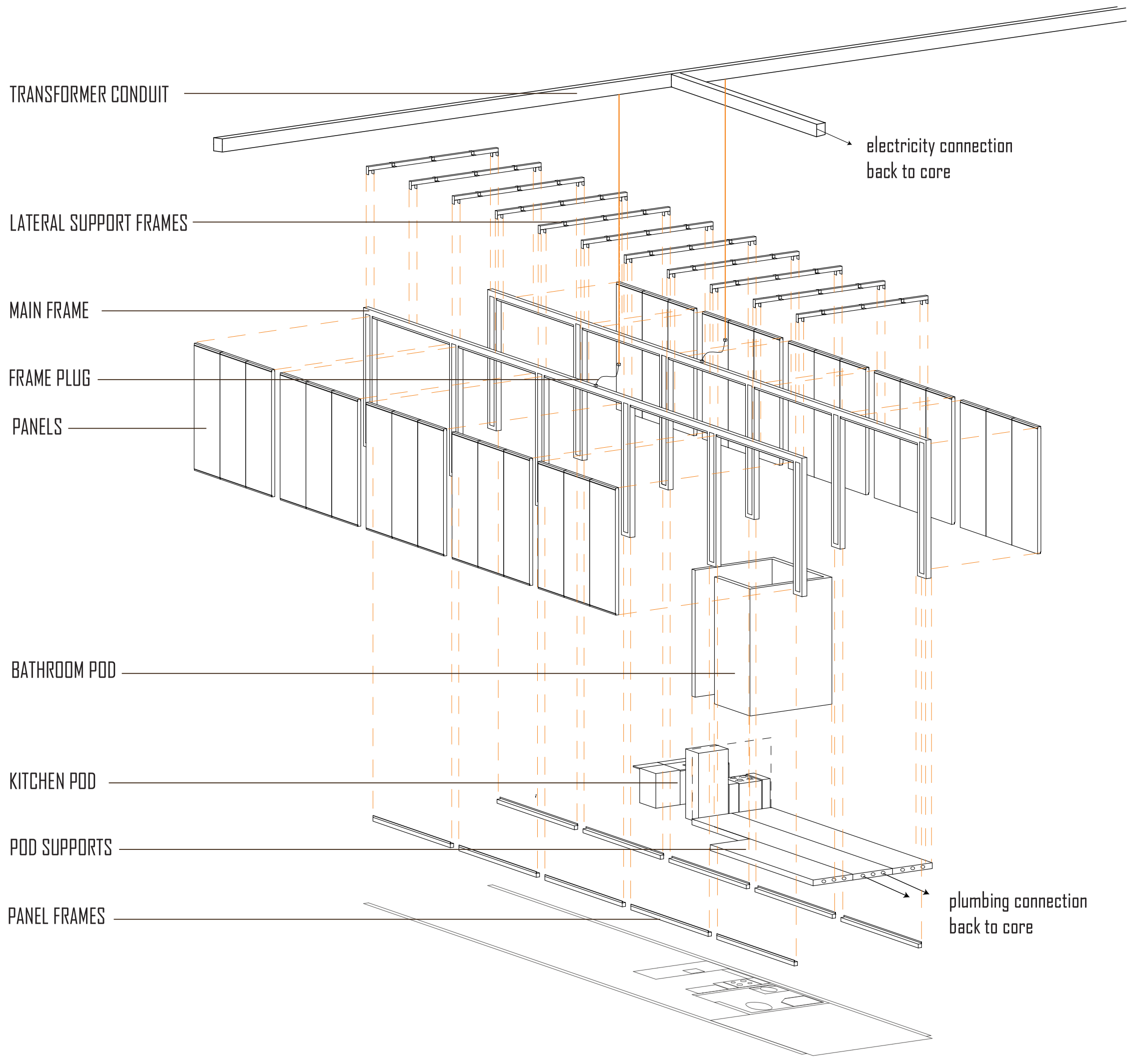


Figure C8. Exploded axon of a typical housing unit

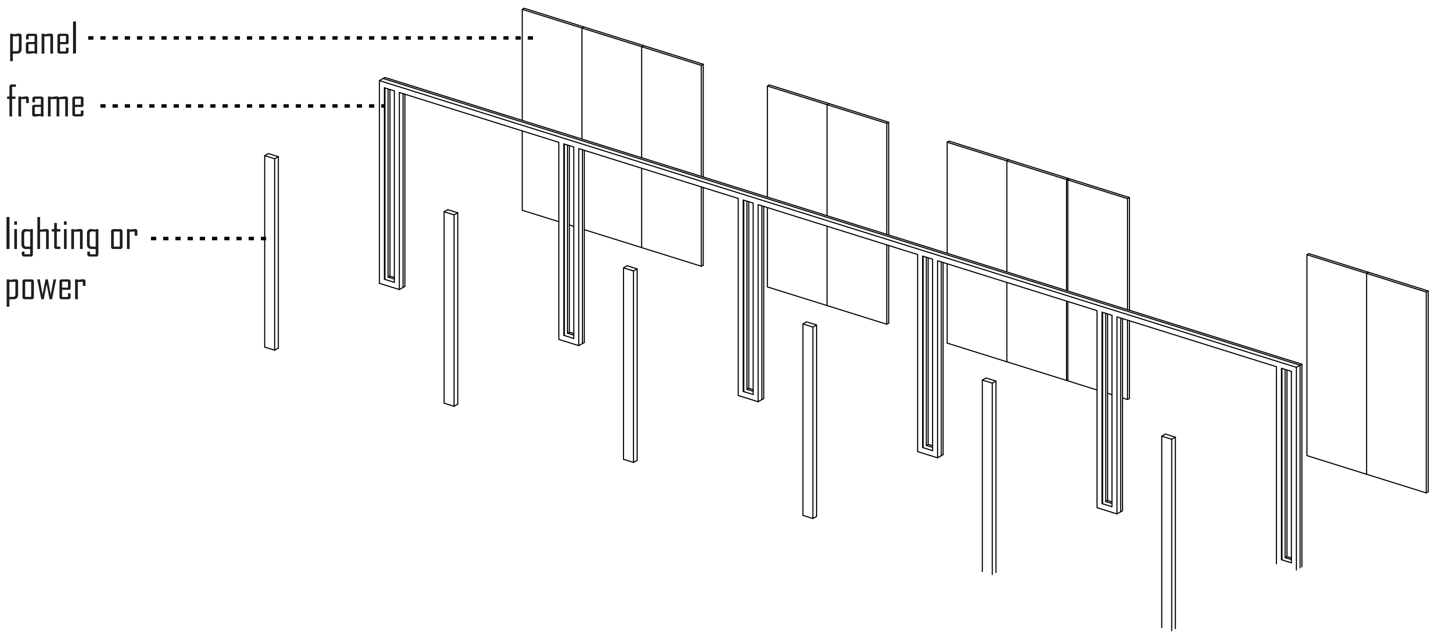


Figure C9. Exploded Axon of frame and panel system

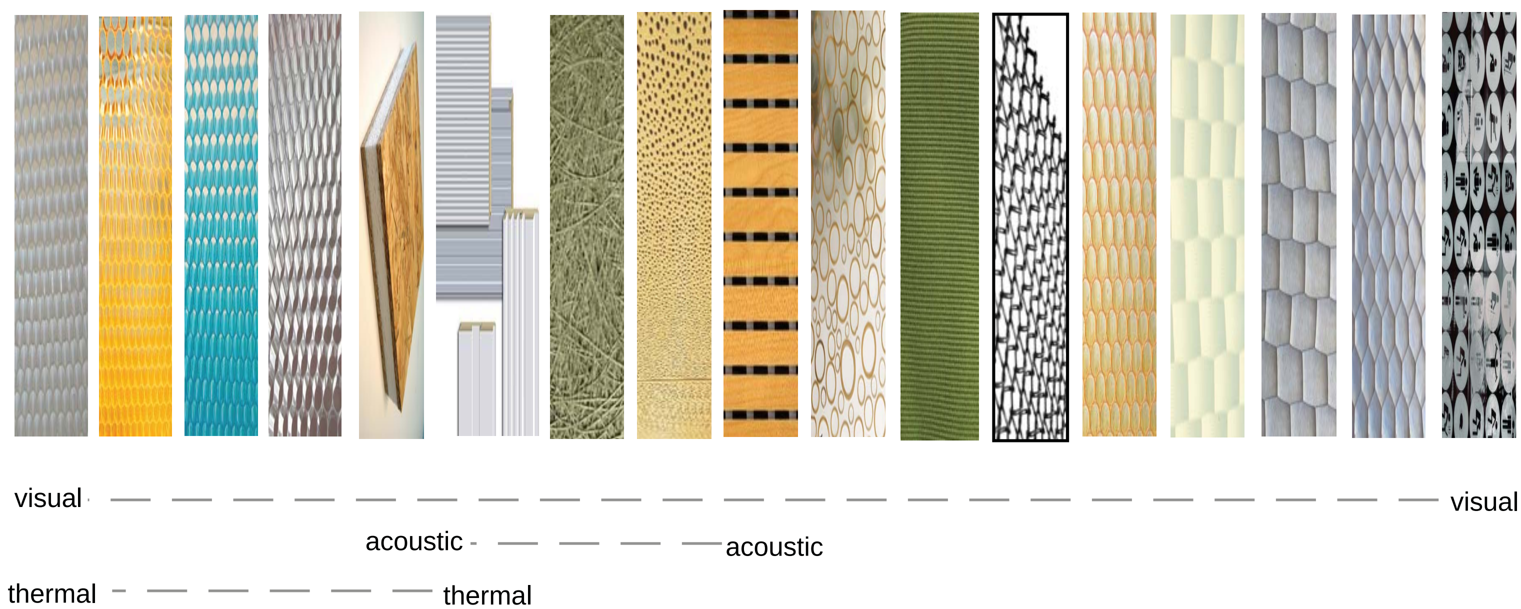


Figure C10. Panel options for frames

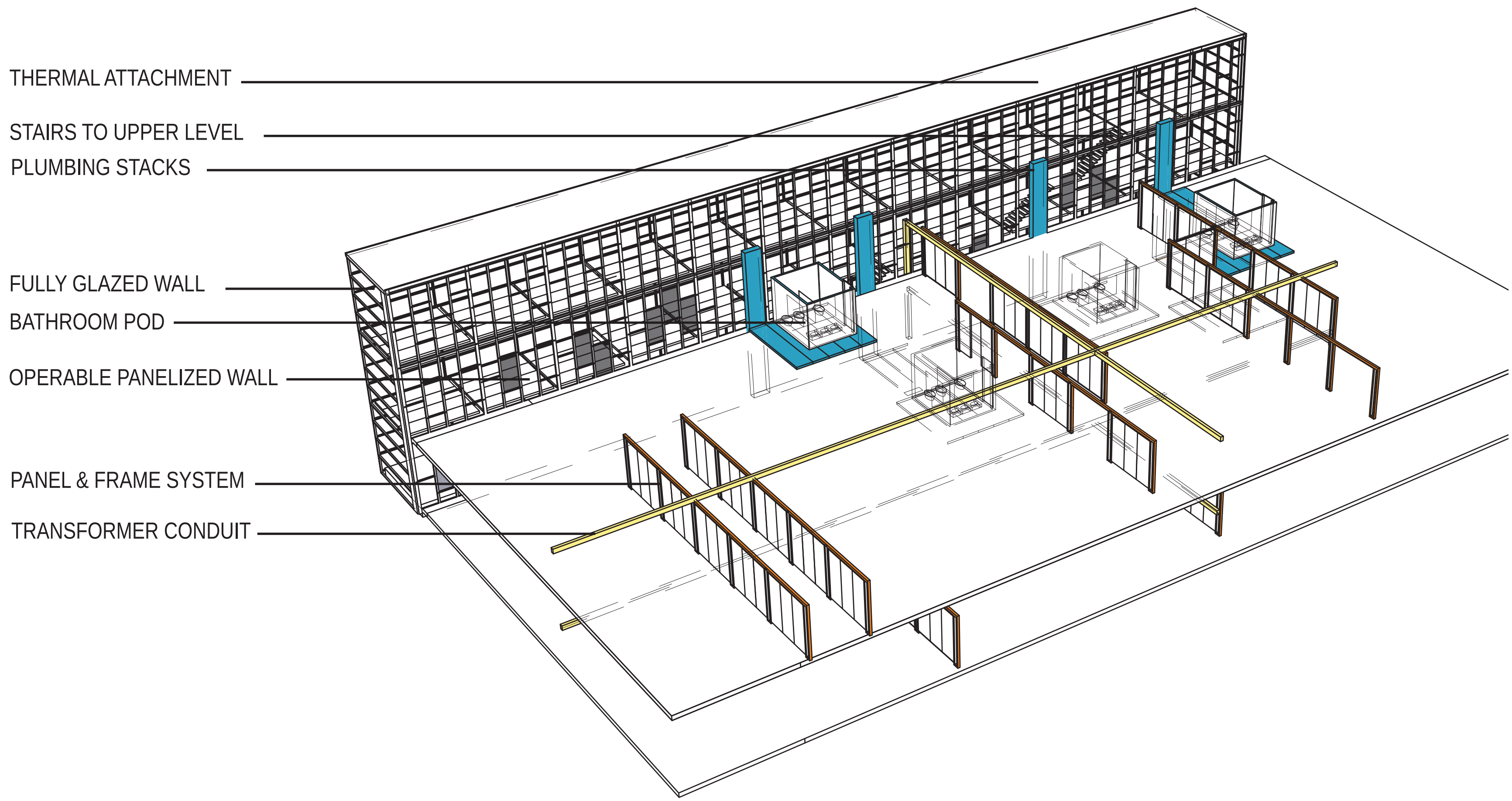


Figure C11. Axon of system components

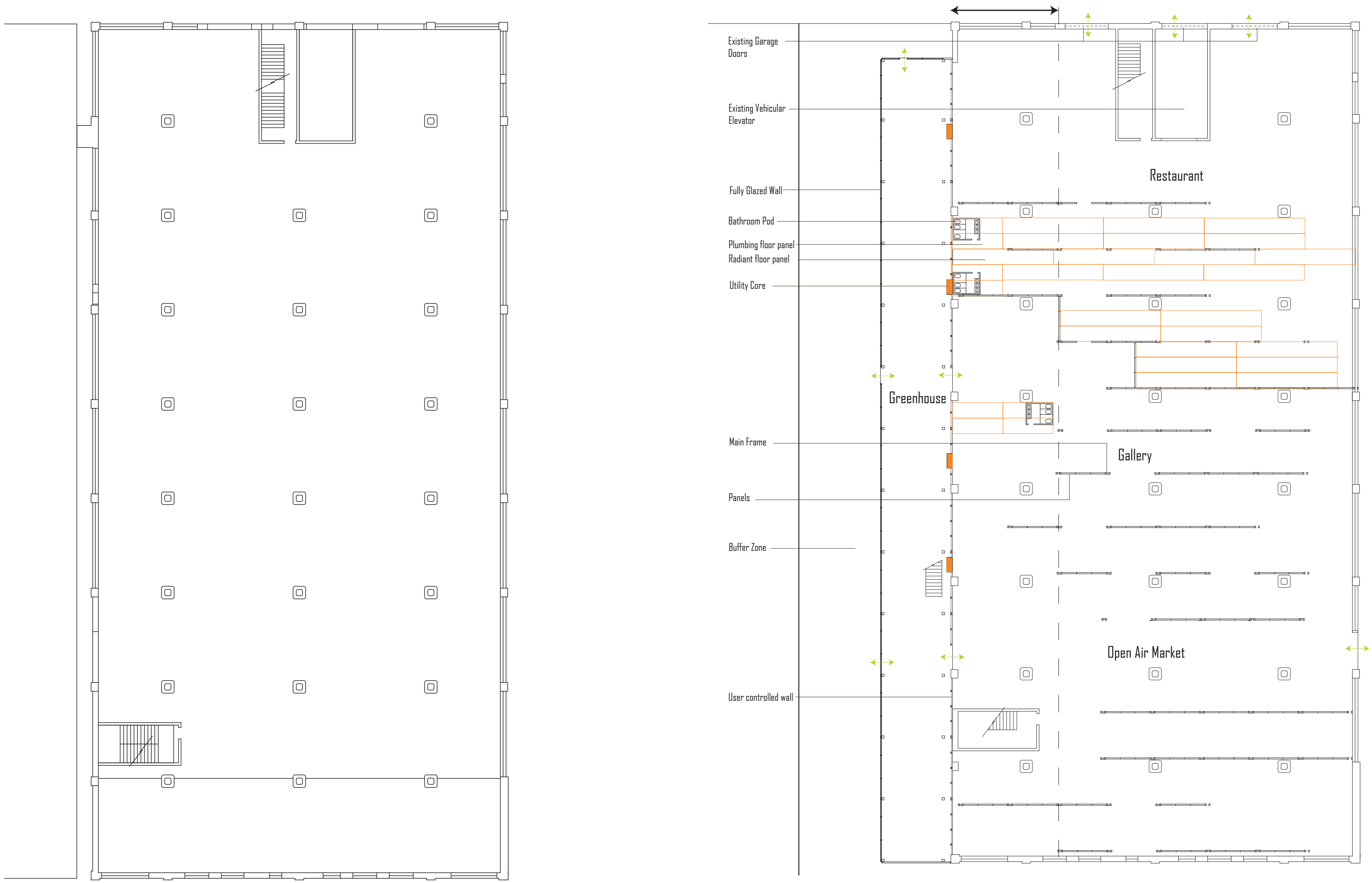


Figure C12. Existing building ground floor plan (left), proposed ground floor plan (right)

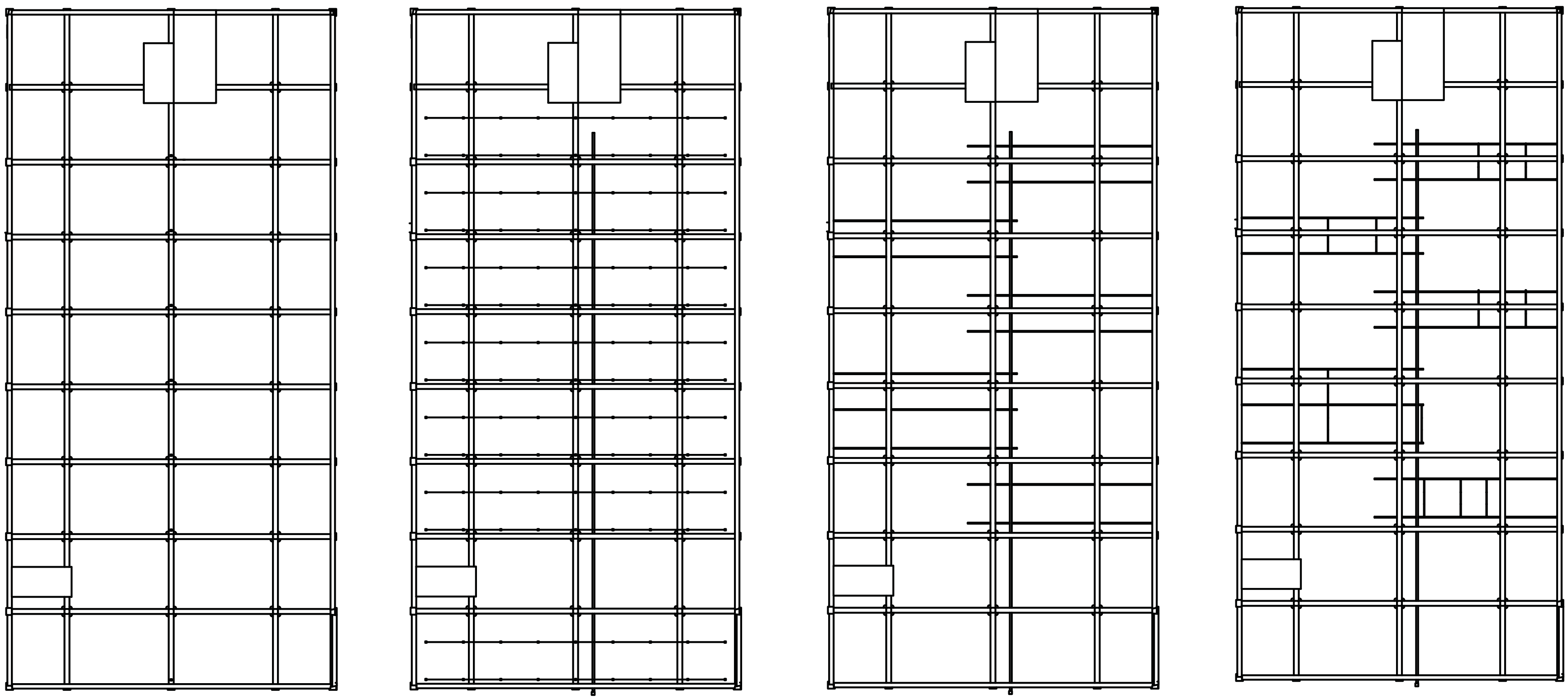


Figure C13. Flexibility of prefabricated system

Figure C14. *Phase One - introduction of revenue generating urban farm for job training*

Figure C15. Exterior Rendering showing revenue generating growing space taking over vacant land

Figure C16. *Section Perspective through proposed building*

Figure C17. Interior Rendering _ community space

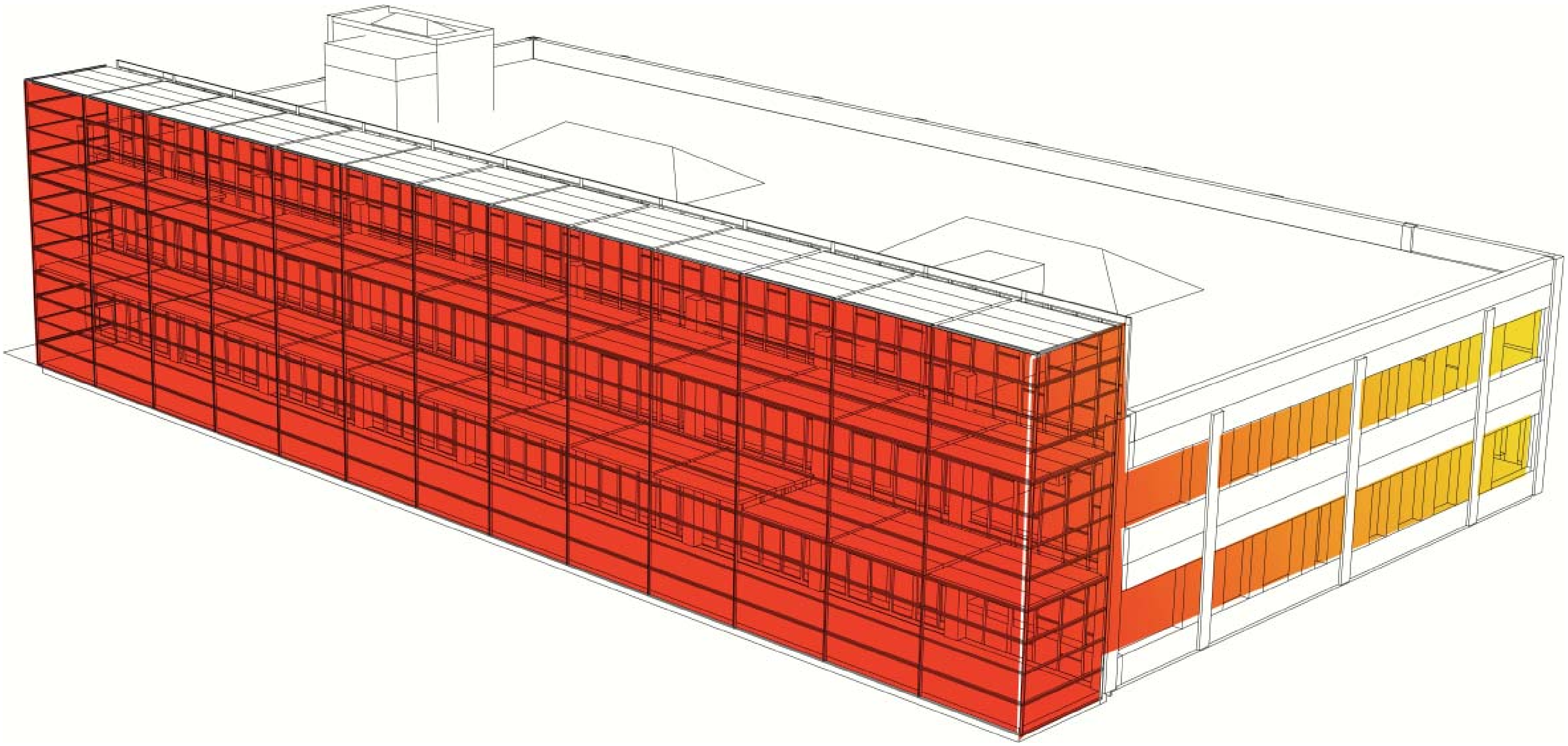


Figure C18. Heat transfer from addition into existing building

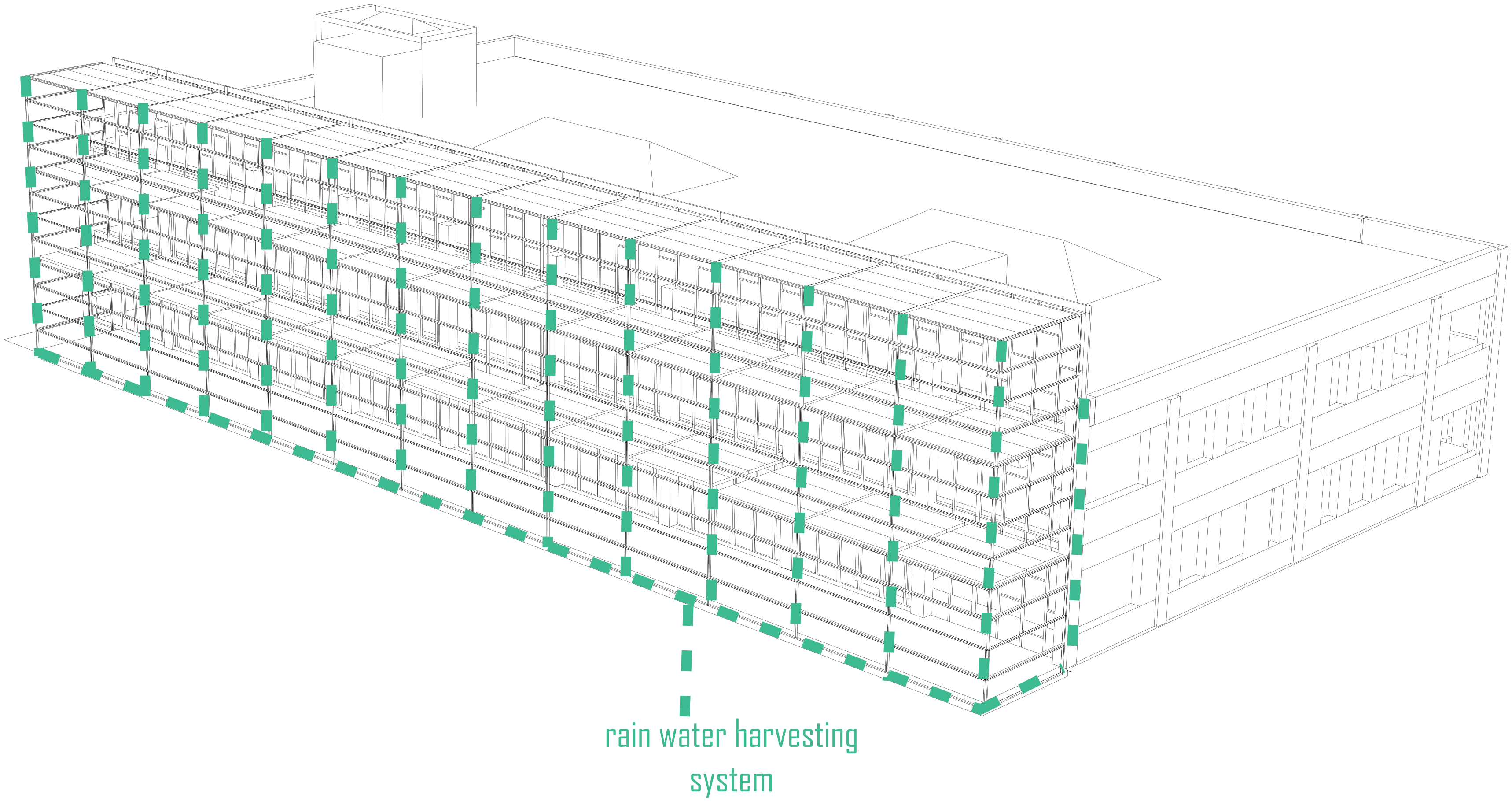


Figure C19. Diagram of rain water harvesting system

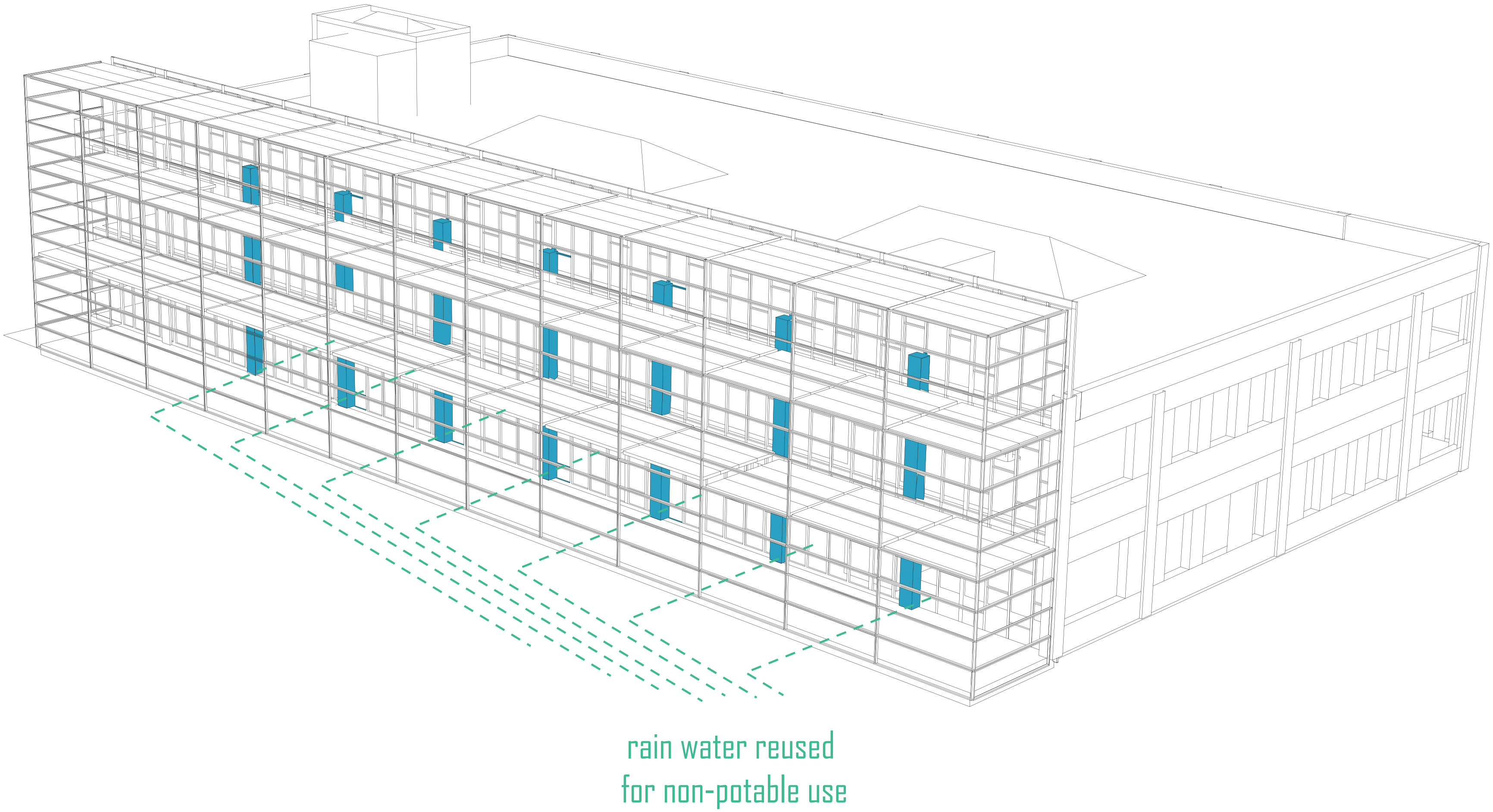


Figure C20. Diagram of rainwater reuse

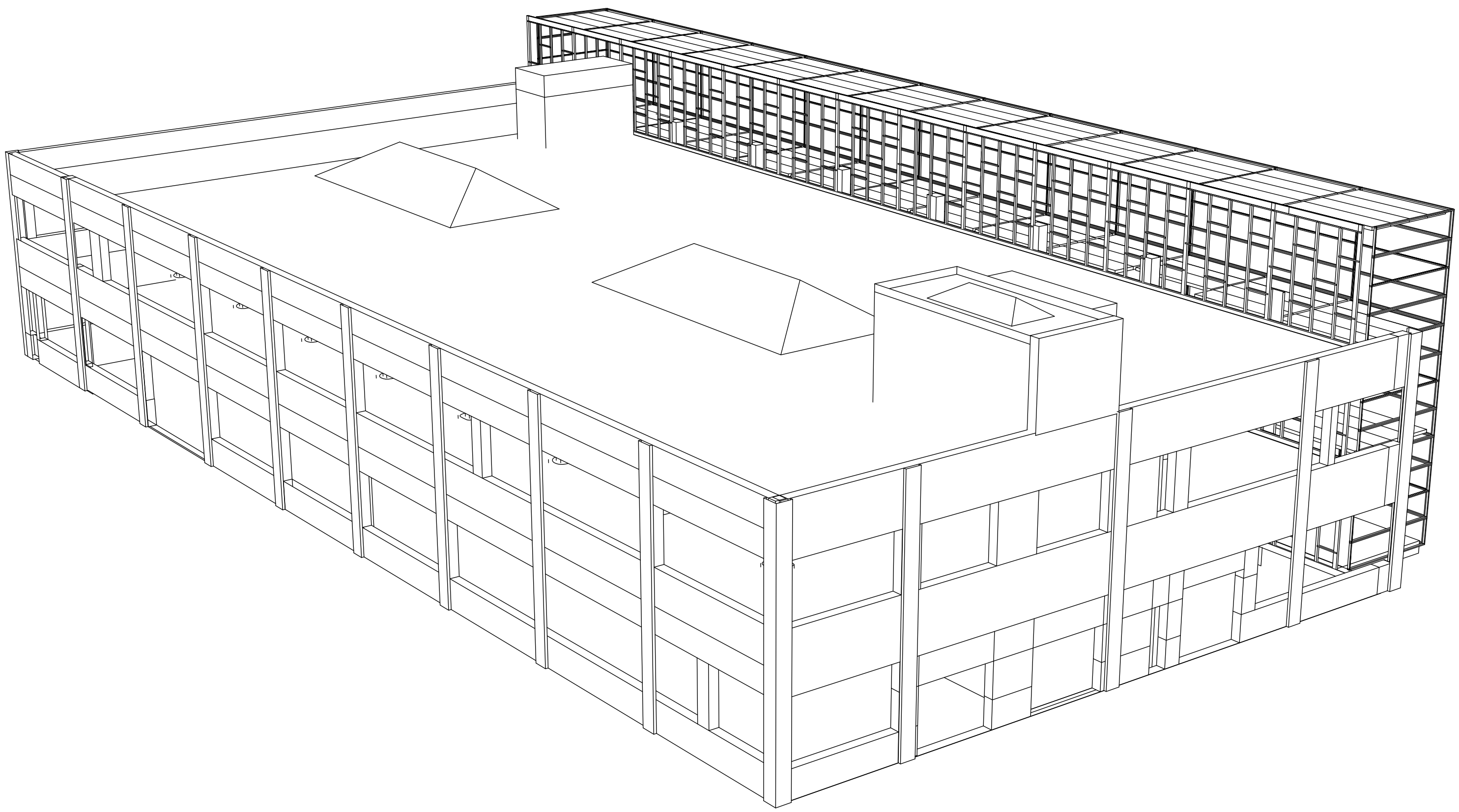


Figure C21. Aerial view of proposed building looking southwest

Figure C22. Phase Two - Implementation of housing.