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UNIVERSITY OF CINCINNATI
Energy in Architecture: 
An Infrastructural Approach

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Abstract

The whole life process of contemporary building design and construction expends tremendous amounts of energy. Through their operation and maintenance, buildings consume 40% of energy expended annually in the United States. In the past century, economic pressures have forced a planned obsolescence upon the building industry, decreasing building lifespans significantly, resulting in energy loss via wasted embodied energy. This leads perceptions of building design and construction to be construed as finite processes engineered for immediate economic benefit and reveals an ignorance of the power and potential of energy systems in the function of buildings. In Kiel Moe’s book *Convergence: An Architectural Agenda for Energy*, he states that both Architecture and energy systems are both “based upon notions of surplus, abundance, and excess.”1 However, contemporary attitudes towards energy are applied based upon contrary notions of conservation and optimization. Moe argues that if based upon principles of energy Architecture can actually become more “simultaneously architecturally and ecologically exuberant and vital...It is time that architects actualize the mutual need for maximal power in both architecture and ecology.”2 Energy, historically under the purview of sibling engineering professions, owned by and aligned with the Architectural process has the ability to produce Architecture that can transcend the current mode of thinking of creating a lesser evil.3 This thesis expands on these concepts, seeks strategies, and identifies existing precedents in order to develop a framework for design, integrating energy system concepts into the Architectural design process. The design proposal

2 Ibid., 16.
3 Ibid., 2-3.
focuses upon a building application that enhances durability, aligning with longer term urban and energy processes. Under the anticipation of change the proposal suggests a separation between permanent and temporary elements in order minimize embodied energy waste through total building demolition. The proposal suggests strategies in programming, phasing, use and construction to develop a building proposal that anticipates change.
# TABLE OF CONTENTS

THE PROBLEM .............................................................................................................. 1

CURRENT ATTITUDES.................................................................................................. 4

AN ALTERNATIVE VIEW................................................................................................ 5

PRECEDENT ANALYSIS................................................................................................ 7

Program .................................................................................................................... 8

Bioclimatic ............................................................................................................... 15

Material ................................................................................................................... 23

AN ARCHITECTURAL THESIS .................................................................................... 29

Characteristics, Strategies, and Implications ........................................................... 32

Program .................................................................................................................. 35

Site .......................................................................................................................... 35

The Temporary and the Permanent ........................................................................ 38
LIST OF ILLUSTRATIONS

Figure 1: Salk Institute Floor Plan ................................................................. 9
Figure 2: Functions of the structure .............................................................. 10
Figure 3: Stacked core .................................................................................. 11
Figure 4: Central core with flexible studio space ........................................... 11
Figure 5: Floor plans ..................................................................................... 12
Figure 6: Infill evolution ................................................................................ 13
Figure 7: Floor plan evolutions. [Source: http://inthralld.com/2012/04/344-square-foot-hong-kong-apartment-transforms-into-24-rooms/] ........................................................................ 14
Figure 8: Directed solar access ..................................................................... 16
Figure 9: Floor plans ..................................................................................... 16
Figure 10: Solar and wind access ................................................................... 17
Figure 11: Floor plans .................................................................................... 17
Figure 12: Dual light scoop .......................................................................... 18
Figure 13: Floor plans .................................................................................... 18
Figure 14: Floor plans .................................................................................... 19
Figure 15: Seasonal strategies ....................................................................... 20
Figure 16: Floor plans .................................................................................... 21
Figure 17: Solar and ventilation strategies ...................................................... 22
Figure 18: Cross section ................................................................................. 24
Figure 19: Floor plans .................................................................................... 24
Figure 20: Floor plans .................................................................................... 25
Figure 21: Floor plan ..................................................................................... 26
Figure 22: Cross section ................................................................................. 26
Figure 23: Floor plans .................................................................................... 27
Figure 24: Cross sections ............................................................................... 28
Figure 25: Site context: Proximity to commercial corridor and mass transit .... 36
Figure 27: Internal site configuration: Two bars converge at prominent corner 37
Figure 26: Site surroundings: Street hierarchy and prominent corners .......... 37
Figure 28 ....................................................................................................... 41
Figure 29 ....................................................................................................... 41
Figure 30 ....................................................................................................... 42
Figure 31 ....................................................................................................... 42
Figure 32 ....................................................................................................... 43
Figure 33 ....................................................................................................... 43
Figure 34 ....................................................................................................... 44
THE PROBLEM

Buildings consume tremendous amounts of energy. According to the U.S. Energy Information Administration’s (EIA) Annual Energy Review of 2011, nearly 40% of all energy consumed in the United States comes from buildings. The EIA’s Residential Energy Consumption Survey elaborated that nearly 50% of the energy expended in American homes comes also from heating and cooling. It’s not surprising to recognize that when considering the total energy expended during the lifespan of a building, the majority of energy consumption comes from heating and cooling. The remaining energy expenditures come primarily from the building’s embodied energy.

Buildings follow economic demands and are therefore constructed to last as long as they are projected to be financially viable. Under this regime of planned obsolescence, the economic performance of a building outweighs its practical and functional performance. As a result, anticipated lifespans of new buildings have decreased significantly in the past century – where once buildings were constructed to last over 100 years, contemporary buildings are intended to last. Most cannot last more than 20 years without replacing a significant building component, such as a new roofing membrane or installing new cladding. Today, most buildings are engineered to adhere to short-term economic

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principles rather than principles of energy and design. This is important when considering the total life of the building, as 5-30% of a building's total life energy comes from its construction.\textsuperscript{10} As building life spans are incrementally decreasing and considering that embodied energy is wasted every time a building is demolished, this presents a scenario of tremendous needless waste.

Moreover, standard rating systems for energy use do not adequately address these problems. The numerous initiatives intended to mitigate excessive energy use and needless waste of embodied energy in buildings (LEED, Living Building Challenge, Energy Star, Net Zero Energy Buildings, National Green Buildings Standard) have been developed upon notions of efficiency and conservation, which run counter to the concepts of energy systems which thrive on excess and abundance.\textsuperscript{11}

While these initiatives are yielding marked reduction in building material and energy waste, the problem remains that these initiatives are nothing more than post-rationalizations of architectural design, implementation and building function. Strategies in seeking conservation in building energy consumption are intent upon preserving established design, building, and living norms, working toward a lesser evil as opposed to finding new opportunity. In Kiel Moe’s book, \textit{Convergence: An Architectural Agenda for Energy}, he argues the need for a more purposeful agenda towards energy in Architecture, one not necessarily engrained in quantitative principles found in


engineering, but rather from a deeper understanding of energy systems aligned with the principles of design rooted in Architecture.\textsuperscript{12}

The lack of understanding of energy systems and building functionality has become a critical source of impairment in the Architectural profession and building industry, demonstrating a profound short-sightedness towards energy (and money) wasted needlessly, but also remunerating the expense of the building as an investment and a piece of working infrastructure, while cultivating greater functionality and interactivity between the building and its users. Architects need a deeper comprehension of the energy processes that enable buildings to function, nurturing a symbiotic relationship between the building’s operation, use, experience and evolution.\textsuperscript{13}

This thesis explores the principles shared in \textit{Convergence: An Architectural Agenda for Energy} and expands on them towards a more direct framework for design, exploring how some of these principles might be applied to the design of a mixed-use building intended for continual adaptive reuse as part of the building’s ecological function.

The following paper will outline contemporary perspectives on buildings, energy and people followed by an explanations of the principles outlined in the book, \textit{Convergence}. This paper will propose strategies for embodying the principles mentioned through an exhaustive precedent analysis, demonstrating principles in built projects. Finally, this

\textsuperscript{13} Ibid., 16.
paper will discuss a thesis proposal in the context of Philadelphia, PA, exploring one of the main principles discussed in *Convergence*, next-use Architecture.\(^{14}\)

**CURRENT ATTITUDES**

Building energy performance has been a hot topic in the Architecture and construction industries in the past 20 years. Numerous rating systems, products, international standards, and measuring tools have been developed, aimed at providing folks in the building industry the necessary information to meet the criteria of the established organizations and rating tool systems mean to curb energy expenditures in building maintenance and construction.

The concern for building energy consumption has developed numerous building energy consumption standards worldwide: LEED, PassivHaus and Net Zero-Energy Development to name a few. These energy standards consider not only how much energy a building requires to function but also where and how the building's construction materials are extracted, the embodied energy consumed to construct the house. Focusing on the ideas of inventory and quantification of materials and inputs, these systems are highly technical and function on notions of extreme precision and optimization.\(^{15}\) The repercussions are mostly positive: less energy use, less waste, greater quality construction. Yet what these programs and standards don’t do could have a great

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negative impact. Their focus on lessening the negatives of development completely obscure identifying any liberating potentials to energy-conscious design.

AN ALTERNATIVE VIEW

In Kiel Moe’s book, *Convergence: An Architectural Agenda for Energy*, he introduces three concepts that work to capitalize upon the energy potential in architecture: 1.) *specifically generic architecture*, 2.) *energy hierarchies*, and 3.) *the complex versus the complicated*.16 Expanding on these three concepts, this proposal intends to explore design and construction strategies that present viable solutions to the subsequent problems, aiming to get the most potential out of buildings. However, the first step is to identify, under the lens of the previously mentioned energy concepts, current issues in architecture which undermine Architecture’s progress towards more energetic buildings:

*Specifically generic architecture* discusses the speaks to the Kiel Moe-coined phrase “Next-Use Architecture” which proposes looking at building design not just in the context of their immediate use, but also what they could allow for in the future. This kind of thinking leads to an approach of the specifically generic – designing with a focused intent to the building’s use, but generic enough to foster adaptation and flexibility over time, allowing for multiple uses/tenants.17

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Energy hierarchies relates to the movement of energy through an open system, from source to end use via feedback loops, exergy and dissipated energy. Moe’s critique is that contemporary notions of energy efficiency view buildings as closed systems, minimizing the amounts of energy placed in the building as opposed taking advantage of the energy potential within the building.\textsuperscript{18} Consequently, thermal comfort in buildings relies dominantly on their mechanical systems – often an afterthought to architectural design and under the responsibility of another profession, mechanical engineering. In addition, the lifespan of new construction has also steadily decreased in the last one-hundred years. This has produced a massive body of built works that not only wastefully consumes energy, but also fails to inform users of our built environment’s role in the larger natural environment. Users and designers become ignorant of natural systems further fueling reliance on mechanical systems for heating and cooling. This paper translates energy hierarchies into bioclimatic design, suggesting that buildings that are more sensitive to their environments have greater opportunities to make the most of the energies flowing through their assemblies.

“Build cheap and maintain expensive,” declares Ralph Knowles in his spot on identification of the leading popular mantra when considering home construction identifies confusing and conflicting priorities in home owning building and construction.\textsuperscript{19} As energy costs have been historically low and stick frame construction adequate, it is small wonder

that this system has been become so prolific. This supports the previously mentioned notion of planned obsolescence, the building is more commodity than investment.

*The complex versus the complicated* speaks to the escalating complexity of building systems in contemporary construction. As problems arise, solutions tend to be tacked on rather than reconsidered, hence typical wall assemblies are typically multiple layers of singular functioning materials. The concept of the complex versus the complicated challenges this notion of complicatedness and seeks to reconsider how buildings are constructed – so that less complicated, more simplistic strategies can coalesce to provide the complex shifting processes of a building.20

**PRECEDENT ANALYSIS**

Expanding upon the three main concepts which take full advantage of the energy potential in buildings in Kiel Moe’s book *Convergence*, this thesis proposal seeks to dig further into how these concepts can manifest themselves into functional built works through a comprehensive precedent analysis. This proposal classifies these previously mentioned concepts into these categories: Programmatic, Bioclimatic, and Material. In each of these considerations there are numerous examples of built precedents demonstrating the criteria necessary for cultivating potential within architecture. This section will explore these precedents and extract their most essential elements or strategies.

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Program

In a lecture given at University of Massachusetts Architecture & Design, Architect Michael LeBlanc identifies three essential characteristics of ideal “Next Use Buildings” or buildings that will have the potential to thrive beyond the lifespan of initial and intended use. He identifies these criteria as robust structure, integrated building systems, and durable enclosures. The notion of “Next Use Architecture” is critical in developing a methodology for buildings to go beyond their predetermined potential. This capitalizes not only on lengthening the lifecycle of the building, but also identifies the areas of the buildings that will have the most impact on capitalizing on the energy potential for the building. In practice, it requires rethinking HOW buildings are used and an examination of the notion of program.

This first group of precedents have been selected for their strategies that transform these buildings into essential infrastructure for living. These buildings demonstrate a variety strategies that accommodate spatial flexibility, integrated buildings systems, future expansion and spatial transformation.

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21 Michael LeBlanc, Next Use Buildings: adaptive re-use and strategies for expanded future uses in new buildings. (Lecture, University of Massachusetts, Amherst, MA, September 13, 2011.)
Kahn’s Salk Institute is successful on many levels, not least of which is its tremendous flexibility of its primary use space. This is possible because of two key elements of the design. The first is the large span structure, bridging the entire primary use space and allowing uninterrupted, unlimited spatial configurations for the labs below. Secondly, this large span is made possible by a deep pre-stressed concrete Vierendeel truss which allows ample space for ducting and maintenance to access and provide any utilities that the primary use space may require. New utilities can be constructed and installed in these plenum spaces without interrupting work in the lab spaces. While these served spaces required what equated to an entirely additional floor for each lab space, it
illustrates a key point, it takes large amounts of additional space to provide complete and
total spatial flexibility within a primary use space.²²

STUDIO HOUSE, 1994

LOCATION: Bavaria, Germany

ARCHITECT: Thomas Herzog

STRATEGIES: Centralized integrated systems

This house is parsed into three distinct zones which run the length of the building creating east, west, and central zones. As a large amount of spatial flexibility was desired by the client, the proposal resulted in a centralized core of structure and mechanical systems. This freed up surrounding adjacent space to allow for a variety of different uses over time. The centralized core accommodated wash and restrooms, storage, sinks, cabinets and other utility spaces.23

**QUINTA MONROY, 2004**

LOCATION: Iquique, Chile

ARCHITECT: Elemental; Alejandro Aravena

STRATEGIES: *Future development expansion*

Quinta Monroy is an infrastructural project disguised as Architecture. Providing the most basic elements for a house: four walls, a roof, a working restroom and running water for a kitchen, this proposal set up the framework for future expansion. As the family grew, infill walls and additional utilities could be piped in to provide for expanding utility needs. Constructed for poor families in Chile, it provided them the necessary foundation for a home and created a framework that allowed for incremental growth, evolution and individual choice in how a community wished to shape their own neighborhood.²⁴


*Figure 5: Floor plans*
Figure 6: Infill evolution
DOMESTIC TRANSFORMER, 2009

LOCATION: Hong Kong, S.A.R.

ARCHITECT: Gary Chang

STRATEGIES: Transformable space

Architect Gary Chang integrates concepts of multi-functionalism with high-density compact living to develop his home, deemed the Domestic Transformer. Capable of accommodating 24 different spatial configurations – and associated differing activities and programs – this sleek and modern apartment in Hong Kong cultivates a staggering amount of variety in only 340 square feet of space. Thickened wall systems glide along tracks to reveal a hidden kitchen or washroom. Wall panels shift and slide to release a bed or sitting area, expose a library or linen closet.25

Figure 7: Floor plan evolutions. [Source: http://inthralld.com/2012/04/344-square-foot-hong-kong-apartment-transforms-into-24-rooms/]

Bioclimatic

This section explores buildings that have a purposeful sensitivity to their surrounding environment. Each of these buildings employ specific strategies ranging from the traditional passive strategies to cutting edge amalgamations of passive and active systems. At the very least, these buildings, as standing pieces of infrastructure, consume significantly less amounts of energy than their standard architectural peers. At their greatest, they stimulate users and residents to shift their habits and behaviors to align with their surrounding environments. The architecture isn't a barrier or shelter from the elements, rather it is a filter through which the user experiences and synchronizes with natural patterns.
VILLA ASTRID, 2002

LOCATION: Gothenburg, Sweden

ARCHITECT: Gert Wingardh

STRATEGIES: Landscape Integration; building orientation and material

Situated in a residential neighborhood by the sea, the architects had to contend with a massive rock outcropping on the southwestern portion of the site that obscured views, blocked vital winter sunlight and reduced developable land area. The proposed design works instead symbiotically with the outcropping, creating a small courtyard beside it. The northern arm of the building reaches above the outcropping providing focused views to the southwest, which also allow direct sunlight in during the coldest parts of the year.26

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A fresh take on the classic townhouse typology, this design represents a solid blend of solar and ventilation principles that complement the buildings internal layout – as opposed to being afterthoughts in the design process. Ample glazing on the south façade with a heavily insulated north wall provide necessary daylighting and insulation reflect the front and back of the buildings respectively. An open stair core leads to the roof garden providing a vertical shaft for stack ventilation, further facilitated by radiant flooring. As a bonus, the lower level is designed to accommodate full bath and kitchen facilities and constructed of moveable partitions to allow for a full unit partitioning in the future life of the building.27

**KENSINGTON LIGHTHOUSE, 2008**

LOCATION: Melbourne, Victoria, Australia

ARCHITECT: Tandem Design Studio

STRATEGIES: *Building form and material*

Located on a shady street in a dense urban neighborhood in Melbourne Australia, this townhouse design embodies bioclimatic principles through building form and materials. Oriented east to west, the building shares a wall with an adjacent lot on the north side. Constrained for sunlight, the design proposes two light scoops situated about an interior courtyard. The two light scoops, lined with plywood paneling, reflect warm natural light over an open floor plan which allows the light to penetrate into the lower levels. To the east and west are a mix of clear and translucent panels which provide necessary admittance of light, shade and privacy.28


*Figure 12: Dual light scoop*  
*Figure 13: Floor plans*
HOUSING DEVELOPMENT, 1982

LOCATION: Munich, Germany

ARCHITECT: Thomas Herzog

STRATEGIES: Maximized solar exposure; Double-skinned facade; flexible modular layout

Situated on a narrow urban lot, this building was meant as a prototype for transparent materials and solar design. The design brief stipulated a flexible floor plan that would allow this unit to function as one building or several, necessitating a continuous unifying approach across the entirety of the building. What makes this building proposal unique is its use of the double-skinned façade for residential use as well as its solar orientation, making the most of a constrained orientation by maximizing the solar exposure on the building.29

Figure 14: Floor plans

The roof is a large sloped surface, a double-skinned roof/façade, oriented southeast, maximizing daily solar exposure and morning insolation. This roof/façade creates a transitional thermal zone with moveable internal louvers that can allow flexible control between different zones in the unit. Additional functions are also provided by the double-skinned façade in the form of natural light, ventilation, and space for PV panels. Collecting cool air through its base while expelling warm air through its ridge in the summertime, the façade allows for constant internal airflow. The double glazing also provides ample light, while movable blinds inside the interstitial spaces provide shade and screening. The uppermost portion of the façade is reserved for PV panels and solar hot water tubes, successfully garnering solar energy even on cloudy days.\footnote{\textit{Thomas Herzog, Ingeborg Flagge, Verena Herzog-Loibl, Sonja Anna Meseure, and Deutches Architekturmuseum, \textit{Thomas Herzog: Architektur + Technologie = architecture + technology.} (New York: Prestel, 2001), 52, 54.}}

\textit{Figure 15: Seasonal strategies}
BEDDINGTON ZERO ENERGY DEVELOPMENT, 2002

LOCATION: Hackbridge, London, England

ARCHITECT: Bill Dunster Architects, Arup

STRATEGIES: Consolidated integrated systems

This zero energy housing community was completed in 2002 and meant to house like-minded individuals bent on living a sustainable lifestyle. The unconventional building forms were designed to maximize solar exposure for insolation and shade for active work spaces. Programmed accordingly, home office and library spaces were placed in the single-story sloped rear of the structures. These areas are more spacious, containing higher ceilings and openings that allowed diffuse light and ventilation. Living quarters were in the two-story front with louvered double facades to control sunlight. The community also recycles its own waste and creates its own energy.31

Figure 17: Solar and ventilation strategies
Material

The previous precedent sections demonstrated how buildings are used and how they respond to their greater environment. This section explores how utilizing certain materials and wall assemblies can impact energy consumption in ways similar and even more profound than the most common contemporary practices. Contemporary construction methods of layered assemblies from cheap, light-weight materials reiterates the symptoms of an industry focused upon immediate economic engineering. This section provides examples of buildings that defy contemporary construction practices in order to demonstrate simplicity, efficiency and innovation in construction methods that do more with less.
MEULI RESIDENCE, 2001

LOCATION: Flasch, Switzerland

ARCHITECT: Bearth & Deplazes Architekten

STRATEGIES: Consolidated integrated systems

Lightweight, monolithic, air-entrained, cast-in-place external concrete walls provide insulation and structural support for the buildings relatively small footprint. 20in thick walls have windows at the walls, using the wall’s thickness as a shading device.32

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STADTHAUS, 2009

LOCATION: London, England

ARCHITECT: Waugh Thistleton Architects

STRATEGIES: Consolidated integrated systems

Cross-laminated pre-fabricated timber panels make up this nine story tower. The lamination process also provide air and moisture barriers. Lighter than concrete and steel, the building foundations and walls can be thinner, allowing for more space. The prefabricated construction of the panels also allows for shorter construction times, in this case, the building was construction in two-thirds the time it would have taken with typical construction methods.33

Figure 20: Floor plans

STACKHAUS, 2008

LOCATION: Granite, Colorado, United States

ARCHITECT: Kiel Moe and Ron Mason

STRATEGIES: Consolidated integrated systems

Simplicity here is found in the use of timber walls; one material here, providing the same function as a contemporary wall assembly of over half a dozen layers. All the materials are local and there is no need for mechanical systems to regulate thermal comfort as the stacked spruce walls provide the right amount of thermal transfer from solar exposure for the enclosed space.34

LIBRARY AM ALTEN MARKT 2, 2008

LOCATION: Berlin-Kopenick, Germany

ARCHITECT: Bruno Fioretti Marquez Architekten with Nele Dechmann

STRATEGIES: Consolidated integrated systems

Figure 23: Floor plans
This building conveys the notions that contemporary construction can be simple and effective. 25” thick load bearing masonry walls possess no insulation save for 6” along the north wall. Wood beams span the 60’ expanse, provide an inversed saw tooth pattern along the façade that provide natural gutters along the roof and blend with the vernacular styles of the surrounding town. Windows are set to align with the interior wall so that the window lintel acts as a natural louver.35

The concepts previously discussed are myriad in relation to the need for Architects to develop a deeper understanding of the energy systems in buildings. This thesis proposal will focus on but a small part of these issues in order to demonstrate how some of these ideas could be manifested into a focused design application. As previously mentioned, planned obsolescence in the last century has dramatically reduced building life expectancy. Because of the following, contemporary buildings have become objects engineered for immediate economic performance:

- Buildings are programmed for more specific uses rather than general uses. The ability to utilize building spaces for unintended uses is hindered as the specificity of the original construction hinders functionality of any subsequently different use.\(^3^6\) This often requires unnecessary alterations, gut renovations, or a completely new structure to accommodate new uses.

- As such, structural and mechanical systems are designed to specifically accommodate these immediate uses. Components and systems are engineered for specific loads, meaning that buildings can only function in ways they were narrowly intended – for example, the option to add on an additional floor to most contemporary buildings would require a much larger expense and intervention because the existing structure would not be designed to accommodate additional load.\(^3^7\)

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- Construction by way of light-weight, cheap materials provides for relatively inexpensive construction, however these assemblages are typically complicated and the materials have a short shelf life; if damaged or replaced, they are difficult to reuse and messy to renovate, meaning they often end up as waste.

- Cheap construction also devalues the building with respect to the land. Therefore buildings are viewed more as an expense rather than an asset because they can be easily demolished and re-constructed to new specifications as necessary.38

Why is this a problem? All of these points perpetuate the idea of building design and construction as a finite process; in other words, the building once constructed is then complete. This fundamental misunderstanding of buildings, coupled by an inherent planned obsolescence in buildings in a capitalist society, often necessitates the complete removal of a building to accommodate a new one; in short: buildings have become expendable objects, neither designed for re-use nor long term, but rather one-(short)-time use.

As the issue of wasteful energy consumption has come to the foreground in recent years, buildings are being designed more efficiently than before. Less energy is expended on operation and maintenance due to these initiatives.39 This suggests that embodied energy will make up a large part of a buildings total life energy consumption and a critical


issue to address with regard to curbing needless energy waste. Buildings demolished 20-30 years after their construction will constitute tremendous amounts of energy expended and wasted - not just in the construction and demolition of the structure but also in the creation of these materials as well. 40

One way to capitalize upon a building’s embodied energy and garner a greater return for the investment is to design buildings that last longer.41 This thesis proposal asks: rather than designing buildings that are constructed and demolished completely, what if certain building elements were designed to remain? What components would remain? What would a building look like? How could the building be used? In essence, it suggests a building meant to be adaptively re-used, a building built for change.

Taken further, this proposal explores the implications of building design and construction not as a finite process, but rather an ongoing evolution; the building at once as occupiable, usable space and also a construction site, where certain common elements remain and new or specialized elements interchangeable. Akin to the construction of medieval Rome atop its ancient classical carcass, this contemporary ruin proposes the design and construction of more permanent building elements to be viewed as infrastructure for future AND interim building interventions.

Characteristics, Strategies, and Implications

Change is inevitable. The purpose of this thesis isn’t to create permanent structures, but rather explore building elements on different temporal scales. Evolution within a building’s framework does not have to happen all at once and neither should it interrupt the functions of the building when an intervention is ongoing. That is why the concept of infrastructure is so important. The very nature of infrastructure is that of a framework meant to facilitate further maneuvers; a pre-existing system (permanent) that becomes the staging area for the intended operations (ephemeral). Viewing architecture in a similar light would identify a number of characteristics.

LeBlanc’s criteria are a critical starting point. His identification of three essential characteristics of buildings ideal for reuse are robust structure, durable enclosures, and integrated building systems. Historically structures that have been successfully adaptively reused are those that possess some if not all of these characteristics. For many buildings built over a century ago, their structure and skin were often the same thing, simplifying the process of adaptive reuse. However, since the advent of the steel frame structure and durable concrete mixtures, steel and concrete have replaced load bearing facades and have demonstrated a durability that is ideal for reuse. Durable enclosures are often seen of aggregate facades, typically of brick and stone. Brick and stone cladding are ideal for reuse simply because of their aggregate nature. When their

43 Michael LeBlanc, Next Use Buildings: adaptive re-use and strategies for expanded future uses in new buildings. (Lecture, University of Massachusetts, Amherst, MA, September 13, 2011.)
joints fail, it is often recognizable due to erosion of material or leaching of interior linings. Replacement of these failed areas can also be localized due to their aggregate nature. Contemporary curtain walls also work as ‘aggregates’ and can be replaced locally (as opposed to replacing the whole façade). Integrated systems is often a characteristic of the intervention as opposed to the existing structure; however, historic structures often accommodate integrated systems into their structures: stair wells that act as thermal chimneys and light wells as well as clerestory windows for light and ventilation. In order for existing structures to remain relevant, they must contain appropriate infrastructure to accommodate integrated systems.

Now that this proposal of building for reuse, in an effort to mitigate the forces in contemporary design and construction that have coalesced into a system of planned obsolescence, has identified characteristics of buildings that are ideal for reuse, the next step in identifying strategies and implications to design can commence. Gathering strategies from the previous precedent analysis, this proposal will explore the implications for implementing ideas of designing for reuse into an architectural proposal, building framework and established hierarchy.

The greatest of these strategies is exemplified in the Salk Institute: Kahn’s notion of servant and served spaces. Every building provides to major functions: the primary function, which is the intended purpose of the building and the secondary function, which are the processes that go into supporting the primary function. This secondary function is the notion of infrastructure which is the focus of this paper. The Salk Institute
demonstrates that space is needed to make more space. Similar to the puzzle, 15-game, where there are 15 tiles that slide into 16 slots to reach a desired arrangement of tiles, the fact that there is one less tile than there is slots demonstrates the practical realities of construction staging – the need to store, shift, hold, rotate, and carry through building materials, tools, and mechanical assemblies in the process of renovation. This is a concept often neglected in building design to make way for more ‘efficient’ uses of space – but one paramount in promoting flexibility for future uses.

Taking cues from Thomas Herzog’s Studio House, ideas of centralized, consolidated systems can be adopted to apply toward liberating adjacent spaces to accommodate a myriad of different uses and programs.\(^\text{44}\) The integration of the structure with the services provides multiple benefits. First is the recognition that vertical structure will already function as a spatial separator, the consolidation of other uses to further accentuate the notion of the spatial separator benefits from the structure’s need to reach all the way to the building’s lower levels. Consolidating not only the horizontal obstructions with vertical connections and ductwork makes sense as an implementation and constructability strategy.

Finally, Quinta Monroy’s expectation for future expansion ideally epitomizes the notion of architecture as infrastructure.\(^\text{45}\) Provided the barest of bones, the notion of infrastructure acts as a backdrop for more ephemeral uses while provided for anticipated expansion.


Anticipating future growth and evolution in the building’s function and façade not only goes a long way in reducing embodied energy waste, but already creates a place with unique characteristics, a nuanced, lived-in quality that is absent in newer construction.

**Program**

One of the primary roadblocks for constructing a building intent upon change is that change is not predictably foreseeable. So this proposal intends to accommodate programming that is by its very nature temporary.

Programs such as:

- Incubator space
- Pop-up retail
- Transitional restaurant space (say from food truck to permanent location)
- Temporary art exhibition space
- Field office locations
- Short term apartment/lease

**Site**

The site is located in the southern part of Olde Kensington, Philadelphia, situated between a recently gentrified neighborhood, Northern Liberties, to the south and a former industrial corridor, West Kensington, to the north. Strategically situated between these two polarizing neighborhoods, the site is chosen to capitalize on this type of area as rents
are low and transience is high. As an area in greater flux, this would be an ideal environment to suggest an adaptable building proposal.

The site is ¼ mile from a light rail and metro line interchange. One block off of a major city collector with a large concentration of retail and commercial including a large grocery store within walking distance. The spaces adjacent the site are also in flux, but moving toward stability. Directly to the west are a strip of new townhomes and further down a multi-family apartment building. To the south and east are a few warehouse and distribution spaces and to the east and north is a large vacant lot with a smattering of existing residential buildings. The primary street adjacent the site bounds the west side where it converges into an interesting 5-point intersection. This is clearly the location where the building’s main entrance should be situated.
The proposal looks at two bars of development to maximize frontage along the site’s two main streets – to the west and the north. The proposed site surrounds an existing residential building which interrupts any chance of gaining any frontage on the site’s east side. As the west side of the site is the prominent side, with close access to commercial street to the south and maximum exposure to the 5-point intersection to the northwest of
the site, the bar facing west promises to be geared more toward active/public uses such as commercial, retail, live/work, office and some residential. As such, the structural spacing along this façade is spaced at 20’ to accommodate this wider range of uses. The other two bars face an interior courtyard and possess a smaller structural spacing @ 16’ o.c. These are meant more for private uses such as artist work spaces, hotel, and residential.

**The Temporary and the Permanent**

This proposal is about creating a permanent or long-term framework capable of accommodating short term or temporary uses. As such the design is comprised of these two parts, though this proposal will only be focusing on the one, Permanent Infrastructure.

The permanent system is meant to be a conduit to allow multiple units to plug in to it, essentially a series of corridors vertically and horizontally. The system is designed in such a way that each tenant can construct their own unit during any time in the life of the building without disturbing the general functions of the units around them. These units can be constructed by any type of construction that the space can accommodate so as not to constrain the needs and desires of the proposed tenant. At the end of the lease period the tenant vacates, leaving behind the built remnants to be used, picked apart or discarded by the next tenant. The remaining infrastructure, builds up, modifies and evolves with time. New construction is made flexible by the regular configuration of structural bays, situated in such a way that can accommodate expansion laterally and horizontally as well.
To make this possible: This project proposes two structural systems. While both systems are meant to be permanent, they each perform polarizing functions. The first system, at the core, facilitates the building's main arteries, conveying people and services laterally and vertically – creating a core and anchor to which units will be fixated. In these corridors is a 3’ utility strip that provides access to the plenum space below each floor for maintenance and hook-ups for new construction. The utility strip is covered with a grating system that opens up allowing direct access underneath the floor. This plenum space beneath the floor also accommodates the building's structure. This more permanent structure is of heavier steel infilled with CMU to protect against shear and also emphasize a sense of permanence.

The second is a lighter external structure meant to be a permanent scaffolding for temporary units. Supported by thin/light columns and bracing, the units can be constructed onsite with available space on all sides for construction workers to access. The exterior structure acts as a scaffolding so that suspended platforms could be lowered to transport materials and provide convenient access to contractors.

Where these two systems converge is a sandwich wall, two smaller walls on either side of an insulated core. These two walls have temporary, insulated wall inserts – knockout panels – already framed out to accommodate the impending connection of a new unit/doorway. These can be reinserted if there is no connection to a unit.
Units are not centered between the external light frames, but rather one side of the unit abuts the framing to share a ‘party-wall’ with adjacent units. The shifting of the unit to one side also allows ample space on the opposite side of the unit for workers to make their way back to the external space to complete cladding and install flashing around the newly finished external unit. This space also allows for small window penetrations to allow diffuse light into the rear of each unit.

Internally, this party wall will be a shared water and air return wall, that will feed below to the majority of the utility hookups and above to an air return vent that leads back into the main structure. Within the main structure is a small, secondary chase connecting air return (above) for each unit down into the underfloor plenum space which contains all of the unit’s utility conduits.
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