LIVING | MACHINE

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Abstract

Architecture can transform. Architecture does transform, but does it change precisely to respond to variable external conditions and adapt to the desires of its inhabitants? To an extent it does this, but the boundaries have not been reached to obtain a new potential of adaptability given new advances in technology and the potential for new combinations of more familiar techniques. Architecture's ability to perform and adapt has only begun to see its potential. Architecture in its very basic form provides shelter, which is a direct response to the needs of its inhabitants. The evolution of architecture has led to advancements in construction, creative ways to use materials, and intricate heating and cooling methods that respond to a society which spends more than ninety percent of their time indoors. Throughout time, architecture has evolved from the primitive hut to where we are today. One might question, "Where is architecture today?" Through recent, as well as emerging advancements in a variety of building techniques, advanced materials, and environmental systems, architecture is increasingly able to achieve unprecedented levels of adaptability and flexibility. Some structures apply these advancements to a degree, but the potential to combine these aspects into one flexible building that transforms to the needs of its users has not been reached. Looking at the building as a dynamically responsive machine that must accommodate various changes based on user scenarios and environmental factors conjures lively images of where architecture can go in the future; creating architecture that changes around us, rather than our changing around it. Architecture now has the ability to dynamically adapt and respond to user needs directly and seamlessly as if it were an extension of the user.

Circumstance

Architecture's ability to transform as a living machine by use of emerging technological advancements is characteristic with an ongoing level of adaptability. For a building to successfully show the capabilities of a fully transformational architecture that responds to external circumstances and by choice of the user it is essential for the climate and atmospheric influences to have variety showing the aptitude of the building's performance. It is also important that the program and general use of the building has a large range in flexibility of inhabitant functions and population size. A site will be chosen that has all four seasons with climatic variations, and different day and night conditions as well as external factors that contribute to the full flexibility of the building. The proposed program is a large live/work facility that must adapt to an infinite level of combinations to fully show the potential for the architecture's ability to dynamically transform to any condition of use.

Le Corbusier expressed that architecture should be "a machine for living in" but he also agreed that architecture should reintroduce nature into people's lives.[1] Merriam-Webster Dictionary defines "living" as "Having life; active, functioning; exhibiting the life or motion of nature."[2] Architecture should accommodate for the functions of living beings, and it should also have the ability to respond to them in an active manner that seems to move with a natural ease. Merriam-Webster Dictionary also defines "machine" as "a constructed thing whether material or immaterial; an assemblage of parts that transmit forces, motion, and energy one to another in a predetermined manner; a combination of persons acting together for a common end along with the agencies they use."[3] Not only should architecture perform as a machine through which technology alters the effects of the architectural environment, but it should also execute functions based on social interactions of the inhabitants. Architecture should accommodate the need for living by giving advanced technological options to successfully adapt to a user's changing condition.

The "living machine," as trademarked by Dharma Group, LC and designed by Worrell Water Technologies, LC, "represents 21st Century technology that treats wastewater to the highest quality."[3] This ecological design strategy uses living plants and organisms to directly respond to environmental conditions to better suit the needs of its inhabitants by creating something beneficial out of waste. These kinds of simple design strategies can be just as influential in architecture as a constructed material. There holds a place in architecture where both an advanced constructed machine and the natural life of organisms can fit together to perform flexibly around the user.

Architecture's ability to perform and adapt has only begun to see its potential. Architecture in its very basic form provides shelter, which is a direct response to the needs of its inhabitants. The evolution of architecture has led to advancements in construction, creative ways to use materials, and intricate heating and cooling methods that respond to a society which spends more than ninety percent of their time indoors. Throughout time, architecture has evolved from the primitive hut to where we are today. One might ask, "Where is architecture today?" Through recent, as well as emerging advancements in a variety of building techniques, advanced materials, and environmental systems, architecture is increasingly able to achieve unprecedented levels of adaptability and flexibility. Some structures apply these advancements to a degree, but the potential to combine these aspects into one flexible building that transforms to the needs of its users has not been reached.

An aspect of architecture that has been and continues to influence flexible development is the use of specific materials. The most common construction materials are concrete, wood, glass, and steel. These materials have developed slightly over the years to make their uses more efficient and innovative to their users such as carbon-fiber reinforced concrete, dynamic information display within concrete surfaces, acetylated wood, electrically heated glass, and shape memory alloys (SMA).[4] Other materials are rarely even considered for architectural building methods. Composite materials such as carbon fiber, which has a tensile strength five times stronger than steel and has been shown to cut heating and cooling within a building down by 50% compared to a steel and glass building, have not been utilized because of the higher costs compared to steel, they have not been code-tested, and they are generally not very resilient to fire. Carbon nanotubes have been identified as the strongest and stiffest materials discovered, surpassing the tensile strength and elastic modulus of diamonds (and obviously steel), but they also have conductive properties that could make them particularly useful as a building material. Though expensive, through continued use and because of their prolonged longevity, as well as their unique characteristics, they could someday be used as a strong building material that could also work as a conductor to heat, cool, or exchange electrical information. A building's frame, skin, floors, roof, walls, and HVAC could essentially fuse as one. The market has recently introduced "smart" materials that can dynamically change based on certain conditions or settings based upon the user. Intelligent materials that are able to "read" factors and decipher the information in order to gauge the use of the product have been popular recently in handheld gadgets, but have not been implemented to the same degree at a larger scale.

Advancements in intelligent automatic systems from as early as the 1960s, which comprehend data and react to it have seen extensive developments into electronic technologies, but their incorporation into buildings is as sparse as their ability to interact with their users.[5] Experimental designs, and some buildings owned by the richest men on our planet are about the only instances where these systems are utilized to directly adapt to their inhabitant's conditions. The ability exists for buildings to automatically regulate the interior environment based on the preferences of its users. Advancements in intelligent membranes allow sensors to detect harmful environmental conditions which shield occupants and regulate desired conditions for the occupants. Thermostats regulate temperatures and sometimes humidity levels for occupants. The ability for any individual space to actively transform to any environmental condition the user might want is not implemented to the degree or scale it can reach. A building can be scanned as an entire formation and as tiny bits in order to respond directly to users' preferences. A room should be able to transform and adapt with ease based on a user's wants and needs because it would provide more efficient space and would improve the quality of life for the user. Architecture should at the very least strive to allow for flexible options that appear to be randomly chosen by its users, but may be architecturally calculated, in order to match the preference of a user, who spends most of their time inside the building. These are not just cool, high-tech gadgets that we should be infatuated with, but they serve a purpose to better transform architecture around the user, rather than enforcing the user's need to adapt to architecture itself.

For architecture to adapt efficiently, it needs to respond directly to changing external conditions. These issues are obviously central to the primary role of architecture, so for a building to transform and adapt specifically for its users, it should start by reacting to the environment around the user to meet their changing desires. Seasonal changes are important because they indicate longer periods of environmental changes that need to be addressed. Seasonal changes can be used as a guideline for predicting how the building should perform based on previous climate history and projected outcomes for the other factors of the environment. Sun path and intensity are important for obtaining the desired level of natural light and shade and for heating and cooling needs through conduction or the use of photovoltaics. Wind patterns and intensities can be utilized by taking advantage of desirable strong breezes for cooling or energy generation. They can also be analyzed to shield from harmful exposure. Precipitation type and amount is important to understand in order to respond appropriately, but methods to reuse these natural resources for something positive could be important to the inhabitants of the building. Proper humidity controls the level of comfort for individuals in the building, and by sensing the external humidity the building could have the ability to regulate the desired levels by incorporating plant life that stabilizes humidity. Day and night conditions are important to adapt to because other environmental factors change from day to night. Providing ample artificial lighting due to lack of natural lighting and changes in user activities such as proper sleeping conditions would need to be addressed.

The ability for a user to respond to external environments can be imagined as a user-driven system. In this case, the user could operate architectural adaptations for their own desires and preferences. The system would also need to easily adapt to any situation seamlessly in order to be affective. In some cases, a building's ability to understand user preferences and adjust to them automatically without the concern of the inhabitant is an important aspect of architecture because it permits the user to perform without distractions, thus allowing them to do whatever it is they are doing without any interruptions. The user would be in a desired environmental condition, so they would be more productive in the activity they were doing.

In addition to this, architecture should respond to the activities of its users. This is important for the ability of architectural spaces to morph, enabling users more freedom to do the things they enjoy doing or the things they need to do. Architectural spaces can serve as working environments, living environments, or both. These spaces should also have the ability to accommodate a more public or a more private situation related to the needs of its inhabitants. An ideal situation for any user would be having the option of changing ones surroundings to better suit their activity needs. Whether the user employs the architectural adaptation is up to them, but having the choice allows for a more complete decision on their part for performing their activity. The user would need to become an active designer for which their architectural environment would encase them inside. A stronger connection between the user and the architecture would link together with the environment in which they both exist, completing a circular relationship that engages all three in a complete manner.

Examples from nature can be mimicked in architectural designs for innovative ways in which buildings can become like living machines. Looking to nature as an example is beneficial because animals and plants require resources; they obtain them, use them, and return advantageous substances to the environment. Buildings should strive for this because they similarly take in resources, but do not always return anything of any substantial value to the environment, but rather create problems for the environment. Since the surrounding environment of architecture includes the natural aspect around it, there should be special attention brought to preserving and adapting to it. As discussed earlier, architectural adaptations can be environmentally-driven, as well as program-driven based on the use of the space within the architecture. Examples from nature that include more environmentally-driven adaptations could be studied, such as the cleaning effects of a lotus leaf, the defense mechanism of a turtle, the thermal adaptations of a lizard, and the cooling effects of human perspiration. More program-driven adaptations seen in nature that could relate to the ever-changing functions of the users include: the pores of a sponge and the quality of light casting through the leaves of a forest.

A building's need to protect itself and its users from external factors can be seen in nature by the beading and cleaning effect of a lotus leaf. A building can be designed to collect and redistribute precipitation, to other areas of the building. The water could be used to supply the cooling needs of the building or for plant growth, or it could also be used to provide fresh water for a living machine.[3] The water could also be routed for use in a heating or cooling system of the building. Waste could be separated from the water and burned for heating needs or in the case of dirt and foliage it could be replaced into the soil for plant growth. The roof structure of a system like this would also protect its inhabitants from harmful elements simultaneously while simultaneously providing for these other functions.

Turtles tend to hide in their shells to protect themselves from danger. By using technologically advanced sensors that could read and analyze external conditions, a buildings façade could shift, creating opened gateways or tightened shields to suit the user's preferences to specific influences. The user would have the ability to open their living space to the environment based on their own desire, or they could prevent any external influence they do not want to affect their intimate dwelling. The flexibility of this "membrane" could demonstrate a variety of patterns based on the user's desires for certain conditions. Protective shading layers could be incorporated allowing the user to look through the glass to the outside, completely block their senses by neutralizing the outside with a dense shading material, or have the flexibility of semi-translucent layers that obstruct only some sensory influences, but not all.

Heating and cooling are important conditions for any living animal and buildings have always incorporated these to a degree, but because of emerging advancements, more efficient and flexible systems can change the way we regulate temperature. Intelligent membranes monitor external influences and automatically respond to those conditions by dynamically transforming the barrier between the outside and inside of the building. Perhaps in the same way that a lizard will warm itself by lying on rocks that have conducted heat from the sun, a building could automatically heat itself and the rooms within it by sustaining a constant temperature with a moveable heat source. Users would not need to move toward the heat source to stay warm, but rather the heat source would come to them, just as the sun essentially moves across the planet to heat it effectively. This could possibly be achieved through the use of a rotating heat core that could follow a path that would not interfere with the circulation or safety of the inhabitants.

To cool off, people sweat and a building can in a sense sweat by incorporating a sprinkling or cool liquid system that chills the membrane. Blood within the human circulatory system, in conjunction with large reservoirs of blood and water, also cool the body off, so if a building incorporated a cold circulatory system it could cool a room in the opposite way that hot water pipes warm a room. If the building became too hot, it could automatically chill itself. Careful attention would have to be taken to prevent the water from freezing in colder temperature conditions.

Perhaps a building could also adapt to breathe, letting in a natural breeze into a room for enjoyment or for the want of fresh air within the interior space. A dynamic façade could regulate these techniques much the same way a sponge utilizes pores as a fluctuating filter. The building could adapt to the environment around it by utilizing a membrane that opens and closes with variable size openings based on the amount of exposure the user desires. A filtration layer could also clean the air coming inside and redirect harmful toxins from retreating directly outside to the natural environment by depleting them somewhere else in the building, possibly through a living machine.[3]

A forest with natural sunlight shining through the branches provides an excellent example of a multi-layering effect which creates an ideal diffuse light. Desired quality of light and shade can be achieved through a user interface that can generate an infinite number of shading techniques based on the user's design. In addition to expressing their creativity, users would increase the functionality and comfort of their inhabited interior space due to their chosen shading techniques that enhance the quality of light for each individual.

Visibility enables users to choose to be secluded or included into a more public or private setting. Similar to a motorcyclist flipping his or her visor up or down to see better, users could have the ability to adapt the skin of the building to suit their needs such as choosing to feel secluded by emphasizing the walls or to feel more included into public society by opening the wall up to view the outside world.

A program that needs to adapt for a large number of different people would benefit from the effects of a highly adaptable architecture. The need for different functioning spaces that are prone to change would be an ideal situation to administer an adaptable architecture that needs to transform to suit the needs of its occupants. The levels of programmatic adaptability could be demonstrated through spaces that have the flexibility of being more or less public or private, and through spaces that can serve diverse user functions which change from more living situations to more working settings. These programs have the ability to work independently or interwoven, so the architecture needs to achieve the flexibility to accommodate a wide range of interactions. A live/work scenario would provide a logical circumstance to reach unprecedented levels in transformational architecture. A live/work building would require a vast amount of fluctuating conditions that would need to be expressed in architectural spaces. The rooms within the building and the formation of the building itself would need to morph to respond to user's shifting desires. The live/work scenario alters the essence of the built world because it presents the user the option to simultaneously choose between a desirable working context and their preferred living conditions. Designs would not designate areas for work or living, rather the architecture would transform around the user to become the desirable space whether it contains one person, multiple people, various living or work configurations, while still responding to environmental changes. The user could at one instance be cooking a meal to enjoy alone, and the next minute share that previous dinner space with prospective clients in an outdoor setting, and finally do a workout before going to bed. We generally picture these scenarios occurring in different rooms designated for that function, but what if the user's surroundings morphed to provide all the necessary amenities for each function? Some people might say that one can never make a perfect building, but what if the architectural design fit together so seamlessly to the desires of a user that to each individual inhabitant the space seemed to perfectly adapt to their personal desires? Even if this cannot be achieved, designs should strive to create a new level of flexibility, which users can appreciate to a higher degree.

"The world wants to know: Why does architecture remain immune to transformation and progress?"[6] Stephen Kieran and James Timberlake ask this question and answer it by explaining how manufacturing and construction are key factors in creating a new typology of architecture. Architecture in its very essence is and has been related to responding and adapting to user needs, but it has not been done in a way that could truly interact with the user and their environment. A relationship between the person and building and the building to its environment could be created through the limitless flexibility of architectural design.

Some buildings have moved forward in creating a more adaptable and flexible architecture that responds directly to the environment and user functions, but in most cases individual examples tend to only deal with a limited number of adaptations. The Elephant and Castle Eco Tower by T.R. Hamzah and Ken Yeang utilizes a unique operational system that can be set to a passive mode, mixed mode, full mode, and productive mode that regulates the internal environment.[7] BedZed by Bill Dunster and BioRegional utilizes a unique wind-driven ventilation system to control external conditions.[8] Dynamic Architecture by David Fisher moves entire rooms to directly respond to the needs of its users.[9] The Tron House by Ken Sakamura integrates a highly sophisticated user interface that responds to environmental conditions automatically or by user preferences by controlling and articulating the building's façade.[5] The L'Institut du Monde Arabe by Jean Nouvel also has a dynamically responsive façade that incorporates an intricate arrangement of glass pieces that work like camera shutters that enable the skin of the building to breathe and diffuse light.[5] Bloomframe by Hofman Dujardrin Architects is a window frame installation that converts itself into a balcony.[4] Considering combinatory hybrids from these examples will suggest creative and innovative ways that buildings can become comprehensive systems that adapt to the desires of its users.

Architecture today is not fully responding to its users to the best of its ability. With appropriate employment of technology, studying viable examples from nature, recognizing environmental and human impact factors, and looking to examples that have worked in the past, architecture has the ability to make unprecedented levels of adaptability to fully suture person to architecture and architecture to environment.

PRECEDENT ANALYSIS 013

Elephant & Castle Eco Tower
BedZED
Dynamic Architecture
Tron House
L'Institut du Monde Arabe
Bloomframe
Dymaxium House

Elephant & Castle Eco Tower by T.R. Hamzah and Ken Yeang International in London, England

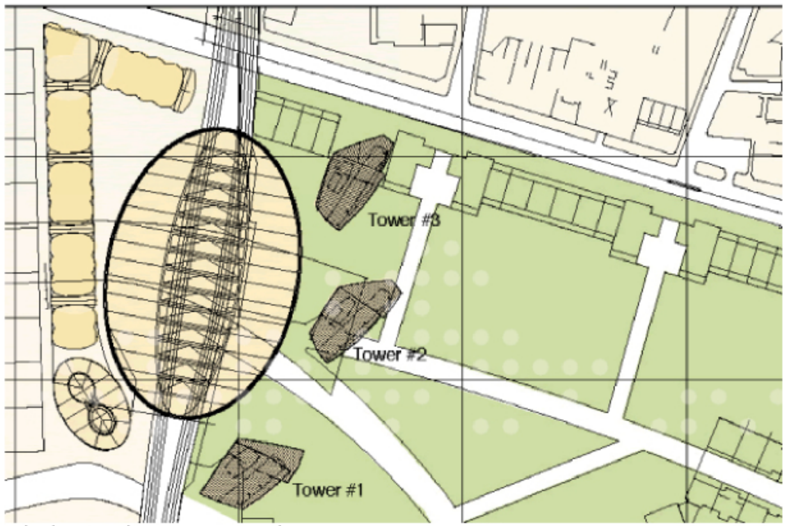
This skyscraper mixes retail and commercial along with what the firm refers to as “Vertical Zoning” residential types, as well as public park and shopping space incorporated in the building.[10] The building captures sun and wind where and when it is needed and blocks it where and when wind and sun are undesirable. The building is sustainable in terms of both energy and material use. The building also works in different operating modes such as: a passive mode that requires no mechanical systems in order to work with low energy, a mixed mode that uses some electro-mechanically assisted systems that help make other ambient energies in the building work more efficiently, a full mode that is an active system that still uses low energy and has low environmental impacts, and a productive mode that generates on-site energy through such things as photovoltaic systems. The buildings orientation and design configuration also make the operating system and the general use of the building act more efficiently. The building also makes ample uses of vertical landscaped gardens that create a cooler area in the summer and creates a healthier and more friendly atmosphere.

The series of towers consists of one large tower that is thirty-five stories tall and two towers both twenty-one strories tall. The design is meant to transform South Central London into a development consisting of retail, social homes, individual residential units, family residential units, luxury residential units, a hotel, and transportation hub, live/work developments, and a series of parks. The design idea was to fuse the elements of a city into each tower by providing mixed uses, proximity to all needed amenities, a chance to work and live close by, and a comfortable and healthy landscape in which to live. There are private open spaces for each living unit such as balconies. There are semi-private courtyards throughout each tower. Finally, there are fully public open spaces where users can interact with one another exposed to the elements or not in some instances. An example of the floor plan shows how each section, or user situation, can easily tie into another location quite easily by entering into a beautiful courtyard, which creates a pleasant, immediate response based on user preference. The general layout of each tower is a double block plan around a centrally protected landscaped core, which still receives natural air and sunlight, but is protected from harmful elements.

Elephant and Eco Tower Perspective views

Elephant and Eco Tower Elevation

Elephant and Eco Tower Section



Elephant and Eco Tower Site Plan

Elephant and Eco Tower Floor Plan

The orientation of the towers takes full advantage of the southern sun for the winter season, letting light travel down through the core of the building, illuminating otherwise shady areas. The unique wings allow for shade and natural breeze to flow through during the summer season, but protect the inhabitants of the building during the winter.

There are four phases the buildings can be set to in order to achieve the desired internal living conditions. The first stage is called the Passive Mode, which is a low-energy design without the use of any electro-mechanical systems. The next stage is the Mixed Mode, which incorporates a partially electro-mechanically assisted systems that optimise other ambient energies of the locality. The Productive Mode generates on-site energy through such means as photovoltaic systems for example. The last option, the Full Mode is a fully active system, but with low energy and low environmental impacts.[10]

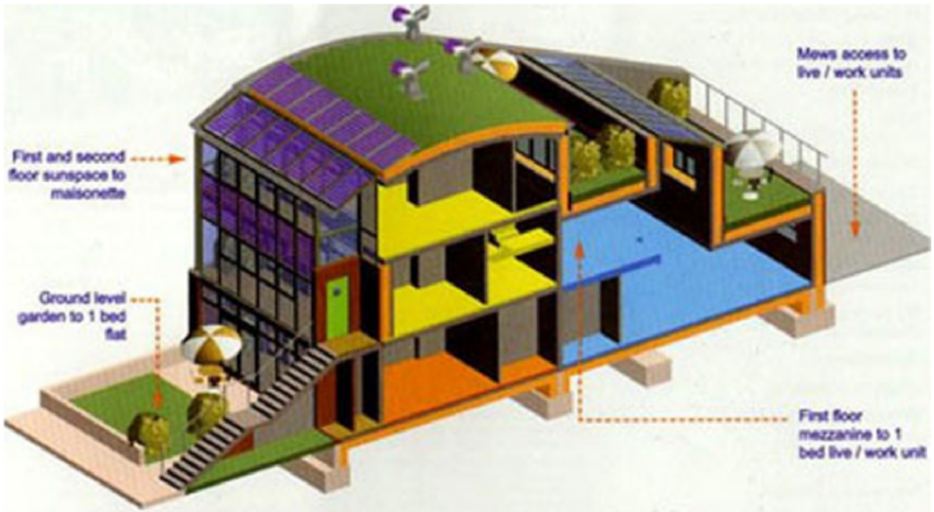
The unique vertical landscaping allows users to take full advantage of gardening and flower growing and creates a more habitable environment with clean air. They also block strong winds, sustain more ample humidity and temperature levels, and absorb and reflect harmful solar radiation in the summer season.

The Elephant and Castle Eco Tower by T.R. Hamzah and Ken Yeang has been influential because of the building's ability to respond to different environmental changes. It is a multi-functioning building that needs to comfortably accommodate public, commercial, and residential users. The building's design configuration and orientation on the site allow it to embrace all the positive aspects of the site and block any negative effects which could be important as an example for this thesis. The building also responds well to varying conditions between seasons, changes in building population, and sun and wind patterns by including vertical gardens that help maintain a comfortable atmosphere. Setting the building's mechanical systems or passively allowing nature to perform in different phases for user comfort is a unique approach in which the building can respond to a situation or to user's needs much like a machine.

BedZED by Bill Dunster and BioRegional in Wallington, England

The BedZED (Beddington Zero Energy Development) is a large mixed-use sustainable community where the inhabitants live comfortably conserving energy usage, water usage, utilizing efficient transportation by rarely driving, using low-impact materials, and recycling waste.[11] It is designed as a zero-energy complex that uses only renewable sources to generate energy. This is done through various ingenious methods such as a unique wind-driven ventilation system that brings in fresh air and helps maintain a constant, comfortable temperature. Other important energy saving methods include: rainwater collection on the roof used to flush the toilets, solar panels that can be used to charge community-shared electric cars, thick walls that are lined and filled with insulation using good use of solid materials, a triple glazed south-facing wall on each complex that acts as a suntrap which heats the inside of the house, and a sewage treatment system where waste water is filtered through reed beds.

This is an important precedent to study in order to realize how people have used simple design strategies to respond to their ever-changing conditions. Not only do these techniques use significantly fewer amounts of energy, but they also bring the community together and create a more environmentally comfortable atmoshere for each user. The wind-driven ventilation is particularly interesting because it gives the building a definite sense of character and through natural means is able to produce heat and maintain a comfortable environment inside for the inhabitants.


Mews access to live / work units
First and second floor sunspace to maisonette
Ground level garden to 1 bed flat
First floor mezzanine to 1 bed live / work unit

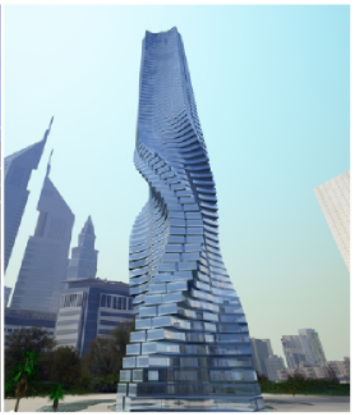
Dynamic Architecture by David Fisher in Dubai, UAE

Dynamic Architecture, created by David Fisher, is a unique design of architecture that moves, changing the overall form of the building at all times and allowing some residents to actively transform the architecture around them, rather than changing themselves based on the architecture.

The ability of the user to change the direction of an entire room or floor allows for different responses based on environmental conditions. It is an adaptable living environment. The user would be able to stay in the sun longer or shorter, take advantage of a breeze where otherwise it was impossible, view a beautiful vista, or react to any number of things in the external environment by changing their interior environment. Residents in this building are able to do this if they own the entire floor, otherwise it is controlled by whoever has control of the computer program that controls the movements.

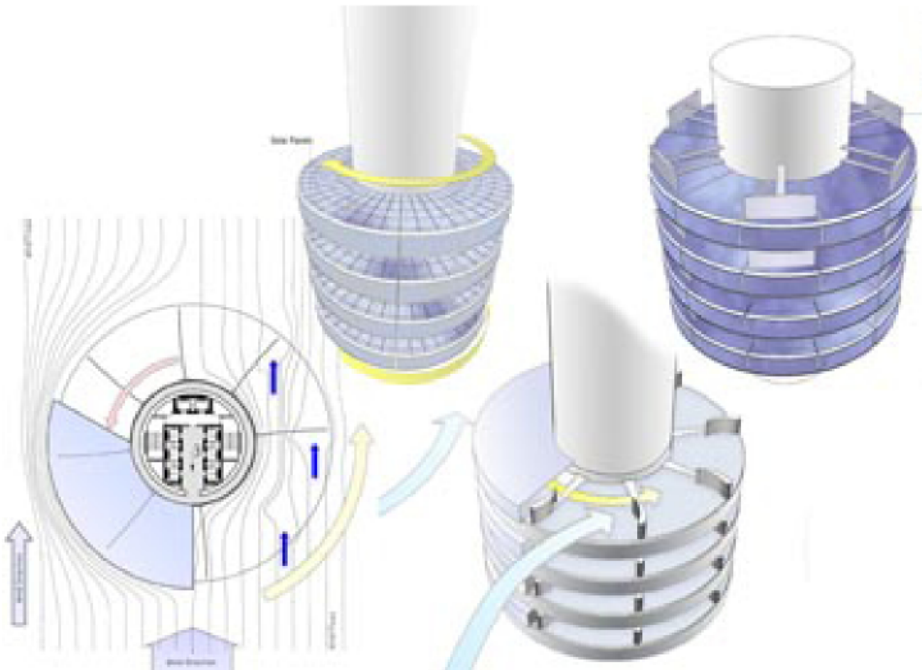
The building utilizes wind power to generate its movements and will allow its turbines to power the surrounding buildings around it. If there are eighty stories, then the building has the potential to possess seventy-nine wind turbines, essentially creating a power plant.


Construction Process


Perspective View


Section

Each prefabricated unit is designed based to the user's preferences in materials and finishes. The plumbing and electrical systems are already equipped into each unit and repairing and installing new units would be easier due to their being prefabricated. Each unit is essentially clamped into place and hoisted up along the concrete core of the building making the construction process for an eighty story building assembled in eighteen days rather than thirty days typical of traditional methods. One floor could be done in six days, rather than six weeks and uses far fewer construction workers.[12]



Wind turbines are located in between each floor, so wind flowing through the 80 story building will produce energy through 79 generators which will power the building and its surroundings. The patented design uses unique crescent shapes and carbon fiber material to conceal within the building's form and remain extremely quiet.

Floor Plan

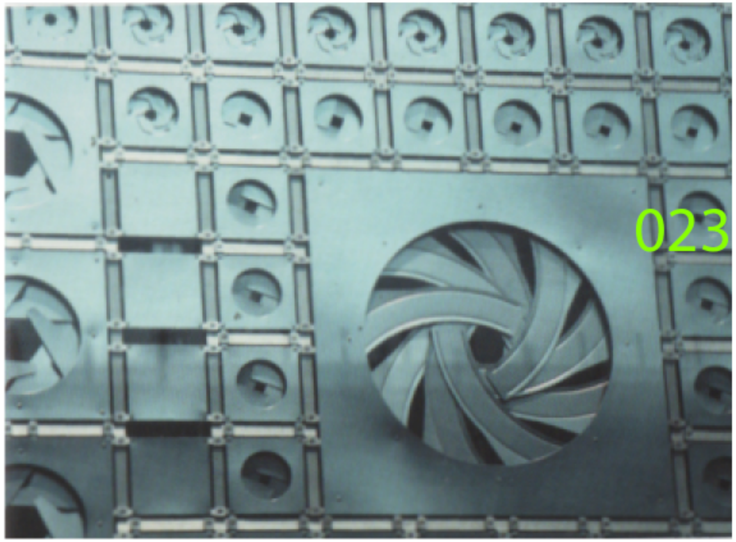
Tron House by Ken Sakamura in Tokyo, Japan

The Tron House was a project done by Professor Ken Sakamura at Tokyo University. The acronym stands for "The Realtime Operating Systems Nucleus." [5] The project was designed to provide precise indications to the future of computerized society. The southern facade of the building is covered with one hundred glass panels that are tuned with sensors that will automatically open or close or can be user changed. A computer system collects and interprets data on the interior and exterior regarding temperature, humidity, barometric pressure, wind direction and velocity, rainfall, and lighting to create the ideal conditions based on the user's preferences. Sound and video can also be set to create a tranquil atmosphere or any various conditions the user may want. The kitchen records different stages of the cooking process and can reiterate previous recipes or suggest new preperation techniques or spices to use. The toilets even have a sensor analyzing urine to indicate health levels.

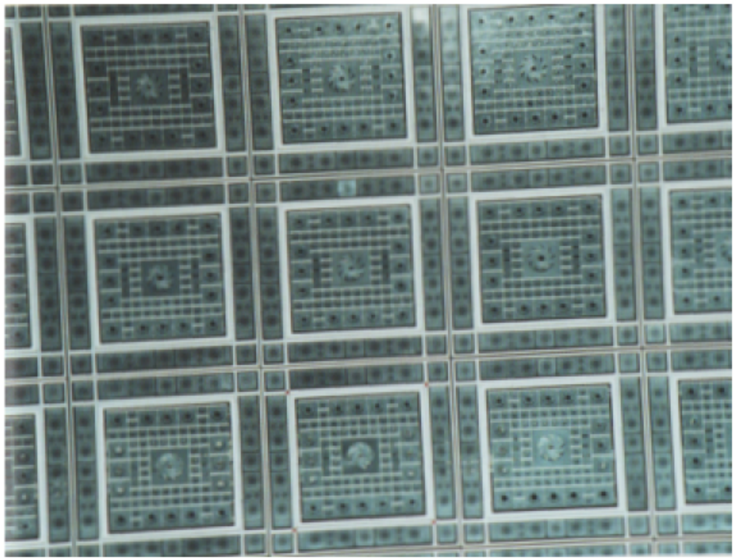
The importance of this case study is not to demonstrate all the cool gadgets we can put into our houses, but it demonstrates the importance of the human role in these emerging advancements. The User interface responds to user-driven or is automatically based on environmental conditions in this instance. A system incorporating emerging advancements in technology needs to work flawlessly, be upgradeable, have limitless options, and have the ability to work for anyone. The user must at least have the option of their involvement with a system that responds to them. They can actively choose what they want and can live more comfortably and effortlessly, but it could be dangerous if the system did everything for them, causing the user to loose enjoyment in life and face boredom due to lack of involvement.

L'Institut du Monde Arabe by Jean Nouvel in Paris, France

The facade of L'Institut du Monde Arabe is made of three layers of transparent glass working within a metal framework that acts like a bunch of camera shutters on a giant wall to regulate admission of light and wind. The result creates beautifully complex geometric patterns inside the building. There are over 27,000 shutter diaphragms covering the facade,which creates infinite levels of light and shade patterns on the exterior facade and interior spaces.[5]



The shutters can be controlled automatically by a photoelectric cell on the building's roof or manually controlled to by use of a remote control. The mechanism itself is quite simple, using steel rods set in motion between two electric motors per diaphragm.



The glass used has a single membrane layer, and double-membrane that utilizes liquid crystals, called Nematic Curvilinear Aligned Phase (NCAP), to change the color and transparency of the glass. By connecting this system to a PC, the user can set these to automatically adapt to certain light intensities or wind speedsor temperatures, or can set them to a specific time, or can change the settings at any time based on their preferences allowing instant privacy or exposure.

Bloomframe by Hofman Dujardin Architects

The Bloomframe is an insulated window frame that can transform into a balcony. It is current available to the market in the Netherlands. The Bloomframe balcony allows for a flexible living environment by creating space where not otherwise available or which has been previously overlooked by designers. The balcony can be deployed from the window frame by a single electronic control in under a minute. The system consists of insulated aluminum profiles with steel-reinforced connections, insulated safety glass, an electric motor, and a sandwich panel floor that transfers movement to tie rods that are regulated by an auto-braking system.[4] Safety precautions secure against collapse during opening and closing, and the fully open position is regulated to prevent accidents. The Bloomframe can be made of a variety of materials and can be adapted to fit custom arrangements. This example is important because it extends the use of habitable space and allows fresh air and light into the livable space allowing the user to transform their environment to better suit their current needs at any given time. These same innovative design principles can also be applied to transform livable space around a user by studying original material elements or creating new designs that react better to users.

Dymaxiom House by Richard Buckminster Fuller

Buckminster Fuller originially designed his Dymaxiom Houses to be the strongest, lightest, and most cost-efficient houses ever built. Key design implementations of the houses were to be factory manufactured kits that could be easily shipped and assembled on any given site and to use resources efficiently. The Dymaxion house represented the first conscious effort to build an autonomous building during the 20th century. The exterior of the house is primarily made of aluminum, which was common for airplane construction during the war, so Buckminster thought the production of airplanes could be replaced with these houses after World War II. The aluminum and plexiglass windows on the facade created an easy to clean surface and helped to heat the interior space. The dome shape with a large overhead vent and peripheral vents allowed cool air to be sucked downward into the livable areas in order to cool the building. The shape also offered more interior space, unrestricted air flow throughout the house, and officially accomodated the utilities in the middle of the house. The final design of the Dymaxion house used a central vertical stainless-steel strut on a single foundation with spokes that hung down from the central strut to support the roof. Beams radiated out, as well, to support the floor. The Dymaxion house was intended to reduce water use by a grey water system and a more efficient clean water system that used compressed air and small water particles to spray water. The roof was designed to drip water in a gutter sytem inside the building to evaporate or follow into a cistern. The bathroom was located next to the central utilities core and was a small molded form, which allowed for easy cleaning. Fuller's methods are influential to designing structures that create efficient use of utilities through simple design strategies that suit inhabitant needs comfortably.


Central Utilities and Plumbing

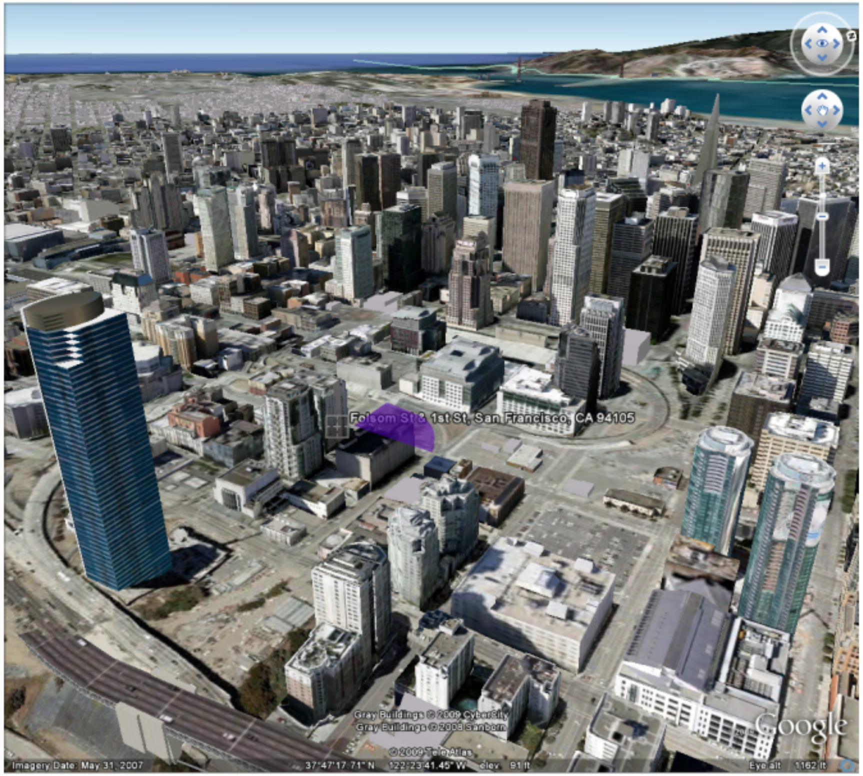

Rain Water Collection Inside Living Space


Dymaxion House Exterior

The site is important to the building program since one central idea is that the building should respond well to its environment. The building will be set in a location that would involve varying seasonal and daily environmental changes that would challenge the effectiveness of the structure, however, the conditions at potential sites should not to be so harsh that the project would be dominated by an external climate. The location would also need to be appropriate for the expected function of the building and work as an appropriate place to accommodate the building type.

SITE ANALYSIS 027

San Francisco
Chicago
Philadelphia


Folsom St & 1st St, San Francisco, CA 94105
Gray Buildings © 2009 CyberCity
Gray Buildings © 2008 Sanborn
© 2009 Tele Atlas
Google
Imagery Date: May 31, 2007
37°47'17.71" N 122°23'41.45" W elev 91 ft
Eye alt 1162 ft


bing

San Francisco – 1st Street and Folsom Street

San Francisco's climate is fairly mild with rather cool, dry summers and mild, wet winters. Because it is surrounded by water, the Pacific Ocean moderates most of the year-round temperature and influences the cool currents during the winter season. The temperatures generally remain constant with a slight increase during the warmer months of September and October and cooler temperatures in December and January. Though it very rarely snows in San Francisco, during the spring and summer seasons, the city experiences a large amount of fog due to the cold ocean water and heat from the California mainland. The varying topography of the city landscape can also change environmental conditions drastically through temperatures fluctuating by ten degrees from block to block. These conditions would certainly need to be addressed for the implementation of an appropriate design.

The site under consideration is located on the corner of First Street and Folsom Street in San Francisco. It is in a newly developing area where a number of high rise apartment buildings are being constructed and plans for more are on the way. The surrounding buildings range from single story, three to four story, eight to ten story, twenty story, and several high rise units.


Newberry Library
Near North Side
Moody Bible Institute
Midtown Kitchen & Bar
Corrington Louis E Jr Office
Gray Buildings © 2008 Sanborn
Gray Buildings © 2009 CyberCity
© 2009 Tele Atlas
Imagery Dates: Feb 28, 2005 - Nov 6, 2007
41°53'34.41" N 87°37'35.79" W elev 705 ft
Eye alt 1942 ft
Google


bing

Chicago – West Walton Street and North LaSalle Boulevard

Chicago is within a humid climate zone, experiencing the effects of four distinct seasons. The spring and fall seasons are mild with low humidity levels, while the summers are warm and humid and winters are cold, snowy, and windy with temperatures often below freezing. There are large temperature variations between the winter and summer seasons, which causes extremes in both hot and cold spells. Heavy snow fall would also need to be considered in the decision of the final site location.

The site is located in between parking structures, parking lots, office buildings, and high-rise residential units. The site is also near a lively shopping district that could open up opportunities for a multi-use facility utilizing residential, as well as commercial functions.

Gray Buildings © 2008 Sanborn
Image USDA Farm Service Agency
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
Imagery Dates: Jun 6, 2004 - Jul 5, 2007
Eye alt 1491 ft

bing

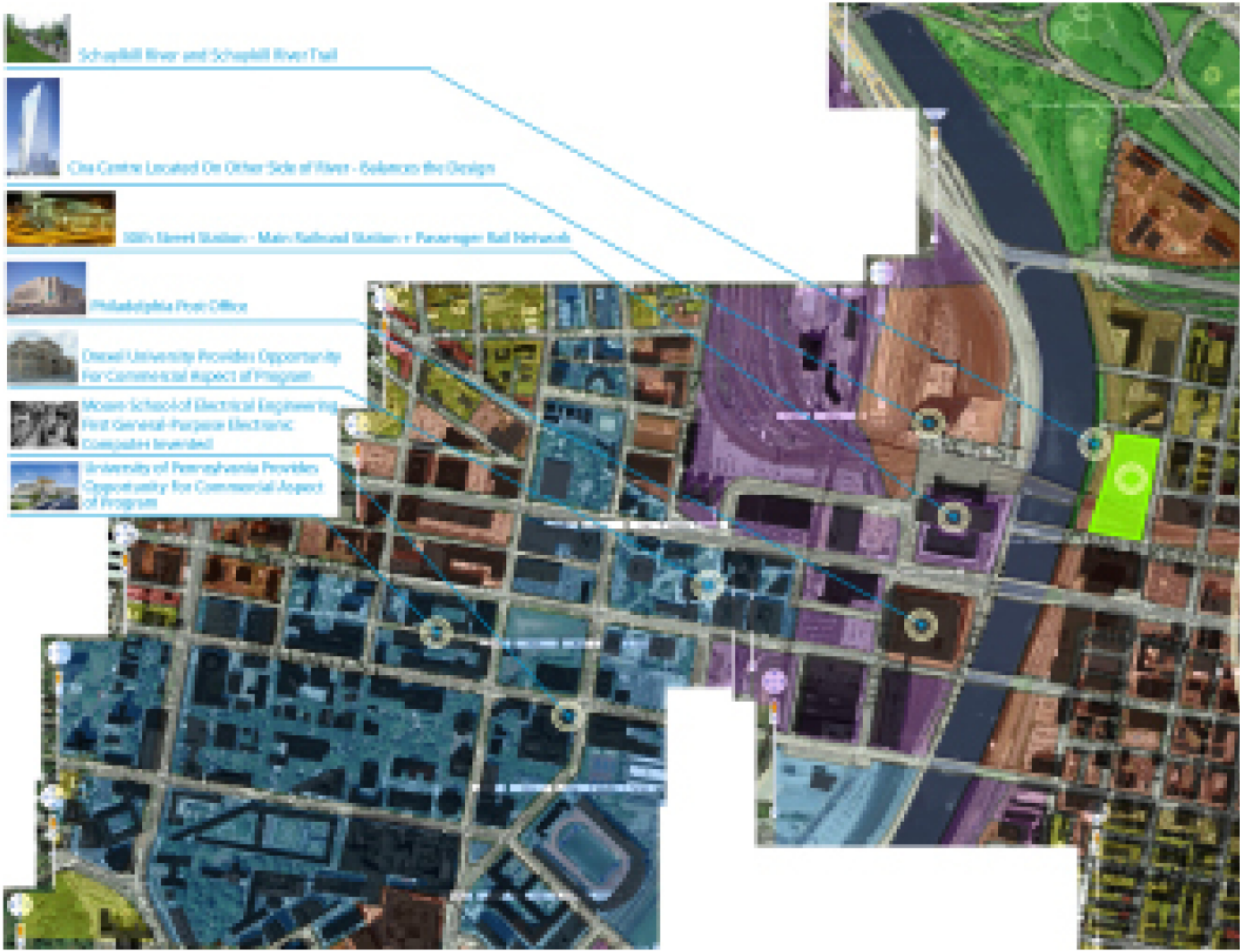
FINAL SITE SELECTION - Philadelphia – 23rd Street and Cherry Street

Philadelphia's climate ranges from hot, humid summers, cold winters, and mild spring and fall seasons. Issues with snowfall and snow accumulation, as well as removal, would also need to be addressed, though it is not as dominant a factor as it is for the location in Chicago. These climate conditions would have to be considered when designing an appropriate structure that would accommodate those environmental changes.

The selected site in Philadelphia is located near a dense urban area. The site is in between a number of important city buildings, parks, schools, and recreational areas. It is along a river, and has a railroad track crossing through it. The site is currently a parking lot next to high-rise and low-rise residential units, a high-rise commercial building, small retail shops, and vacant lots and buildings. The river and schools are primarily to the West of the site and the downtown urban core is located to East of the site.

The Philadelphia site was chosen because it had all four seasonal changes that would need to be accommodated, and it had the most influential surrounding environmental factors both by user reaction and natural elements.

Philadelphia's climate conditions were not too overbearing in any one category that would dominate the effects of the building's ability to operate. This site also brought a number of external conditions to be dealt with, other than climatic changes. There is an active running trail next to the site that is highly populated, an elevated train track on the edge of the site that would cause vibration and undesirable noise, and a river that could be used for its natural water flow and to possibly provide clean water and energy efficiency. The site is in a denser urban area, so more people and a wider variety of user types would need to be accommodated for in the design. The projected program would have to respond to the external climate conditions and surrounding context with their effects on the architecture itself such as desirable light and shadows cast from other structures, noise pollution, visual scenery, and orientation within the site.


Schuylkill River and Schuylkill River Trail
Cira Centre Located On Other Side of River - Balances the Design
30th Street Station - Main Railroad Station + Passenger Rail Network
Philadelphia Post Office
Drexel University Provides Opportunity For Commercial Aspect of Program
Moore School of Electrical Engineering First General-Purpose Electronic Computer Invented
University of Pennsylvania Provides Opportunity For Commercial Aspect of Program

City Zoning Key

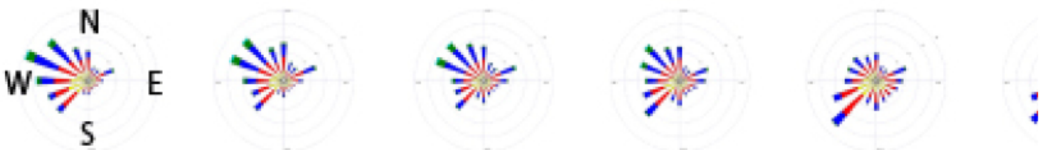
- Parks + Recreation
- Commercial + Retail
- Educational
- Industrial + Manufacturing
- Low Density Residential
- High Density Residential
- Mixed Use

Philadelphia Master Plan - Final Site Highlighted in Green

Month	Percentage of Possible Sunshine Hours:	Average Monthly Precipitation:	Average Total Snowfall:	Average M Temperatu
Jan.	49%	3.52 in.	6.4 in.	39°F
Feb.	53%	2.74 in.	6.4 in.	42°F
Mar.	55%	3.81 in.	3.2 in.	51°F
Apr.	56%	3.49 in.	0.6 in.	62°F
May	57%	3.88 in.	0.0. in.	72°F
June	62%	3.29 in.	0.0 in.	81°F
July	61%	4.39 in.	0.0 in.	86°F
Aug.	62%	3.82 in.	0.0 in.	84°F
Sept.	59%	3.88 in.	0.0 in.	77°F
Oct.	60%	2.75 in.	0.1 in.	66°F
Nov.	52%	3.16 in.	0.4 in.	55°F
Dec.	49%	3.31 in.	1.9 in.	44°F

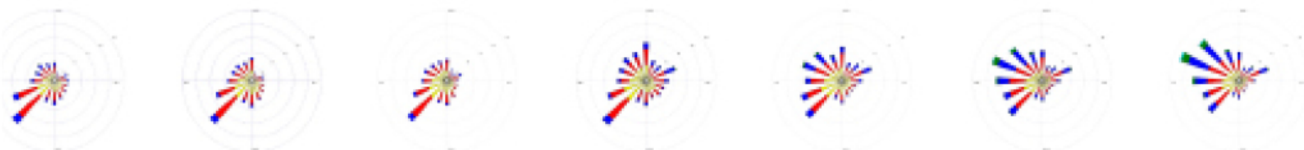
Monthly Wind Intensity and Patterns:

	January	February	March	April	May	J
Average Wind Speed in MPH:	10.3	10.9	11.3	10.8	9.5	8



...Monthly ...ure Highs:	Average Monthly Temperature Lows:	Morning Relative Humidity by Month:	Afternoon Relative Humidity by Month:
	25°F	73%	59%
	28°F	72%	55%
	35°F	72%	53%
	44°F	71%	50%
	55°F	75%	53%
	64°F	77%	54%
	70°F	79%	54%
	69°F	81%	55%
	61°F	83%	56%
	49°F	83%	54%
	40°F	78%	56%
	31°F	74%	59%

June	July	August	September	October	November	December
8.8	8.2	8.0	8.3	8.8	9.6	10.0



This is the Philadelphia site climate data showing various external influences crucial for the design of the architecture project. A site with a diverse climate in which all four seasons changed in sun path and intensity, wind path and intensity, precipitation, temperature, humidity, and day and night conditions would challenge users for the need to respond and adapt in a building that could facilitate their desired reactions. [14, 15, 16]

Panoramic images of proposed Philadelphia site.

RESEARCH 039

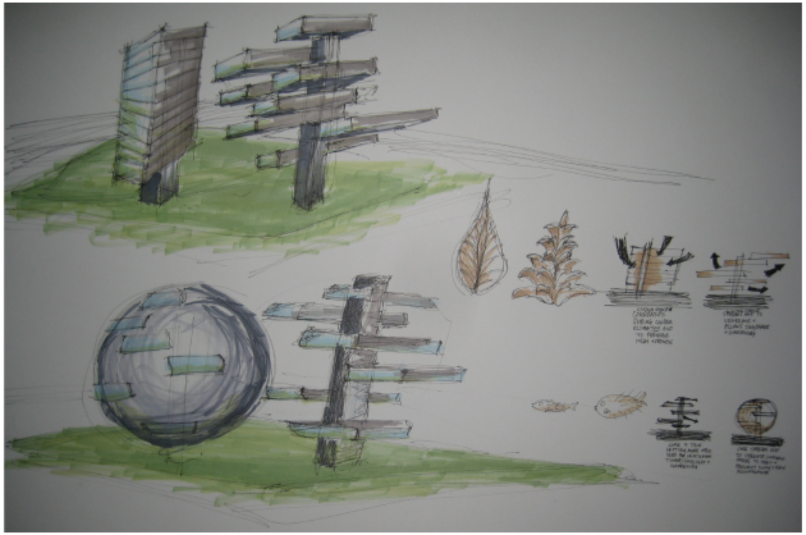
Pastel Interpretation
Biomimicry Exploration
Adaptations

Pastel Interpretation

This pastel interpretation depicted an early conceptual idea regarding building functions such as commercial areas generating heat in some locations to heat other parts of the building, the environmental influences, and circulation flow with necessary amenities carried to parts of the building and taking advantage of the elements.

Biomimicry Exploration

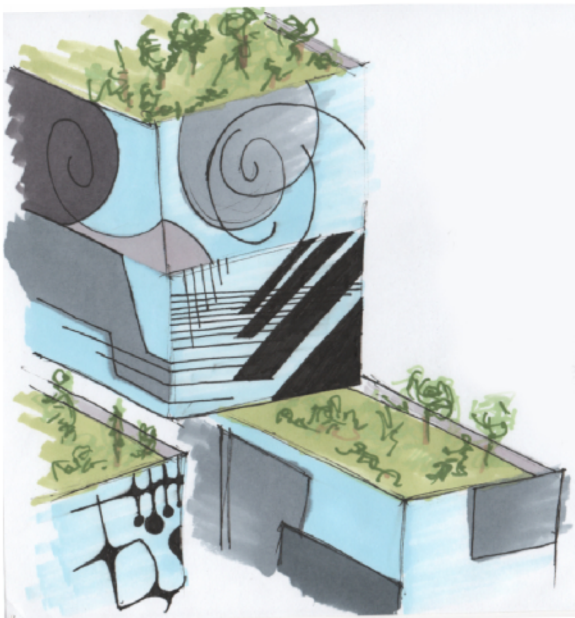
These drawings explore upon how pincones naturally open to cool off, using that idea loosely to show how the living space condenses during colder climates, preserving heat and dryness, but then could spread out to ventilate allowing both shade and sun and gardening possibilites to the livable space. The second example uses the blowfish as an example where interpreted in the building the core is thin letting more open voids for ventilation, shade, sunlight, and gardening possibilites. The core then speads out to insulate liveable areas to heat and prevent snow and rain accumulation.



Adaptations

A number of graphic representations and design concepts were explored based on a building's ability to adapt. They needed to respond directly to the changing conditions of its users, but they also related to the external environment. Flexibility within the building should allow user-driven or operated adaptations that relate to the environment, as well as adjustments that the building automatically makes on its own.

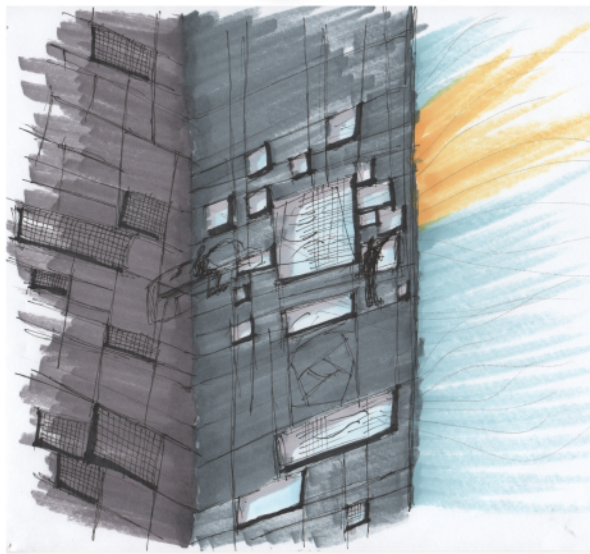
Visibility enables people to see better. Motorcyclists flip their visors up or down to gain better clarity and protect from harmful debris or elements. Similar to a motorcyclist flipping his or her visor, one might put on or take off sunglasses or reading glasses in order to see better. These same notions can be mimicked into architecture. Visibility enables the user to choose to be secluded or included into a more public or private setting. A wall can open to provide a view or can be emphasized in a different way for feelings of security.

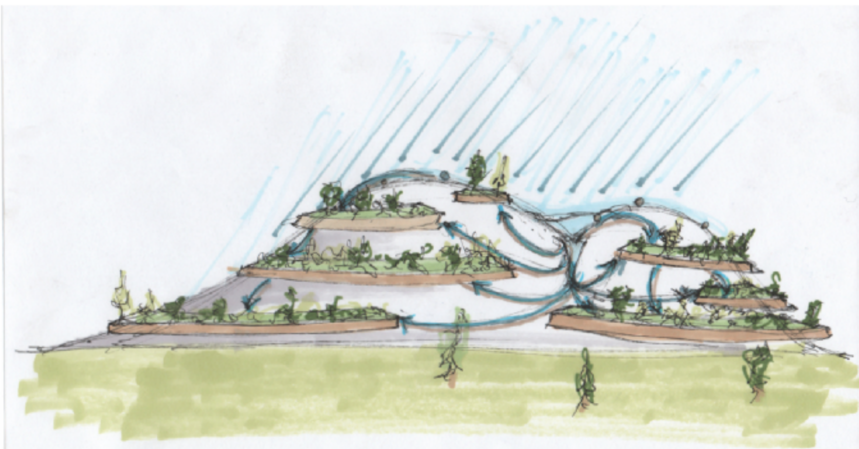


043

A forest with natural sunlight shining through the branches provides an excellent example of a multi-layering effect which creates an ideal diffuse light. Desired quality of light and shade can be achieved through a user interface that can generate an infinite number of shading techniques based on the user's design. The user would get a sense of creativity and be able to express their individual character showcased on the building façade as a social interaction. Businesses could also use their walls as billboards that advertise to their clients. In addition to expressing their creativity, users would increase the functionality and comfort of their inhabited interior space due to their chosen shading techniques that enhance the quality of light for each individual.

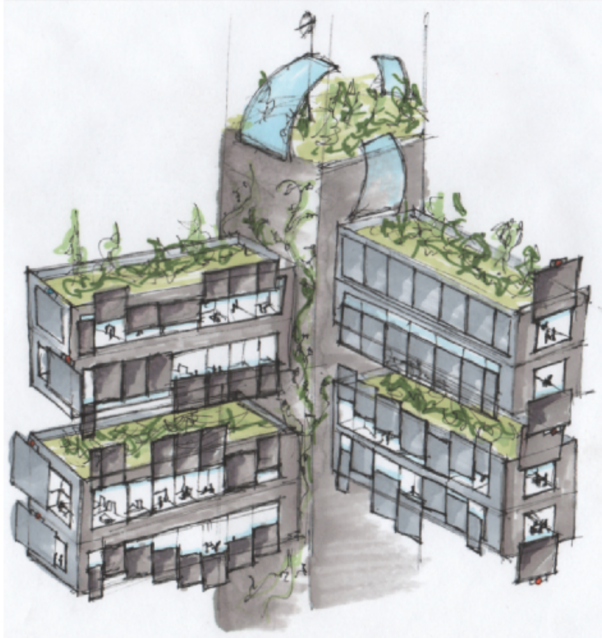
A building can be adapted to breathe, letting in a natural breeze into a room for enjoyment or for the want of fresh air within the interior space. A dynamic façade could regulate these techniques much the same way a sponge utilizes pores as a fluctuating filter. The building could adapt to the environment around it by utilizing a membrane that opens and closes at variable sizes based on the amount of exposure the user desires. A filtration layer could also clean the air coming inside and prevent harmful toxins from retreating outside to the natural environment.

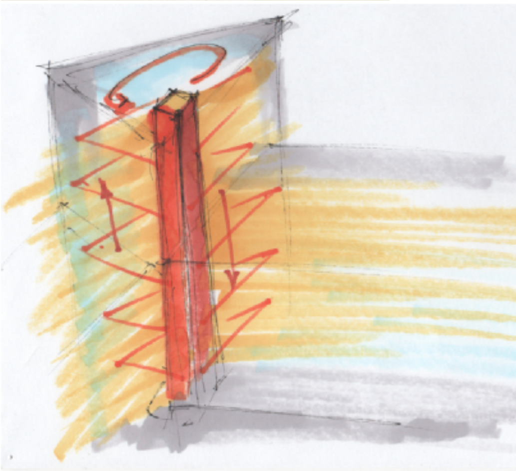




A building's need to protect itself and its users from external factors can be seen in nature by the beading and cleaning effect of a lotus leaf. A building can be designed to collect and redistribute rain water, water from snow, and waste from the roof to other areas of the building. The water could be used to supply the cooling needs of the building or for plant growth. It could also be used in the same method as a living machine, which turns wastewater into clean water that could be utilized for user needs. The water could also be routed for use in a heating or cooling system of the building. Waste could be separated from the water and burned for heating needs or in the case of dirt and foliage it could be replaced into the soil for plant growth. The roof structure of a system like this would also protect its inhabitants from harmful elements simultaneously with these other functions.

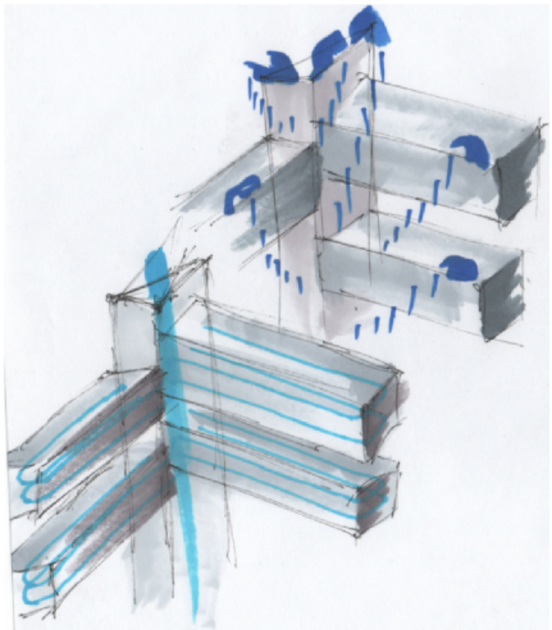
Turtles tend to hide in their shells to protect themselves from danger. By using technologically advanced sensors that could read and analyze external conditions, a buildings façade could shift, creating opened gateways or tightened shields to suit the user's preferences to a certain external influence. The user would have the ability to open their living space to the environment because of their own desire, or could prevent any external influence they do not want to be a part of from ever entering their intimate dwelling. The flexibility of this membrane could demonstrate a variety of patterns based on the user's desires of certain conditions. Layers of protection could be involved allowing the user to still view the outside with glass, completely block the senses by neutralizing the outside with a dense material, or the flexibility of a mesh that would obstruct some sensory influences, but not all.





Heating and cooling are important conditions for any living animal and buildings have always incorporated these to a degree, but because of emerging advancements, more efficient and flexible systems can change the way we regulate temperature. Intelligent membranes monitor external influences and automatically respond to those conditions by dynamically transforming the barrier between the outside and inside of the building. Similar to the way the sun warms areas of the building exposed to it throughout the day, a lizard will warm itself by lying on those areas that have conducted heat from the sun. A building could automatically heat itself and the rooms within it by sustaining a constant temperature with a moveable heat source. Users would not need to move toward the heat source to stay warm, but rather the heat source would come to them, just as the sun essentially moves across the planet to heat it effectively. This could possibly be imagined by a rotating heat core that could follow a path that would not interfere with the circulation or safety of the inhabitants.

To cool off, people sweat, which induces evaporation which in turn consumes heat energy from the skin, so perhaps a building can in a sense sweat by incorporating a sprinkling or cool liquid system that chills the membrane. Blood within the human circulatory system, in conjunction with large reservoirs of blood and water, also cool the body off, so if a building incorporated a cold circulatory system it could cool a room in the opposite way that hot water pipes warm a room. If the building became too hot, it could automatically chill itself. Careful attention would have to be taken to prevent the water from freezing in colder temperature conditions.

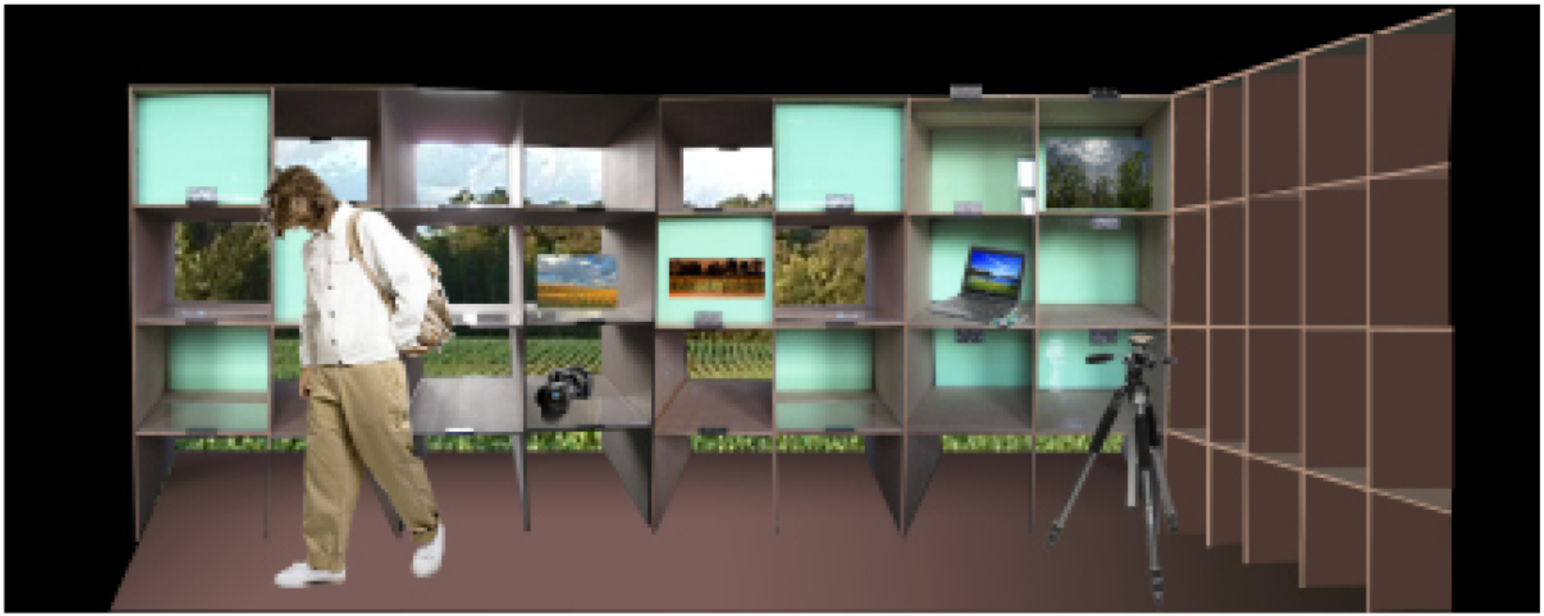


SKETCH PROBLEM 049

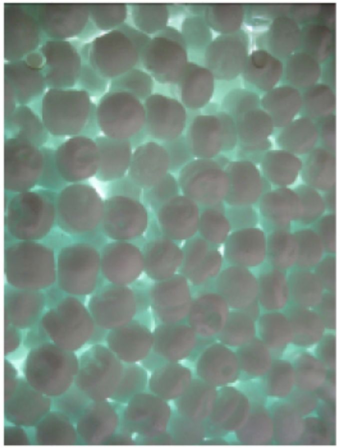
Photographer Cottage

Exterior Facade of Building Showing Air-Flow Windows In Various Positions

Exterior Facade Showcasing Photography Artwork To Public



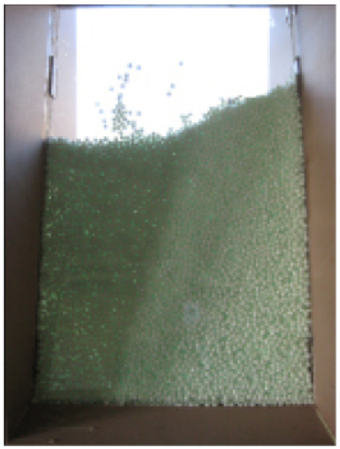
Interior Space Showing The Varience of Insulation, Air Flow, Lighting, and Storage Capabilities



Closeup Image of Insulation Beads

Photographer Cottage

The design for this sketch problem called for a one room cottage or studio with a loft area to be used often throughout the year as a secondary residence and outpost for excursions into the prairie for photographic expeditions. The site was an imaginary cornfield with slightly undulating terrain, and climactic conditions identical to Ames, Iowa. The cottage would have no mechanical heating and cooling system and therefore would have to adapt to changing weather conditions to provide as much comfort as possible through the manipulation of the building skin. The materials were to be construction materials commonly available at building construction shopping centers such as Home Depot. In terms of construction techniques, some emphasis was placed on the liberal use of sheets of straw board. The client was a reclusive and slightly morbid photographer whose neighbor lives one mile away and possesses a CNC machine with a three axis router that is capable of cutting and milling four foot by eight foot sheets. The neighbor was also a sign maker who was handy with a circular saw, pneumatic nail gun, and other tools associated with conventional wood frame construction enabling the ease of construction and freedom to the design.



Insulation Beads Set Within Double Membrane

Throughout the thesis design process and sketch problem it has been important for architecture's ability to easily adapt for the user. The user must be engaged by allowing them to directly interact with the functions of the building. This sketch problem showed the possibilities of a user actively responding to environmental effects by dynamically transforming the wall. The user can showcase his work through the egg-crate structure. The egg-crate structure also allows the interior of the structure to be used as storage and workspace. Small windows that act as doors in conjunction with blocks of removable foam insulation allow the user to shield from harmful elements or open to engage the surrounding environment by letting a natural breeze cross-ventilate the interior space. Foam beads can also be placed within a double-glass membrane to insulate the interior in the winter, while still letting light into the structure. An infinite number of possibilities based on the user's preferences is a achieved through simple design strategies.

PROGRAM DEVELOPMENT 053

Project Program Summary

The program is important to the thesis in order to show the aptitude of a building's performance to achieve a higher level of flexibility in architecture. For a building to show the capabilities of transforming around a user, rather than a person changing to fit the architecture, an expansive range of functions and fluctuating populations would demonstrate the flexibility of architecture's ability to do so. The proposed program is a large live/work facility to confirm the problems addressed in the thesis. It would provide a large number of people that are constantly moving throughout the building based on different activities that can be predetermined or unpredictable. The climate and atmospheric influences from the external environment would also be more influential in a large-scale building, so the interaction between those external factors and each individual would need to be accounted for. The live/work setting could incorporate living units, working units, and shared units for both living and working. Levels of publicness or privateness could be revealed within these units to express or attempt to dictate levels of transformational qualities in the architecture. The configuration and interaction between different rooms and their relationships to other rooms and the people inhabiting them will be key in the design proposal to express the effectiveness of a flexible architectural design.

Preliminary Program Outline

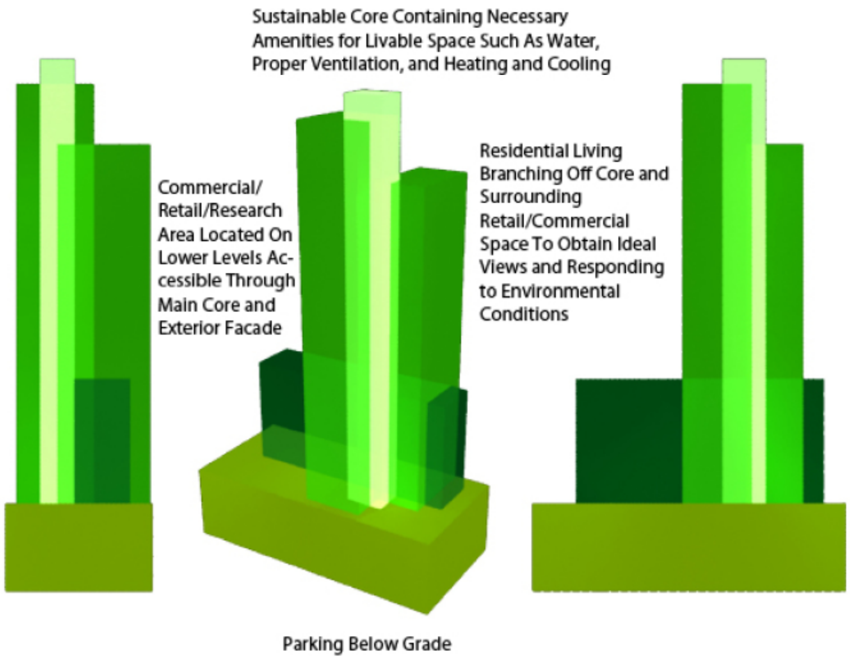
Large-scale Live/Work Facility

Live Units		
	Public	27,588 ft^2
	Private	148,855 ft^2
Work Units		
	More Public	36,739 ft^2
	Less Public	93,097 ft^2
	More Private	36,713 ft^2
	Less Private	25,841 ft^2
Live/Work Shared Units		35,140 ft^2
Restrooms		80,795 ft^2
Mechanical/Electrical Rooms		10,232 ft^2
Circulation		41,421 ft^2
Exterior Space		
	Greenspace	219,710 ft^2
	Roof Gardens	43,794 ft^2
	Parking	
Gross Square Footage		862,956 ft^2

Conceptual Program Diagrams

This was an early attempt to justify the large scale interpretation of the building, mostly articulated as a tower with a circulation core and surrounding residential and commercial, retail, or research areas and underground parking. The core would provide the main circulation path of the building, the necessary amenities such as water, proper ventilation, and HVAC. The program direction has benefited from this early design by understanding the context within the city and how the architecture can express that a live/work facility would allow for more options and to demonstrate the flexibility of a tranforming architecture articulation as opposed to segregating functions. The building's configuration and orientation are not explored here; this is only an early attempt to grasp the scale of what the design could achieve.

Conceptual Designs For Responsive High-Rise Living and Commercial Structure



SCHEMATIC DESIGN 059

Preliminary Design Summary
Initial Project Collage
3D Models
Vignette Scenarios
Conceptual Program Configuration
Adaptation Exploration

Preliminary Design Summary

The ideas and issues being explored during the preliminary design phase of the thesis project mainly grappled with the architecture's ability to respond to user functions and environmental influences. The thesis has progressed through time, evolving from a heavy influence on digital media and the capabilities of information networking to adaptable strategies and transformational architecture that acts as a living machine. Throughout the process, emphasis has always been centered on creating architecture that is much more actively responsive to changing external conditions and changing desires of the inhabitants. Architecture would be allowed to achieve these methods through a flexible articulation that challenges the ways buildings are constructed and the advanced forms of materials, assembly ideas, and applied technological system, among others. The role of architecture can change extensively going beyond traditional methods to create more transformational and dynamic architectural situations. We don't have to change in response to architectural space, but instead architecture can transform around us.

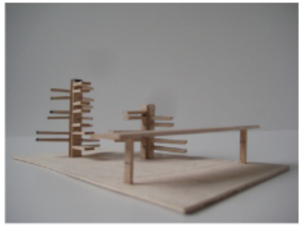
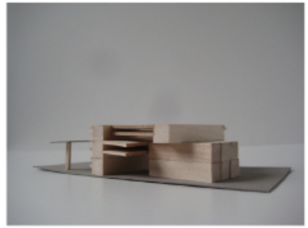
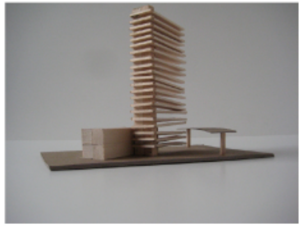
Through the study of a number of influential precedents that are attempting to deal with this transformational quality, researching relevant literature, experimenting with sketch problems, analyzing site and environmental conditions, three-dimensional and two-dimensional investigations, and exploring live and work functions the thesis has developed. Not all that was studied was relevant, but each step helped to develop the thesis to broaden the author's architectural knowledge.

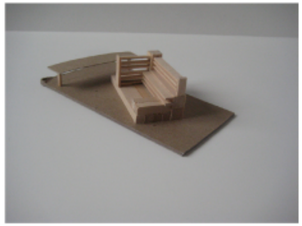
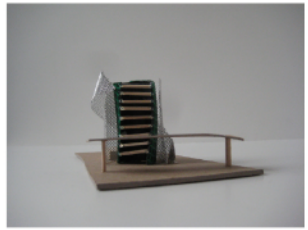
Initial Project Collage

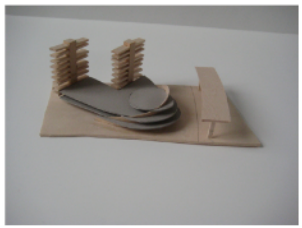
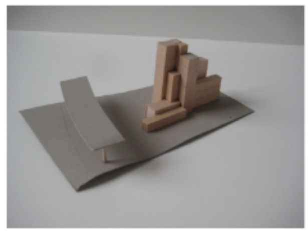
This collage demonstrated an early representation underlying the thesis project. It represents how a structure could be responsive to environmental conditions. The structure could be responsive to a variety of climate and weather conditions such as sun, shade, rain, snow, fog, and wind during all times of the day. It could also be responsive to city life, but it should try to fuse the relationship between the natural and urban settings. It should essentially be ready for anything life throws at it. It should also test and exemplify the limits of digitally designed architecture. The tower of different houses in the collage represents the potential for mass customization options for the users to choose, adapt, customize, and adjust to fit their own needs and wants. The intent is for individual units to plug into a fully sustainable structure that provides all the amenities of a livable space such as water, proper ventilation, and heating and cooling.

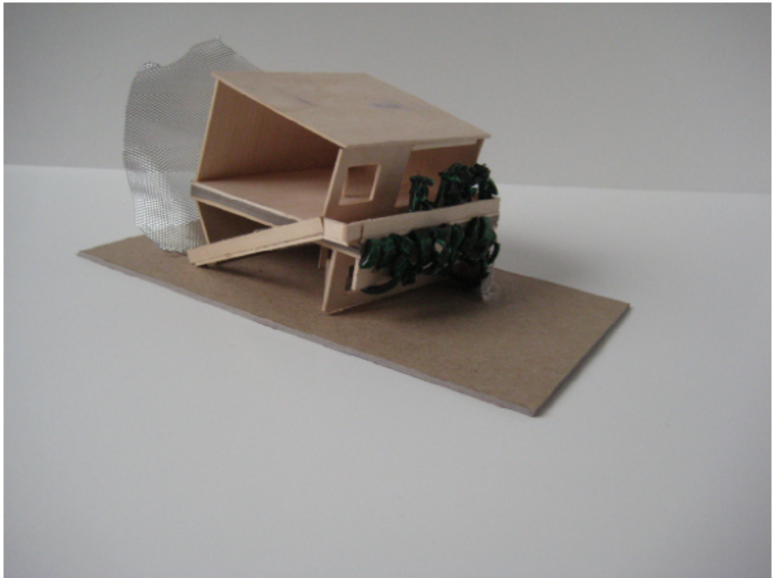
3D Models

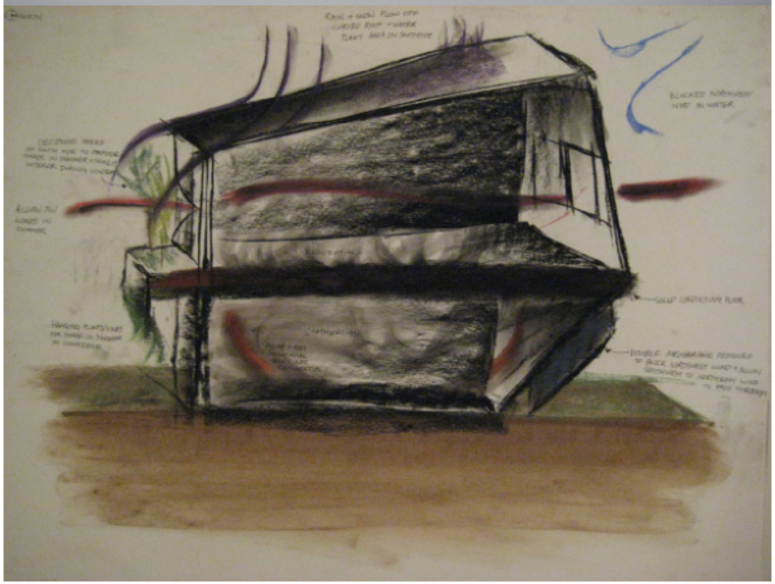
These models made of wood, chip board, and matte board were mainly an exploration of scale, orientation, and configuration options available within the site. They are designed to study the effects of accommodating a large number of programs and a large building population. They also take into account desirable and undesirable environmental conditions to take advantage of their orientation on the site and the configuration of the building form. They give a number of options for the building to adapt to changing conditions.





063

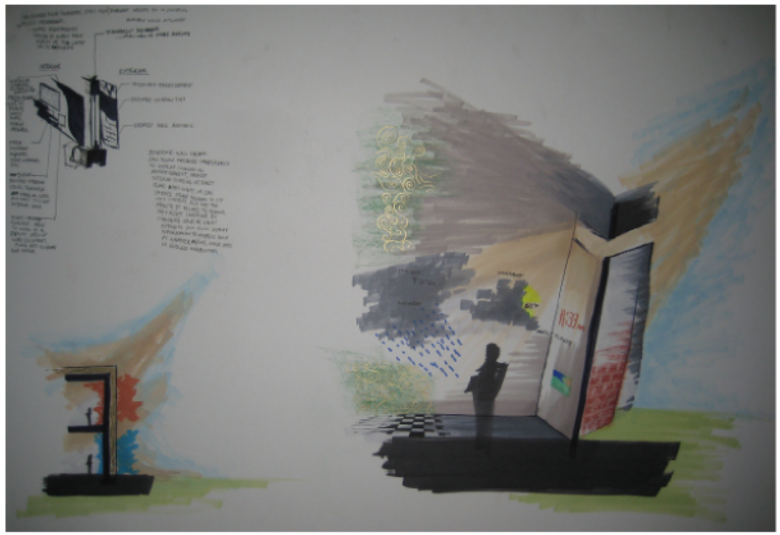
This was a study that related the use of adaptive architecture through traditional building methods and simple design strategies in order to effectively understand those techniques.

The sloped roof allows rain and snow to trickle down to water the deciduous trees on the south side, which provide shade in summer and a sunlit interior during the winter. The small building is separated into a top residential unit and a lower commercial level. The heat produced from the commercial rises into the residential area. A solid conducting floor helps maintain a comfortable interior space for both units. The building is tapered to allow southwest winds in summer to cool the interior space. The large Northwest facing wall with few windows blocks harsh winter winds from that direction and a double membrane is designed to block northwest wind and allow southwest to northeast winds to pass through for warmer seasons.

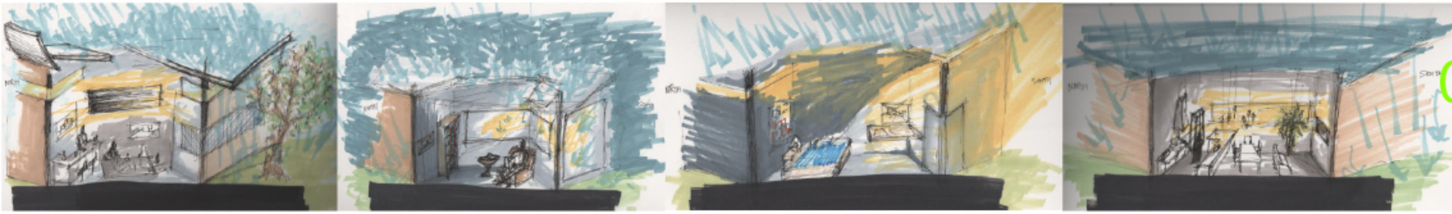
Vignette Scenarios

These series of vignettes display a number of scenario configurations that accomodate a number of funtions that the user may typically perform and they also relate to varying environmental factors. User activities were the focus of these studies that explored the range of adaptations possible in order to realize effective transformational qualities in the final architectural design.

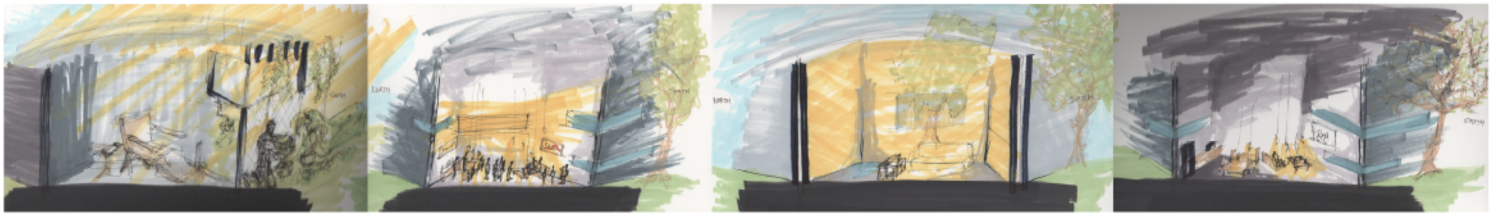
These two examples to the left explore the possibilities that polyester film substrate with an OLED membrane could offer to the articulation of the building interior and exterior walls. The system is similar to mobile phone displays or television or laptop displays. The system would implement a PC to control exterior and interior facade strategies. The interior could provide shading and light filtering in endless possibilities based on the user's designs. The display could act as a media player to play live TV, watch movies, display artwork, display important agendas, news, weather, change the interior wall covering color, texture, illumination in video or image in any location on the wall which would create a multi-tasking surface. The exterior could project an advertisement, a desired window tint, and information to public such as time or weather.



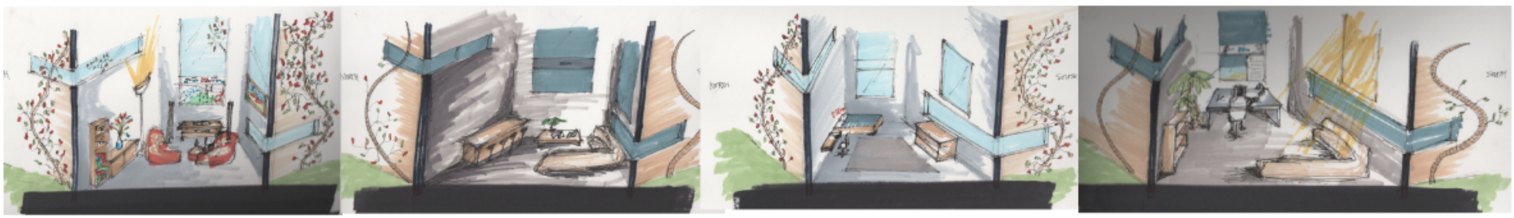
These scenarios on the next four pages were based on the four seasons with typical climatic conditions for each and different activities which the user could take part in during different times of the day and during the week. They explored the effects on one specific residential unit at a time. They are also based off of Philadelphia's climate conditions and common user activities that may take place there.



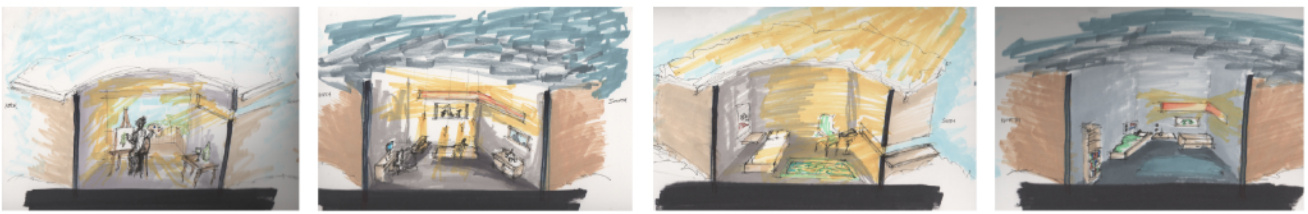
Typical spring conditions and functions during the week, weekend, and night and day



Typical summer conditions and functions during the week, weekend, and night and day



Typical fall conditions and functions during the week, weekend, and night and day



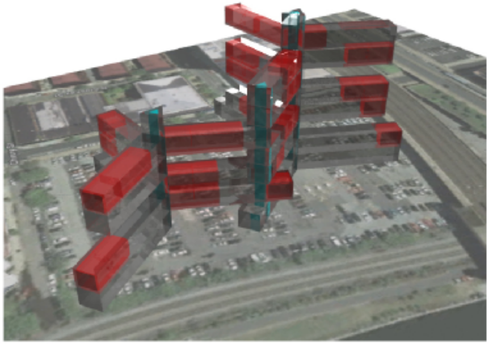
Typical winter conditions and functions during the week, weekend, and night and day

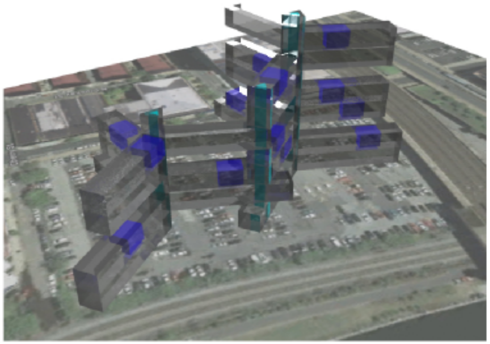
These two examples combined the earlier seasonal scenarios in attempt to justify their configuration to a larger scale, picturing the building as a whole, trying to predict locations in which some of the building's systems could be best suited. This idea was replaced with the live/work functional combinaton concept, but picturing the building as a whole was an important design stage realizing the effects one user might have with another user.

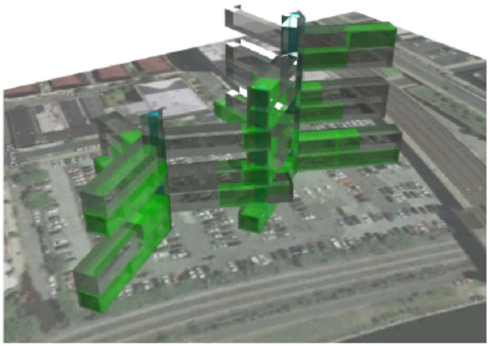
These primarily integrate the live/work program idea to the pervious vignette drawing methods. They explore a range of settings that could take place in each unit in correspondence with another unit within a building. There are some instances where residential units are incorporated into the design next to office space or where residential units break up the space between public and private settings. The intermediate spaces allow certain users to work from a more private unit with the benefits of having their work space right next to them. Public spaces for all such as a computer lab and print room make societal interaction possible, but also serve functional purposes for a number of working areas of the building. They also link and separate semi-public areas like offices or workshops with other ones. These different functions attempt to justify certain functional relationships by their placement within a section of the building.

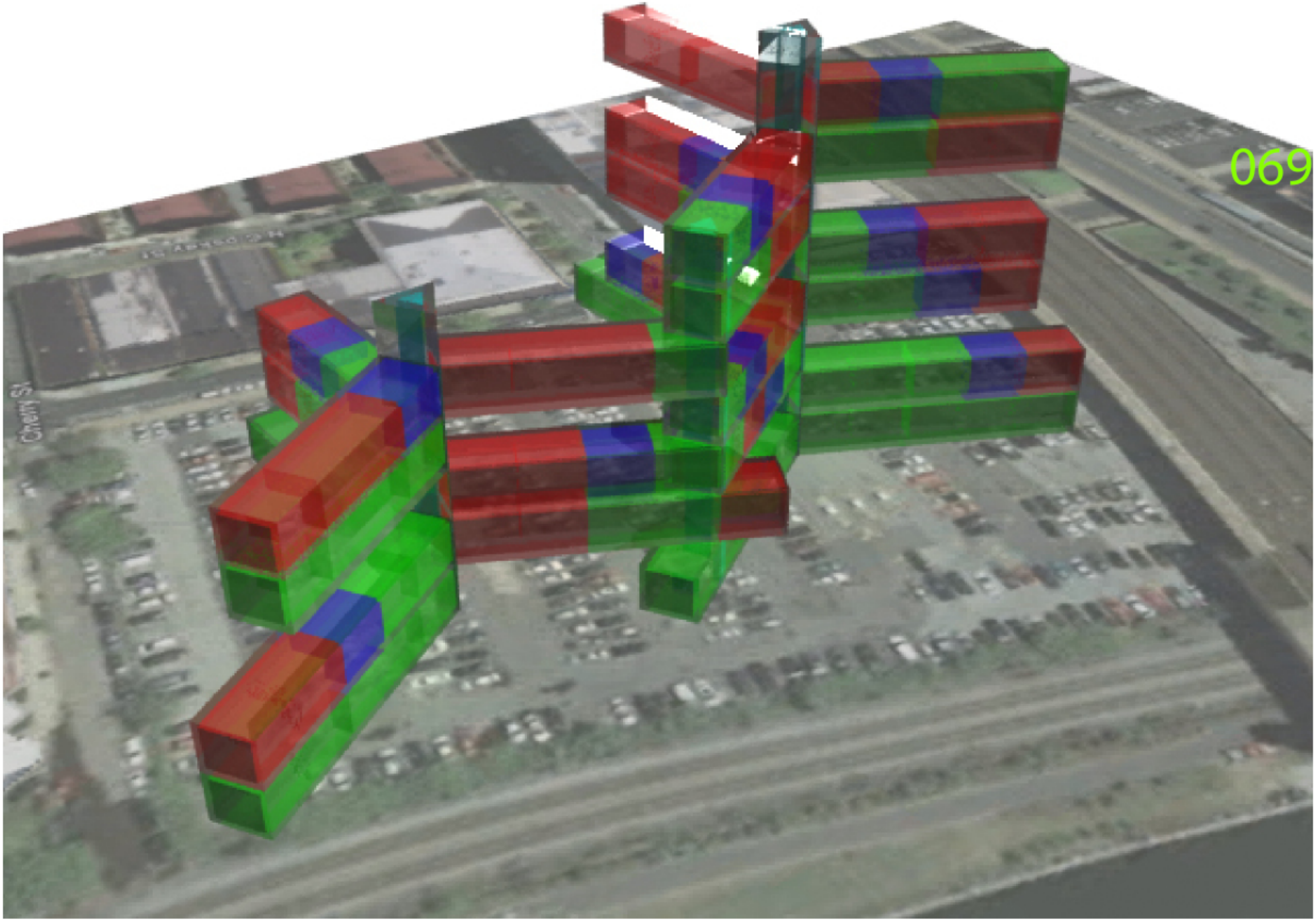
Conceptual Design Configuration

This diagram looks at the building as a whole; seeing how each public, private, and intermediate setting can make sense with different programs. It studies how any one user has the ability to respond to a given function and addresses how they might interact with the building in regards to that chosen response. The building complex consists of two independent towers that are also connected into a stacked public unit tower. The configuration of the form is dominantly determined to protect from harsh winter winds and take full advantage of summer winds as well as take full advantage of sun path in the winter, but with rooftop gardening some protection from sun rays is mediated during warmer seasons. Humidity can be regulated in the warmer seasons by creating a stable condition allowing the building to breathe from its spread design with generally just two levels at a time, and with the use of rooftop gardens. Because there are generally just two levels at a time, those units would be easier to heat and cool by conserving heat with a smaller area, or allowing natural breezes to flow through the extremeties. Other site factors such as the river and rail tracks have not been applied yet to this design.


Private

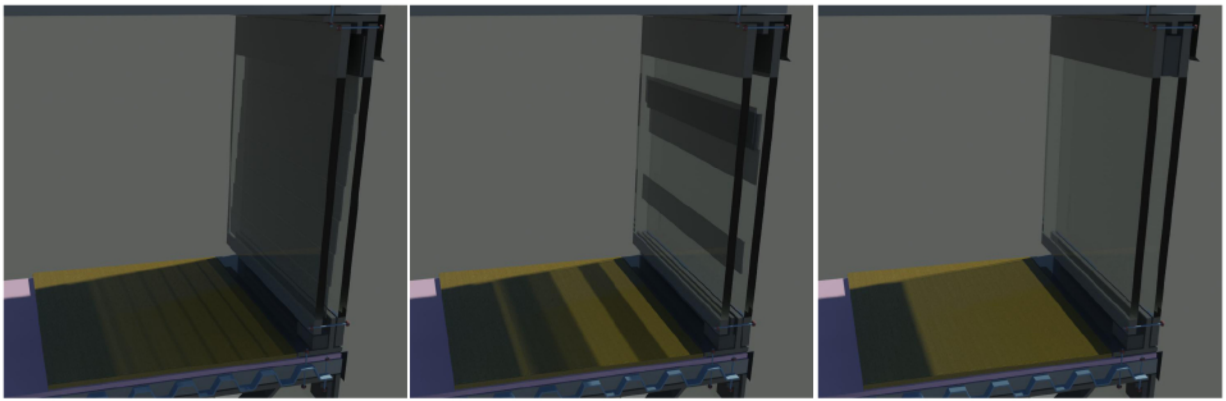

Intermediate


Public



Private, intermediate, and public spaces within the entrire context of the structure form

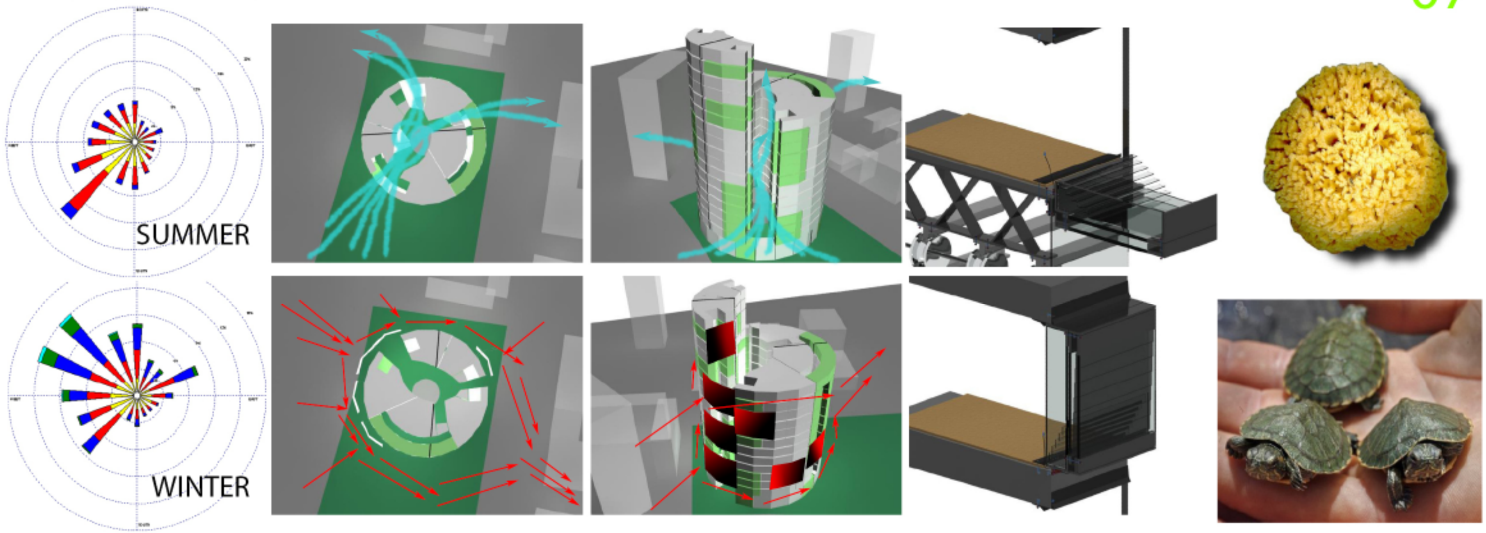
Visibility



The first step toward the final design looked back to the simple design strategies from the Adaptations studied. These were explored to find appropriate answers to architecture's ability to change. The Adaptations were condensed into four categories including: Visibility, Breathe and Protect, Precipitation Collection and Cooling, and Heating.

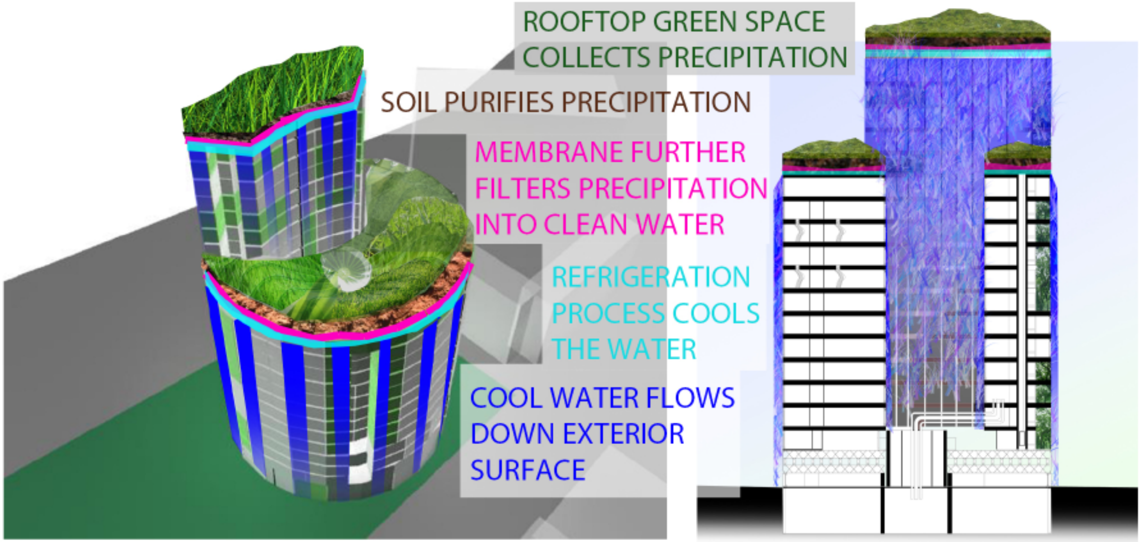
Visibility was studied through the different effects light could influence the exterior of the building and the different possibilities of shading devices on the membrane of the building. This example shows how a double membrane could incorporate automated shading devices in between the glass panels. The tinted shaders could overlap and create unique plays of light within the exterior space.

Breathe + Protect



The building's ability to breathe and shelter itself from harmful elements was explored using the wind averages for summer and winter conditions. The idea was to open the building to the elements for ideal conditions that would cool the building and provide a natural breeze. Carving out of a cylindrical form would provide natural air flow from all directions and would also allow wind to be easily bypassed for unpleasant conditions. Protective coverings, or "shields" could operate to remain open or shut to contain the building and prevent harmful elements such as strong winds, precipitation, and too much sunlight. The exterior was also examined, where balconies could be deployed with shading devices integrated in the double membrane system, allowing light and air into the interior spaces when users preferred it or not.

Precipitation + Cooling

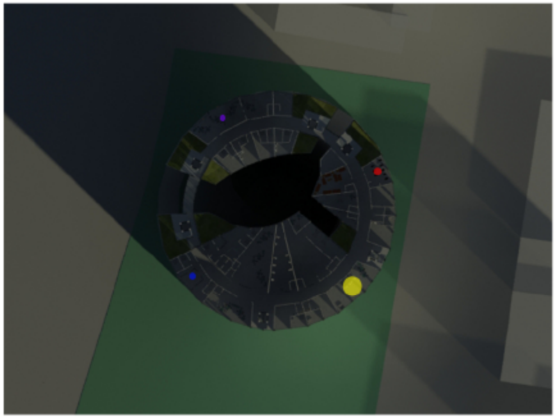


Another concept was to cool the building through a rainwater collection sytem. The rooftop would serve as a greenspace that would collect precipitation, turn it into clean, usable water that would be cooled by a refrigerant and trickle down the facade to cool the building as a whole. This system would be similar to the rainwater collection and cooling capabilities found in the lotus leaf combined with the way the human body sweats to cool off.

On the opposite page was a concept showing how the building could rotate based on the sun path, so each interior unit would receive the same amount of light in any given day. Each colored dot indicates the amount of sunlight gathered and received during different times of an ideal perfectly sunny day.

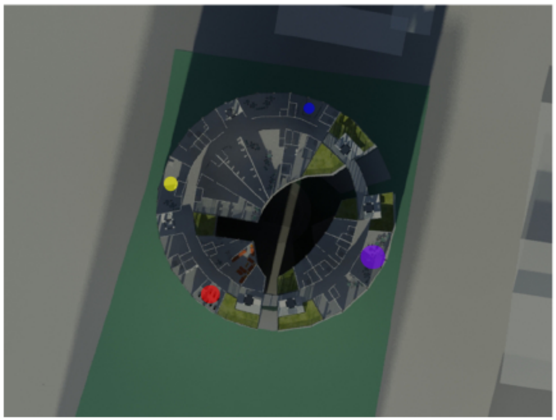
Heating

9:00 AM

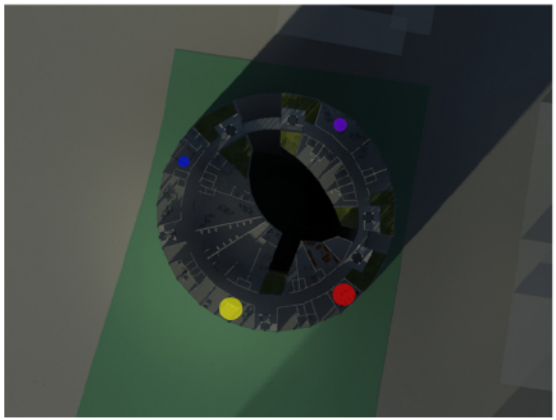


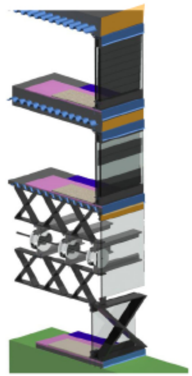
11:00 AM

1:00 PM



3:00 PM





UTILIZING PHOTOVOLTAICS IN BETWEEN FLOORS

FINAL DESIGN 075

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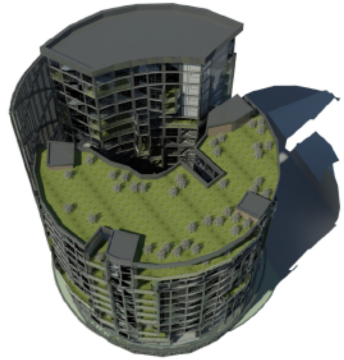
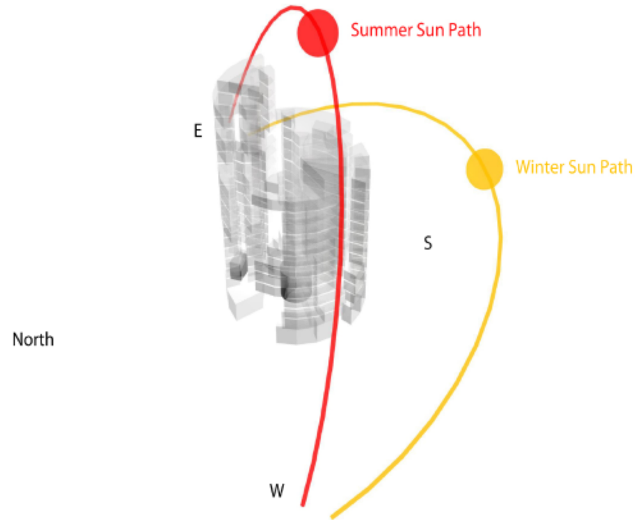


The underlying concept of this thesis challenges architecture's ability to transform or change.

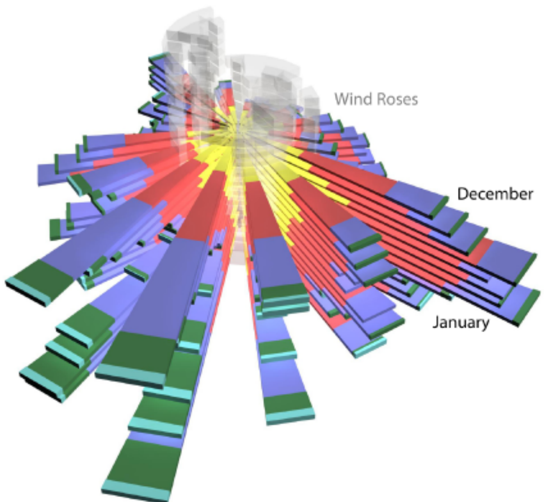
Countless examples found in nature prove their ability to transform, change, and adapt. A sunflower, for example, positions itself to get more sunlight. Trees shade themselves with their leaves which would otherwise be in direct sunlight and within the path of wind. Leaf stomata, or pores, also allow trees to breathe and maintain their desired states. These became the main factors to challenge how an architectural response might change to heat or cool the building in response to sunlight and wind. Using these same, simple ideas found in nature and implementing recent, as well as emerging advancements in a variety of building techniques, advanced materials, and environmental systems architecture is able to achieve unprecedented levels of adaptability and flexibility, which has not otherwise been reached.

Looking at the building as a dynamically responsive machine that must accomodate various changes based on user scenarios and environmental factors conjures lively images of a future where architecture can change around us, rather than the inhabitants being forced to adapt to a static built environment. The circumstance selected to explore these ideas is a high-rise live|work building that has the ability to respond to its users based on environmental conditions, utilizing sun and wind to its advantage in order to heat or cool the entire building. The building operates similar to those ideas found in nature. It has the ability to complete a full counterclockwise rotation based on each season, allowing each unit to receive the same amount of sunlight as well as provide a different exterior view for each user throughout a year. An Atrium also lets light into the inner units and allows wind to pass through when needed.

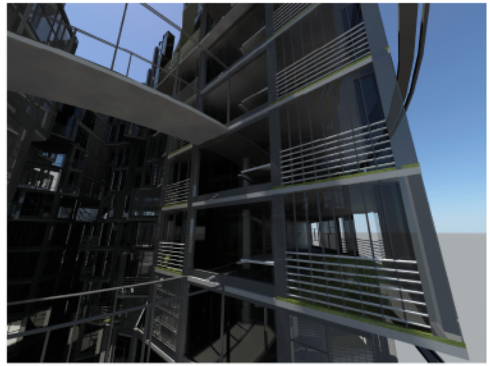
Green spaces are located throughout the building to take advantage of any strong winds to pass directly through the building during any stage of rotation. These greenhouses have accordion glass walls that open up for winds to cool the building when desired or can shut, blocking winds and containing heat.



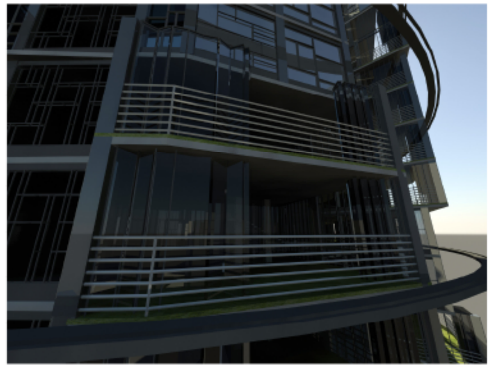
Summer and Winter Sun Path



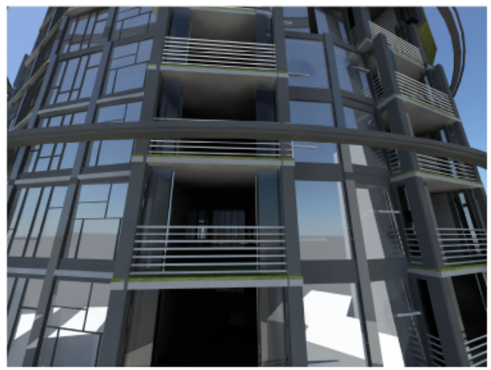
Wind Roses from January to December



Green Space Walls Closed

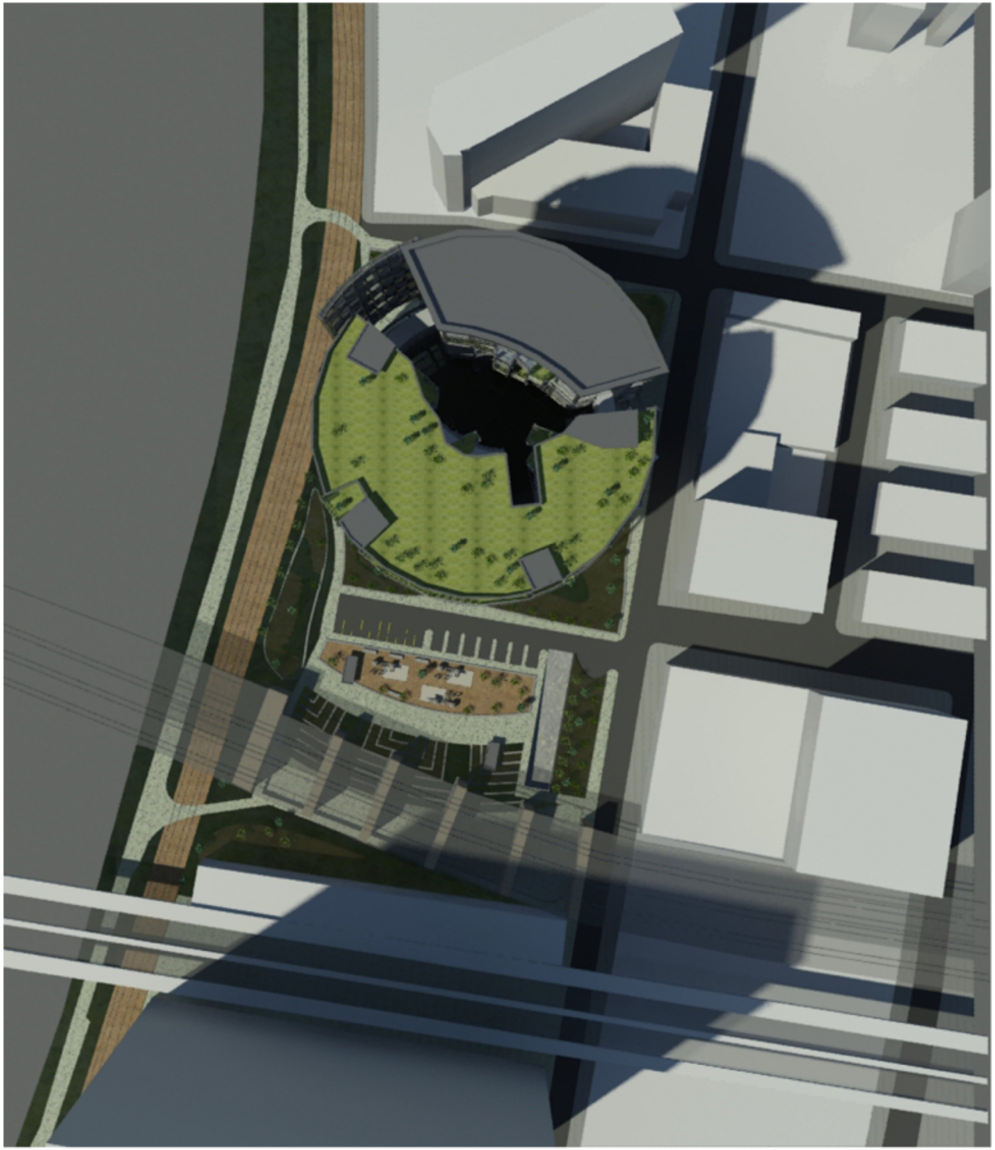


Green Space Walls Half Open - Half Closed

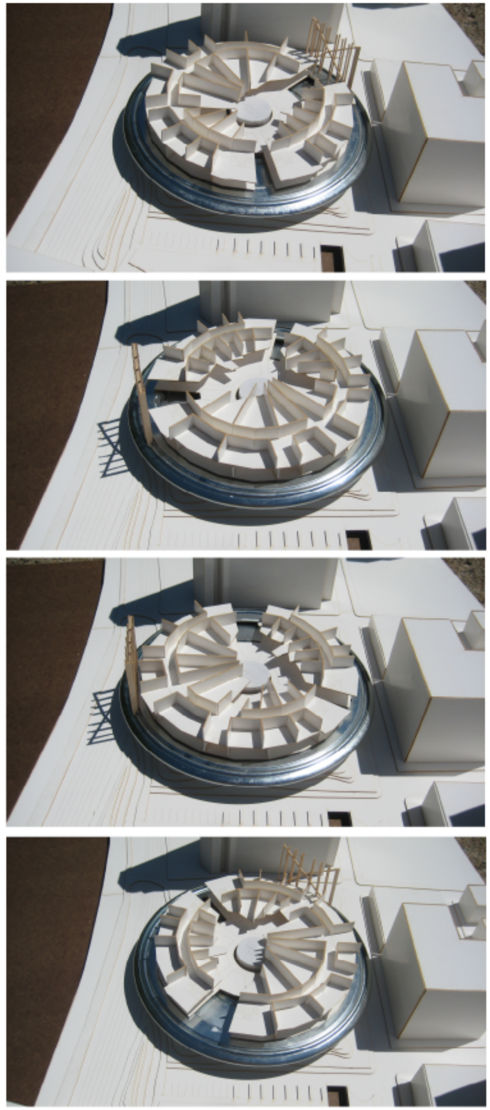


Green Space Walls Open

In addition to the building rotating, a protective shield on the outer perimeter of the facade is able to move independantly in response to wind sensors or based on sun path. It can detect strong winds from any direction and position itself to either deflect harsh winds or move out of the way of a desirable breeze. This shield is made of tinted glass so some light can still pass through and so users can still look outside their windows. Because the glass is somewhat tinted, it can also be used as a shading device for conditions that are uncomfortably warm, aligning itself with the sun path where strong winds are not accomplishing a cooling effect. This shield, in conjunction with the building's rotation, can take advantage of atmospheric effects to dynamically respond to any environmental condition for user comfort. It can even break out of its cycle so the shield becomes the dominant driver, which means the building could complete a full rotation in a completely sunny day. A completely sunny day would present an ideal condition so each unit gets the same amount of lighting throughout a single day by the rotation of the building and it could either block the sun or move out of its path with the shield depending on what condition is desired or what season it is.



Site Plan

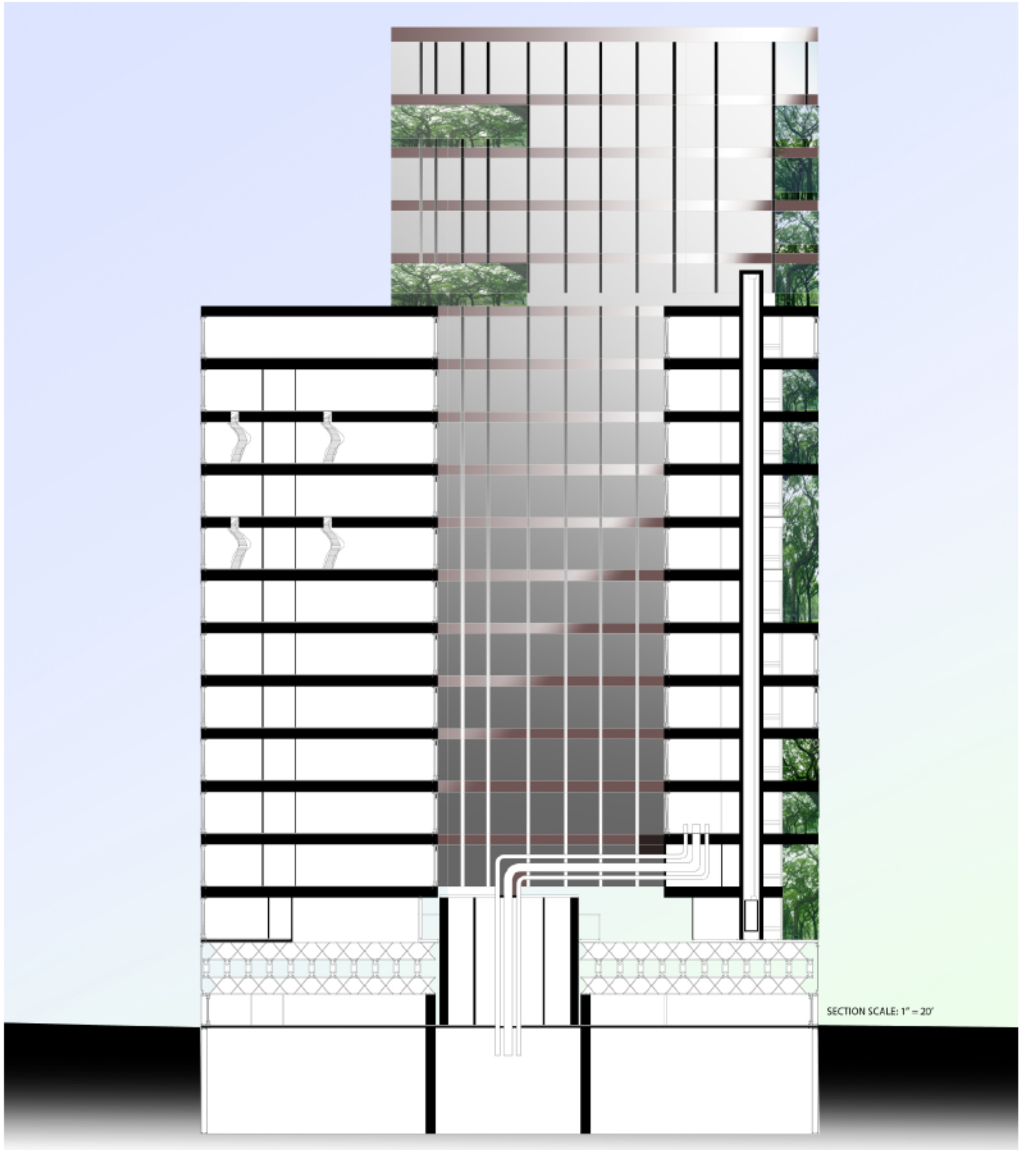


Physical Model Depicting First 3 Floors and The Flexibility of the Moving Mechanisms

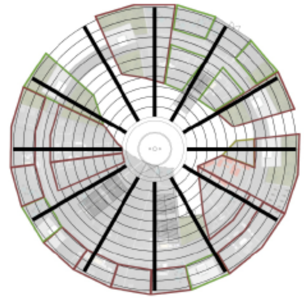
In discussing how the building rotates, obvious concerns are brought to clear circulation flow, the problems of distributing utilities to the building, and incorporating a structural system that can handle the size and function of the building. Since these basic integrated systems are rarely encountered today with rotating buildings of this scale, a certain level of experimentation backed by a logical understanding was implemented. The obvious concern to the ground floor and foundation was solved by keeping the ground level stationary, as well as two levels of underground parking below. The above floors, two through eighteen, are able to move together.

In terms of the structure, loads are carried to the inner and outer perimeter of the form. Heavy trusses radiate from the center to support a track and wheel type of turntable located in between floors one and two. This mechanism serves to move the above floors and transfer the weight from the building above to the fixed floors below. The structural system was designed oversized since this building is unique due to its changing capabilities, and is therefore an experiment.

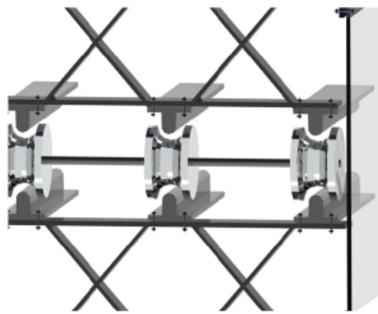
All necessary utilities such as gas, electricity, and water suppling and returning to and from the building lead to the center of the building's rotation. These separate tubes are connected to city lines below the structure and supply the rest of the building connected at floor three above the turntable mechanism via a mechanical umbilical cord for the building. Flexible joints that can expand are located along each tube in order to compensate for overlapping due to the building's rotation. After the connection of the utilities to the third floor mechanical and electrical rooms, the regular distribution of systems is carried out similar to any high-rise structure.



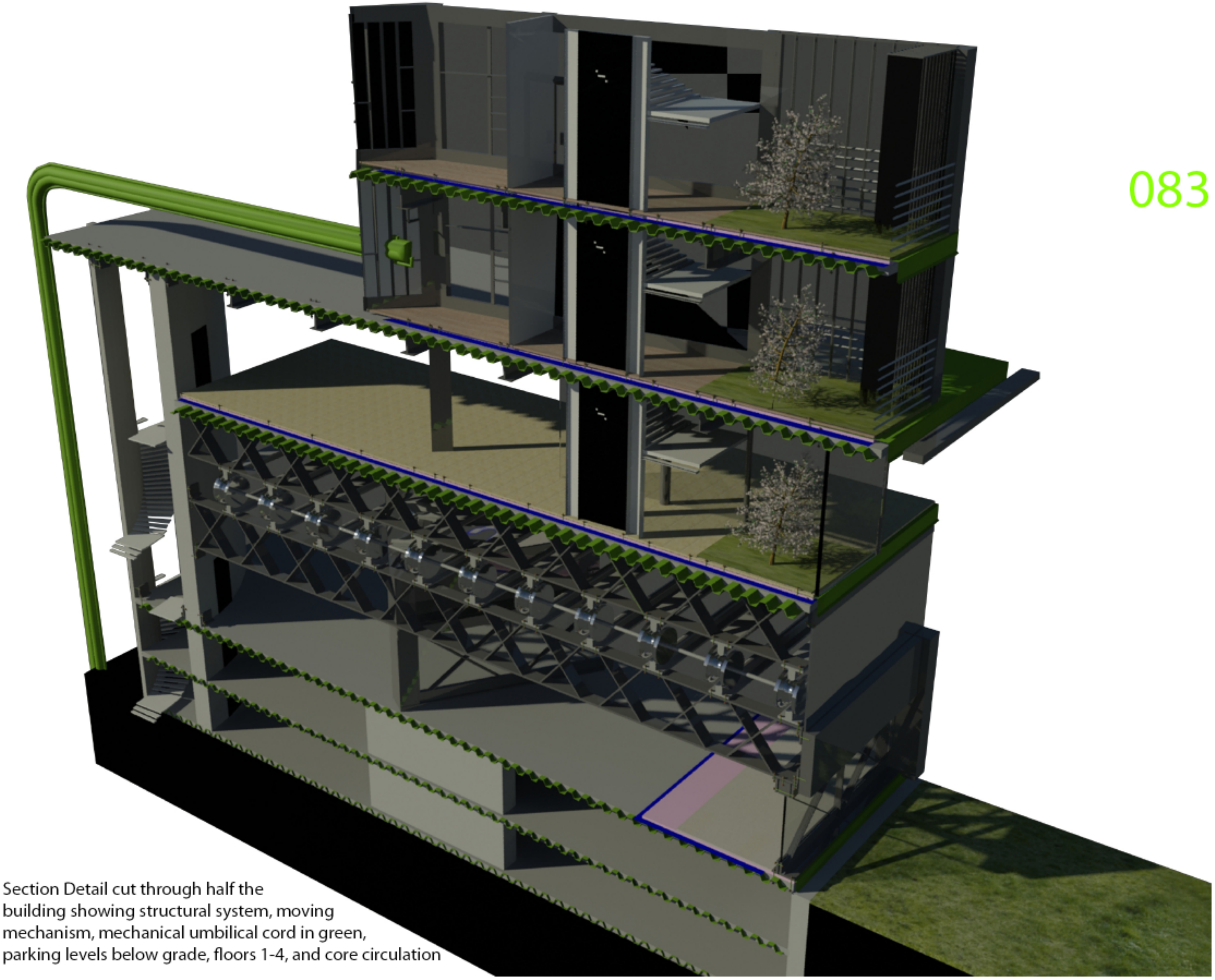
Section Through Entire Building



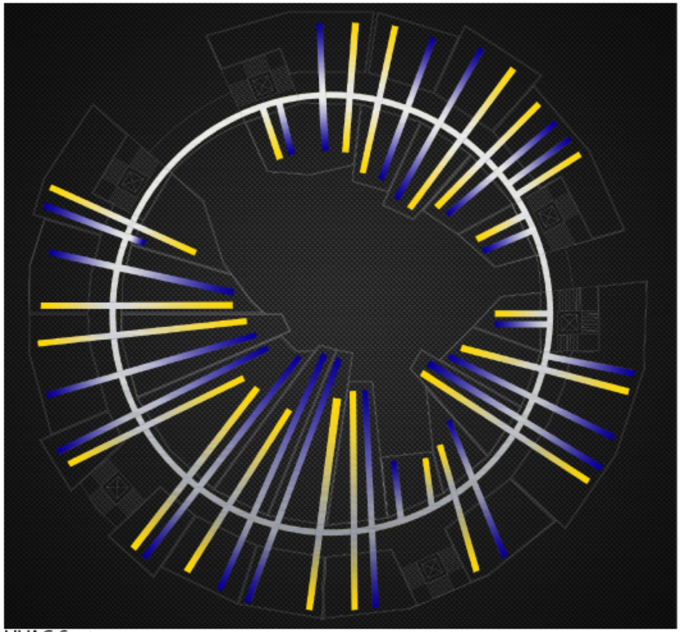
Plan Showing Trusses and Track Radiating From Center

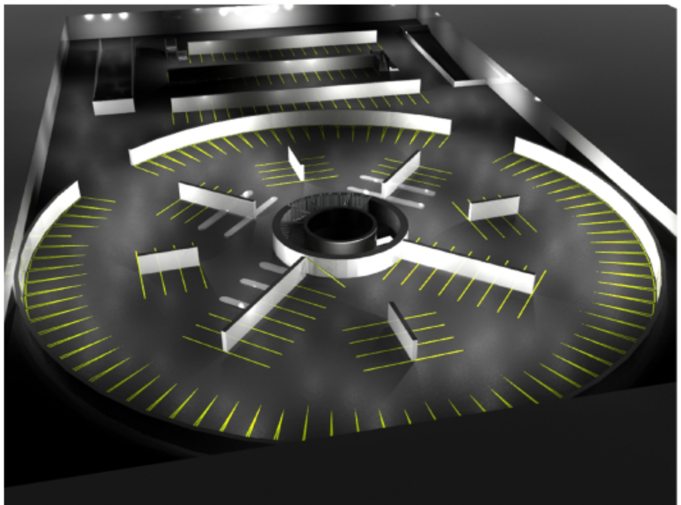


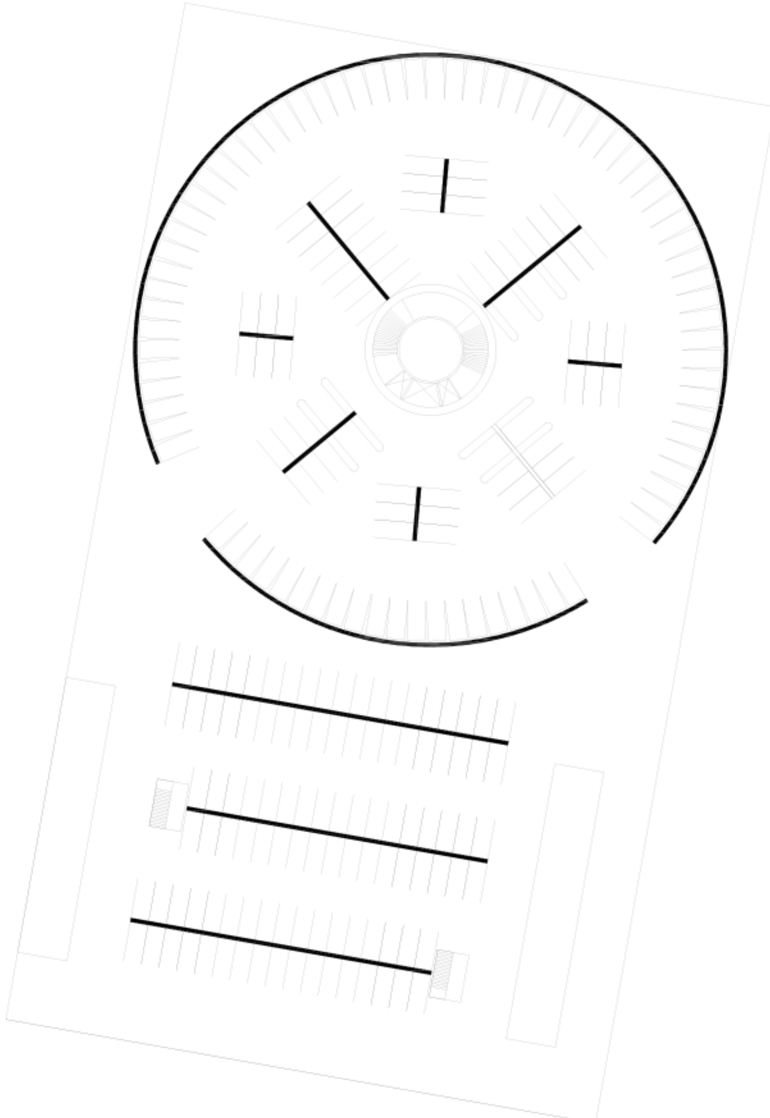
Moving Mechanism - 5' Diameter Wheel Assembly Guided in 11 Tracks



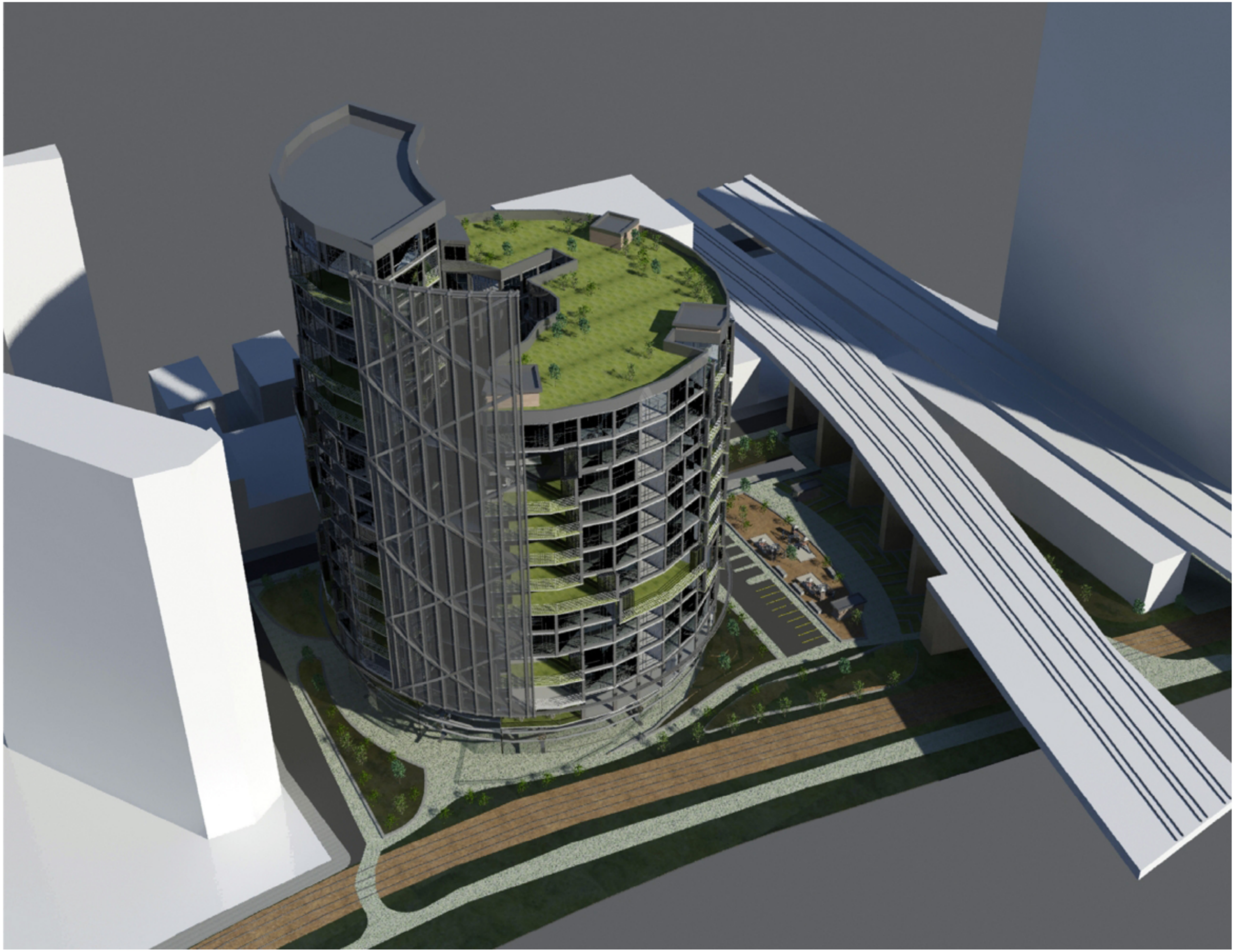
Section Detail cut through half the building showing structural system, moving mechanism, mechanical umbilical cord in green, parking levels below grade, floors 1-4, and core circulation


HVAC System

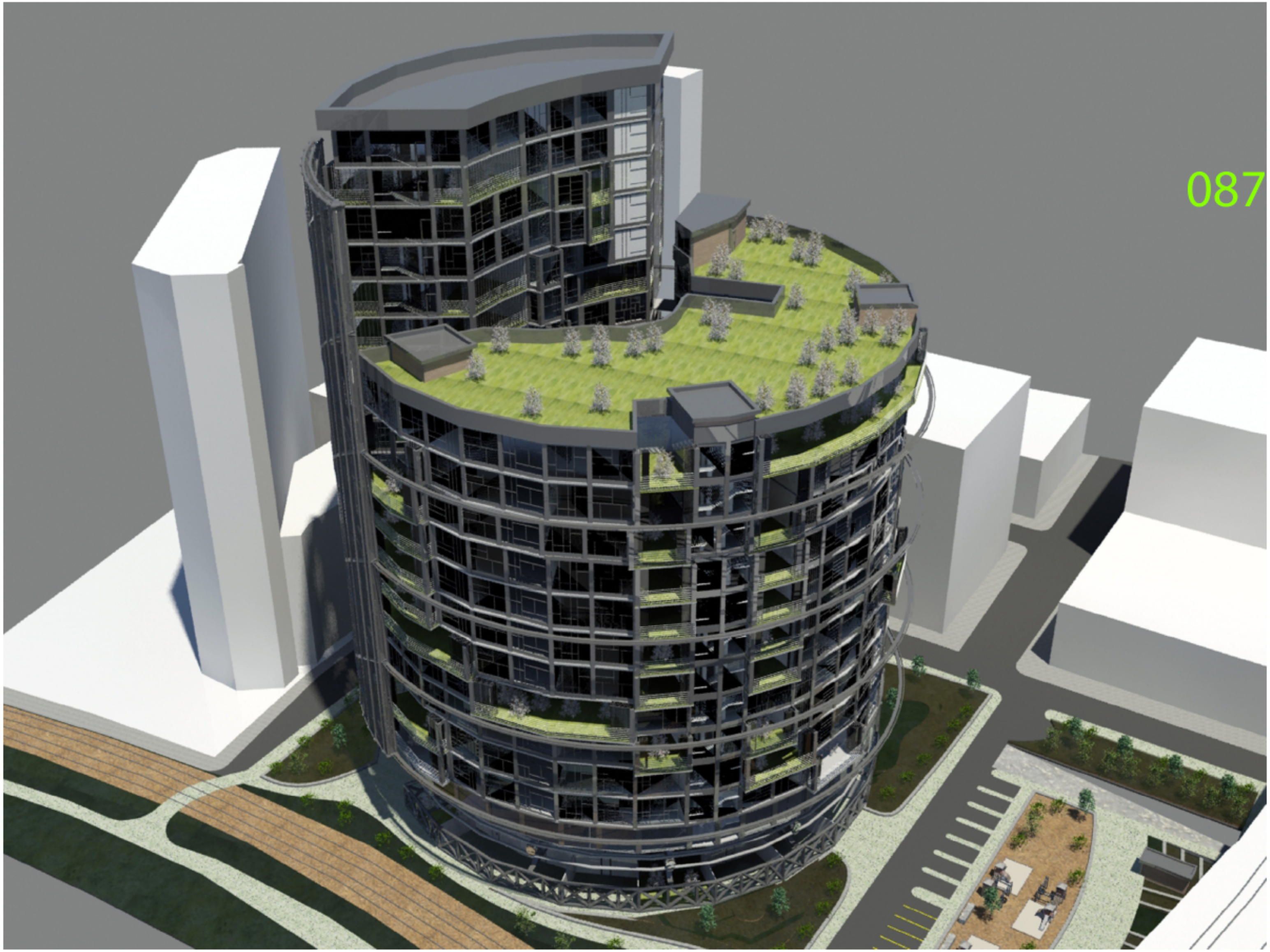

Underground Parking Level 1. Level Two Similar


Underground Parking Level 1 Plan. Level Two Plan Similar

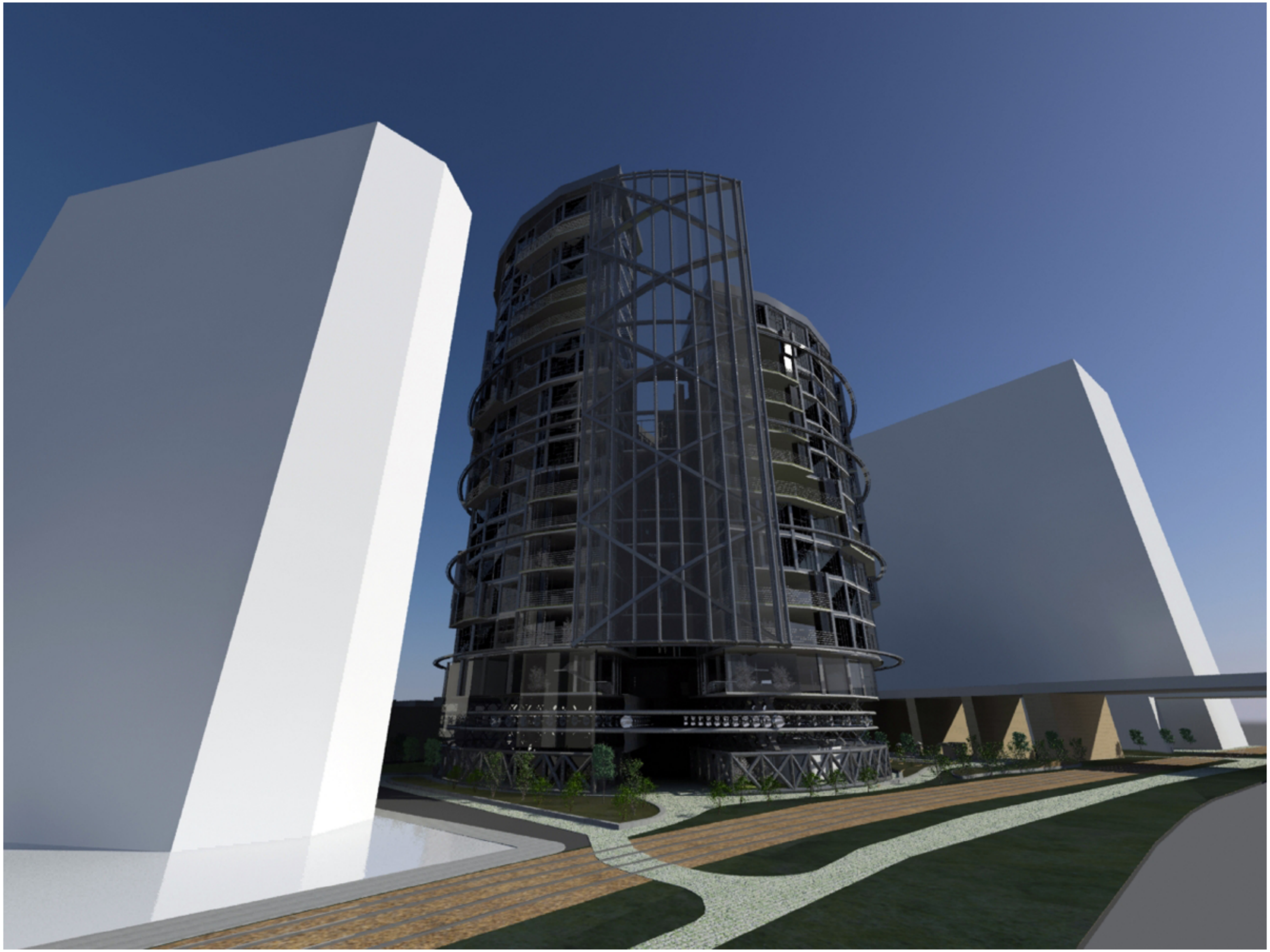
Access into the building is through a ramp leading to two levels of underground parking and through several street level entrances that can be seen on the floor plans section of the book. There is also some ground floor parking located in front of the building. Access to the above floors is through a central core that connects floor one and the underground parking with floor two and the remaining floors. Circulation branches from this core on floor two to elevator shafts along the perimeter. The elevator shafts and stairs are located along a circular corridor on each floor. The HVAC ducts also travel along this hallway and branch out to each room supplying and returning ventilation not achieved naturally through the building's heating and cooling properties. The main supply duct runs below the return duct while smaller ducts branch out to each room as shown in the diagram. The orange color indicates the supply route and the return is indicated by the blue color.



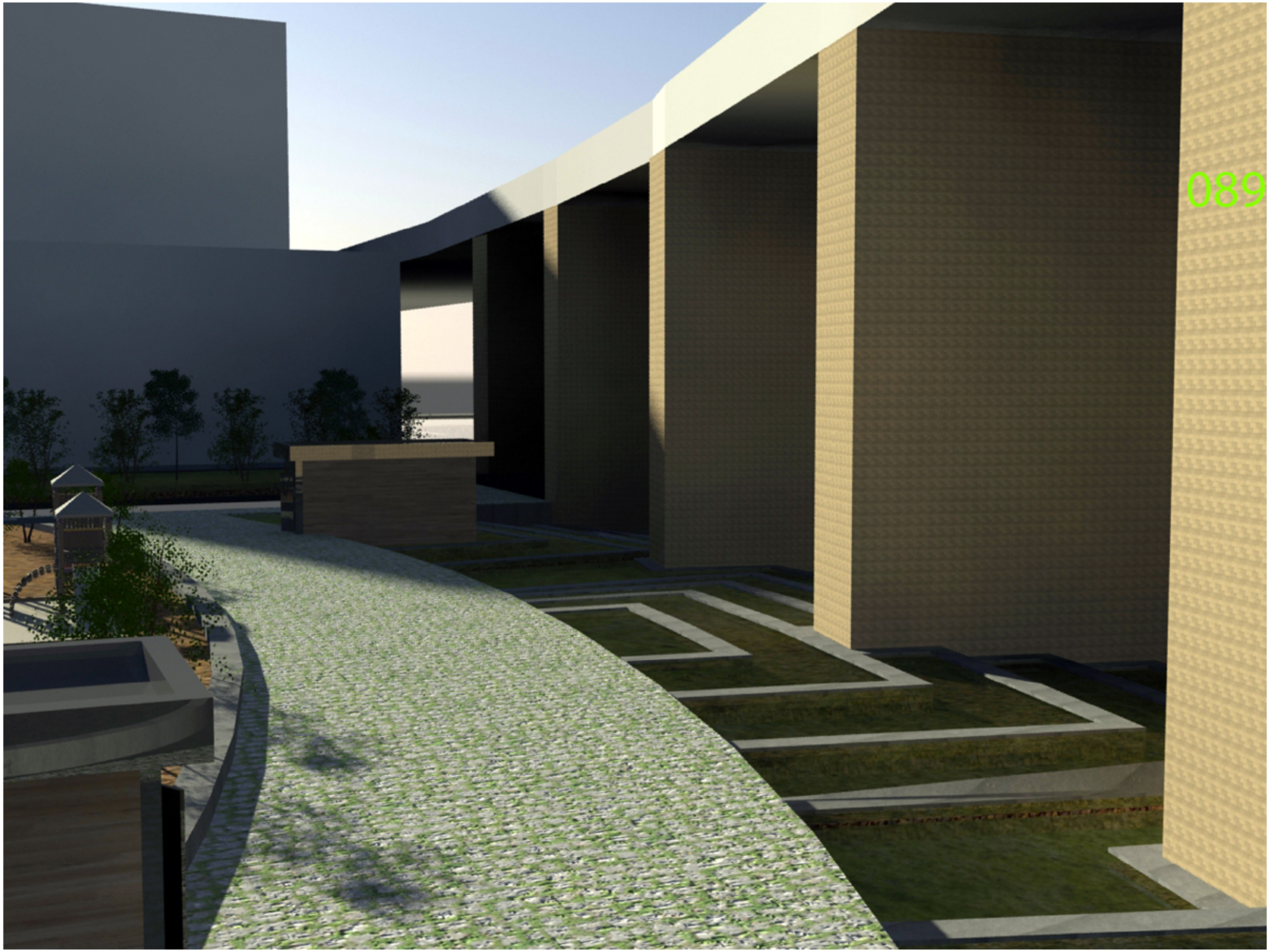
Aerial Perspective Looking Southeast



Aerial Perspective Looking Northeast

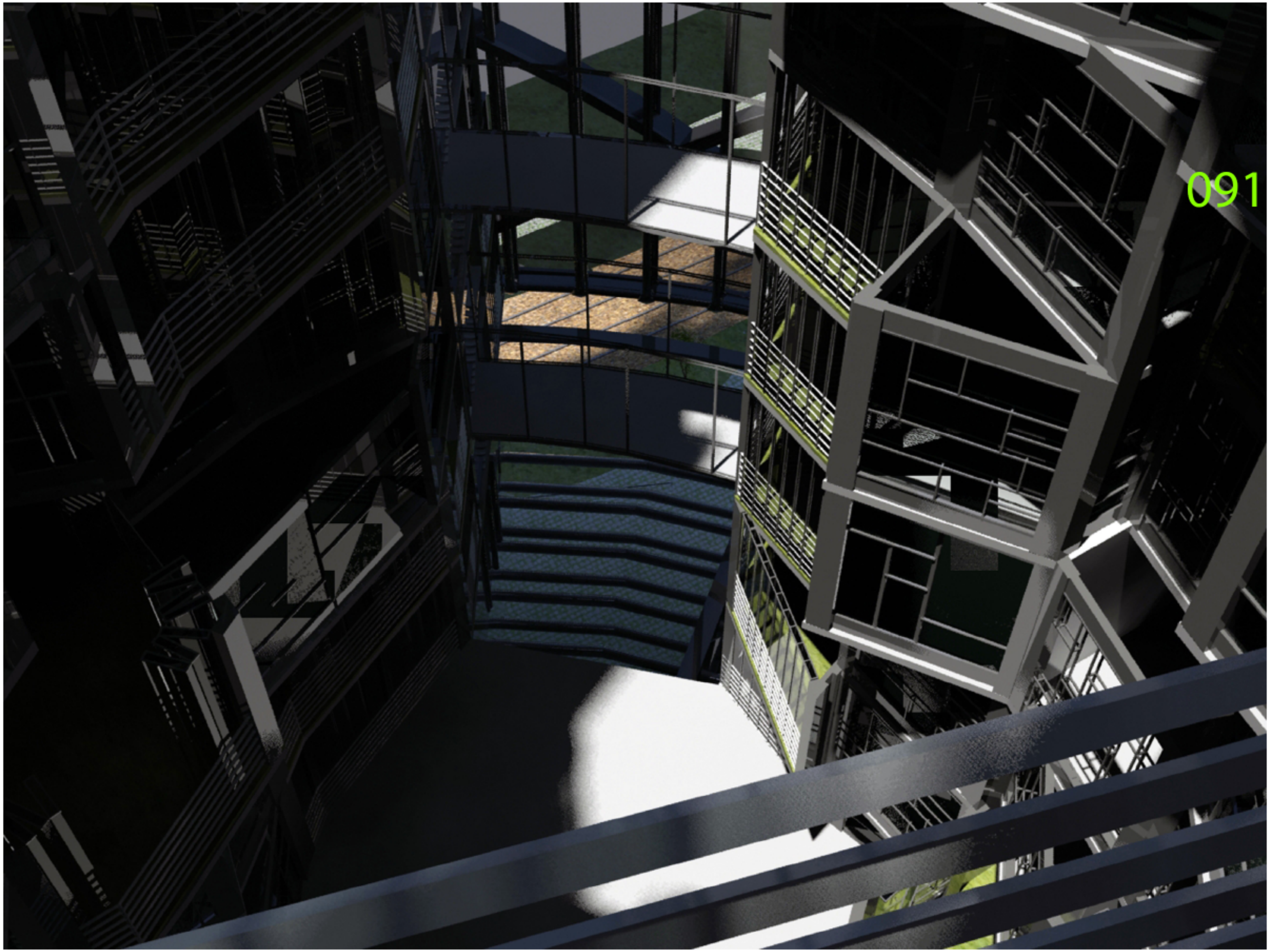


View Looking South

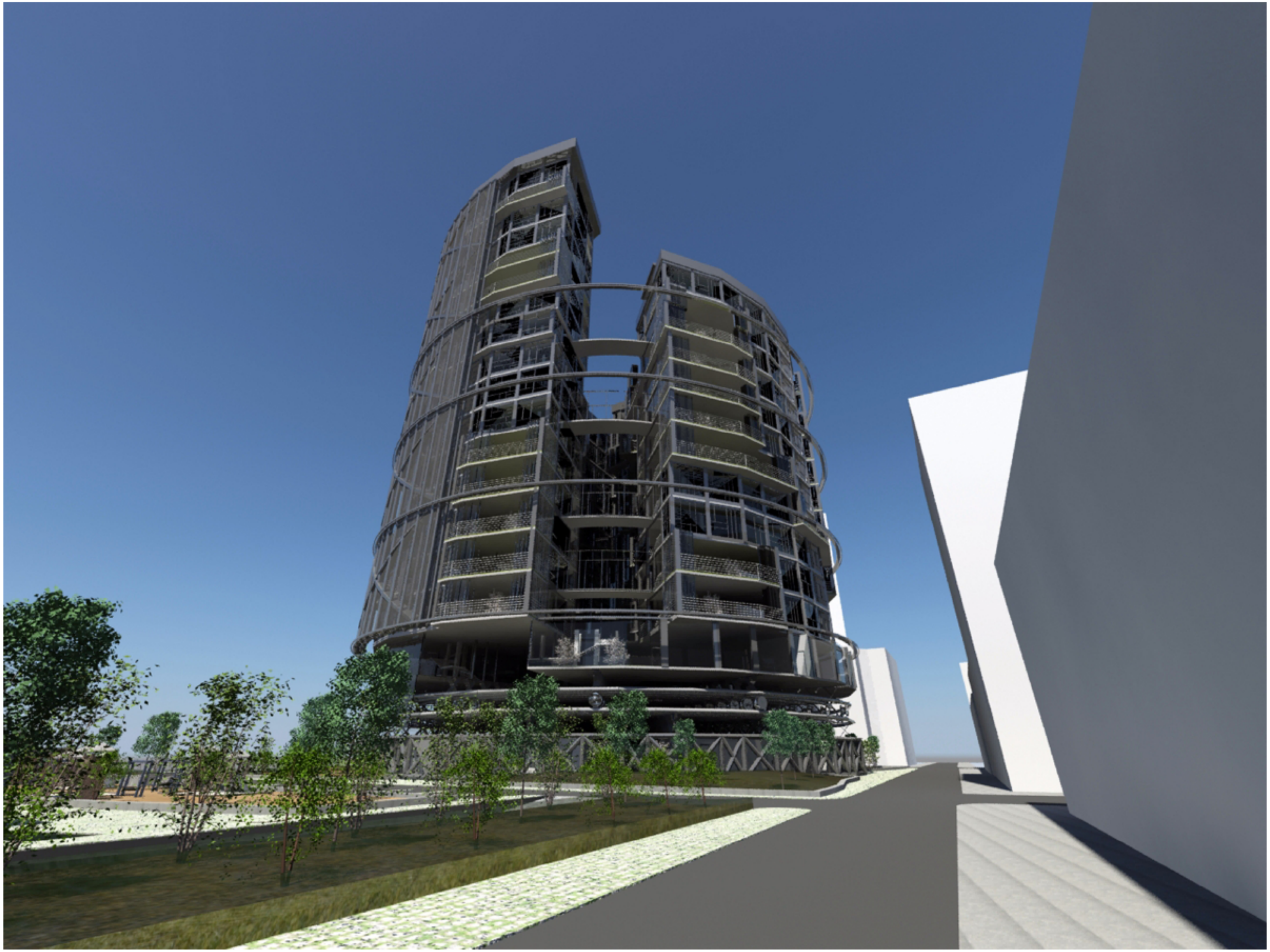


View into Zen Garden below Rail Tracks

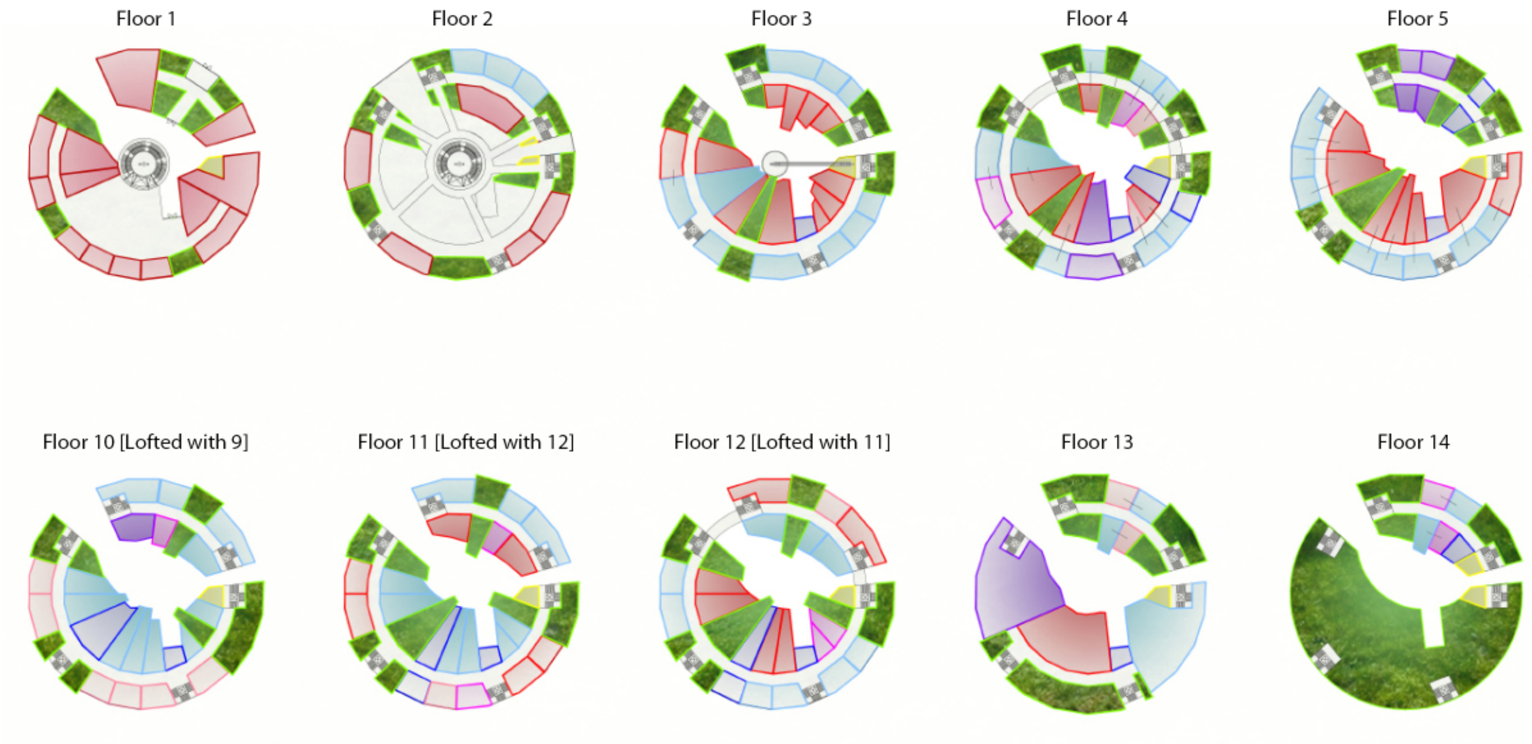
View Looking Up Inner Core



View Looking Down Inner Core


View Looking North

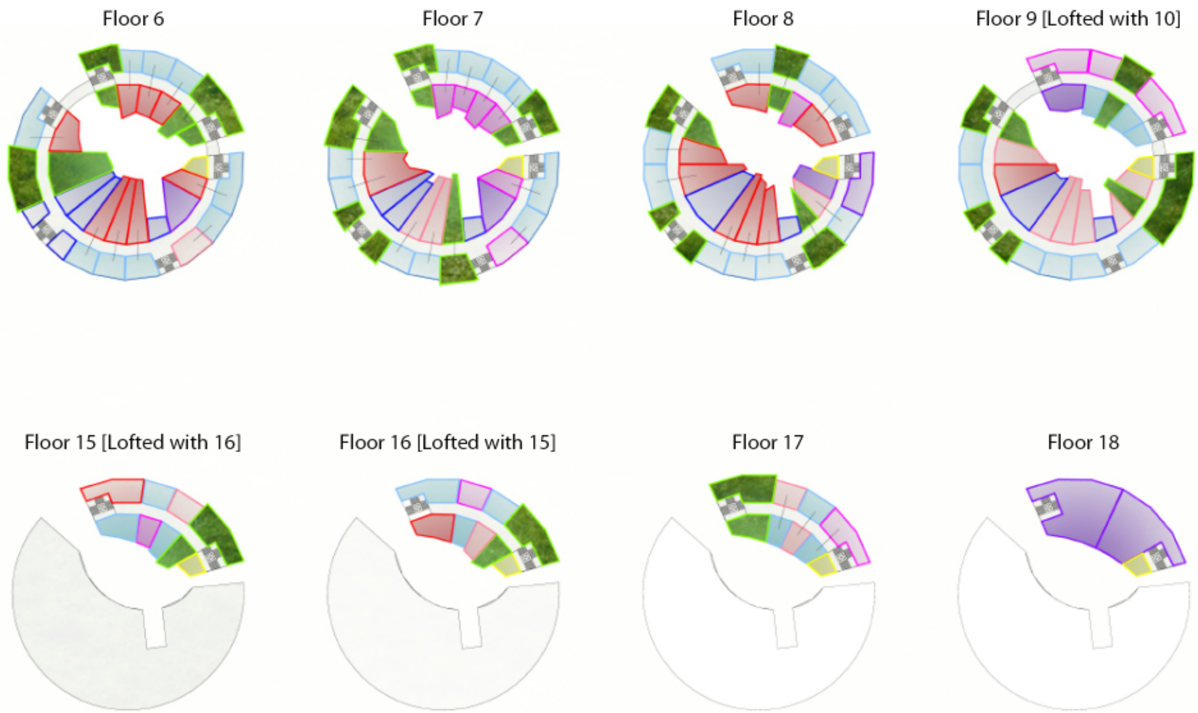
Watercolor Painting of Building



Floor Plans 1-18

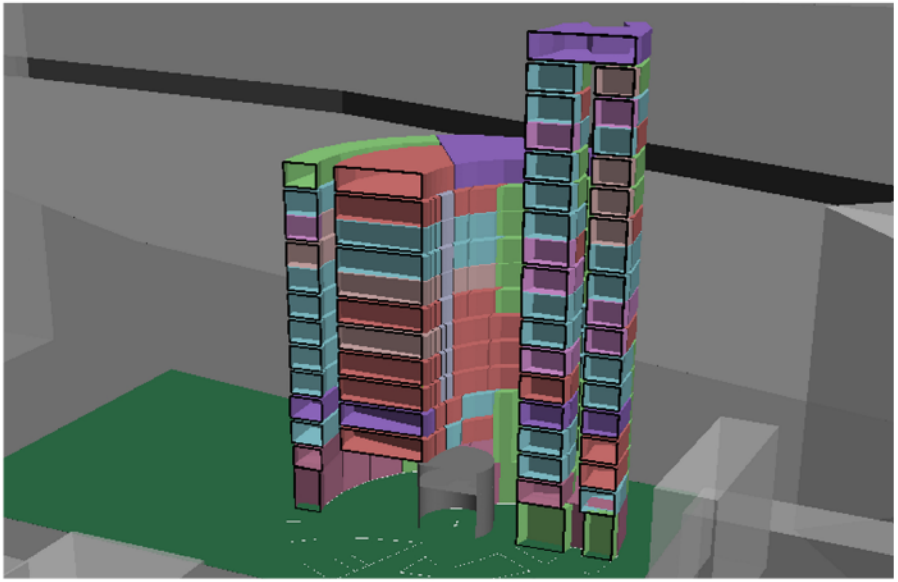
Key:

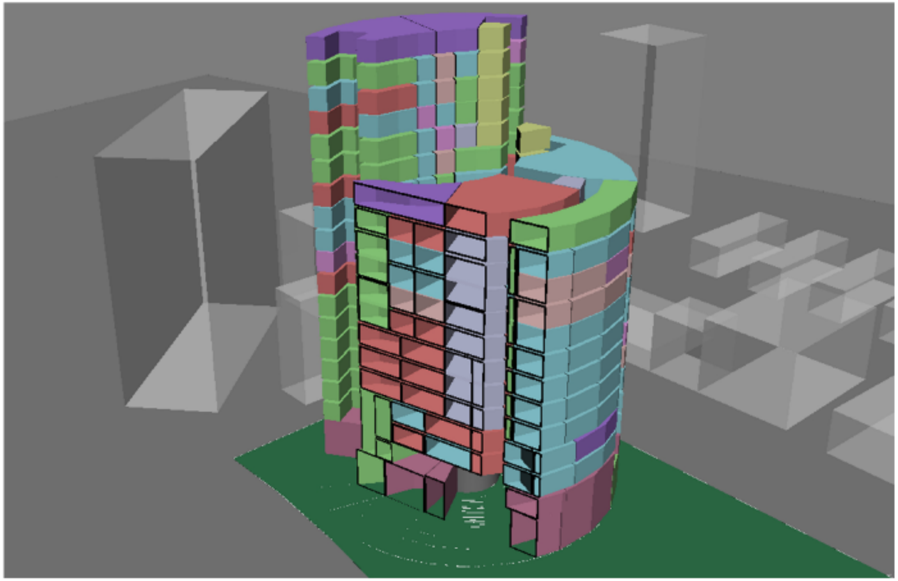
- Work Public +
- Work Public -
- Work Private +
- Work Private -
- Shared
- Live Public
- Live Private
- Green Space
- Mech. / Electrical Room



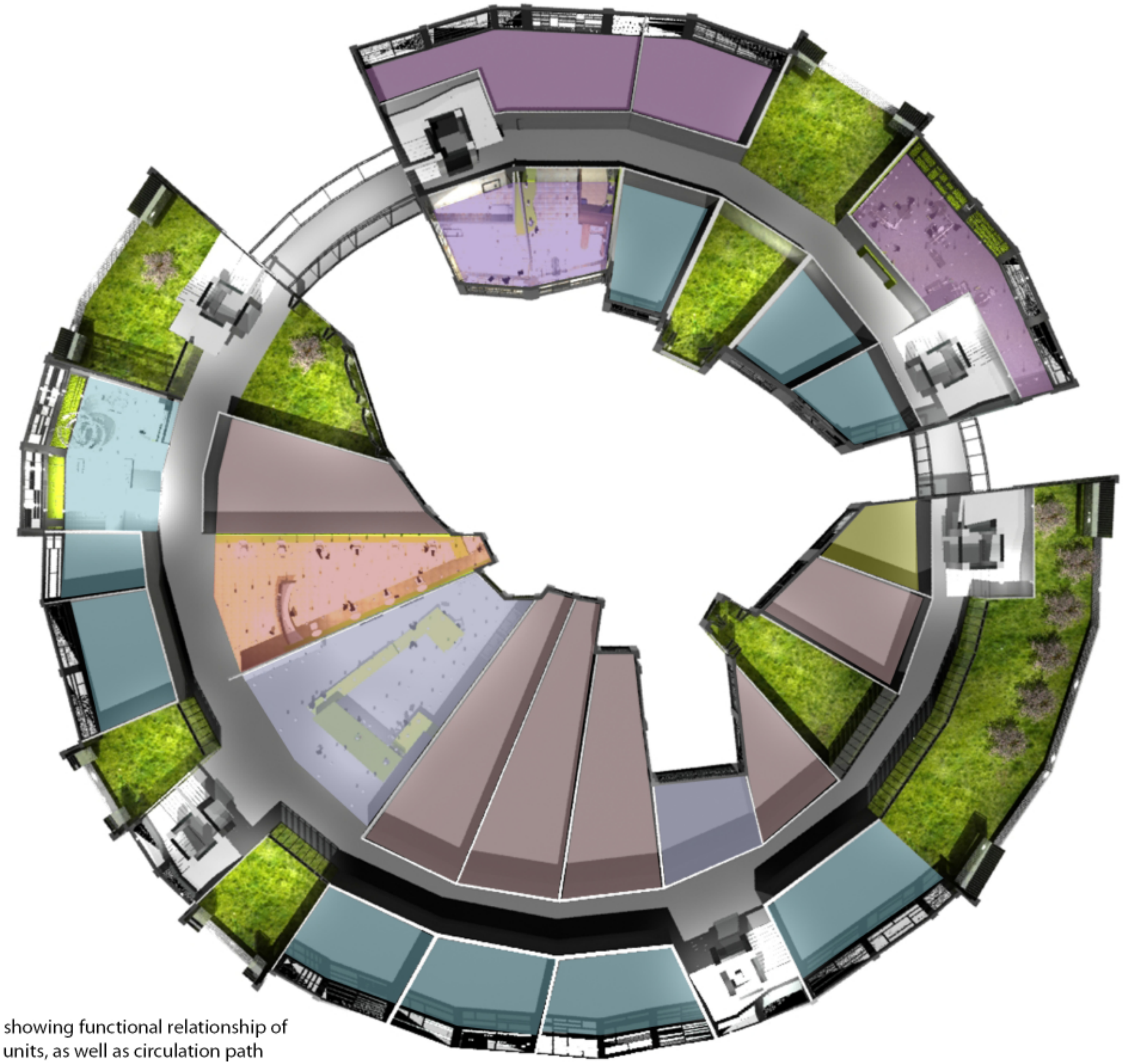
The building's program serves as a large live|work facility that ranges from public to private functions, or hybrid spaces. An open floor plan was used with utilities supplied to each unit to achieve the most flexible situation based on the user's needs and wants. There would be designated areas for each type of unit such that is shown in these floor plans, but the flexibility of the design aspect for each unit would be achieved by each user's design creativeness. Some units are connected as lofts where private living areas are connected either above or below private work areas. Hybrid units such as shared units accomodate for both live and work functions. Live Private units are designated as places where people live and Work Private areas are where people work with little to no public interaction. The work areas can range from public to private depending on the user's level of interaction with customers. Public Spaces such as Live Public Units and Green Spaces are designed to be sanctuaries for the inhabitants of the building. They maintain the ideal conditions of flexibility reminiscent of the entire building and provide several locations for users should they want a change of pace.

Individual comfort levels are achieved at a smaller scale in each unit based on shading devices and a variety of window options to attain proper air flow and sunlight. The exterior membrane of the building consists of different shaped windows that allow the user to open or close them based on the amount of air flow or direct sunlight they want to achieve. Each separate window has blinds for a simple approach to achieve the correct amount of sunlight on an open or closed window. These are depicted in the interior renderings following these pages. These interior images are also just examples of designs user's may create.

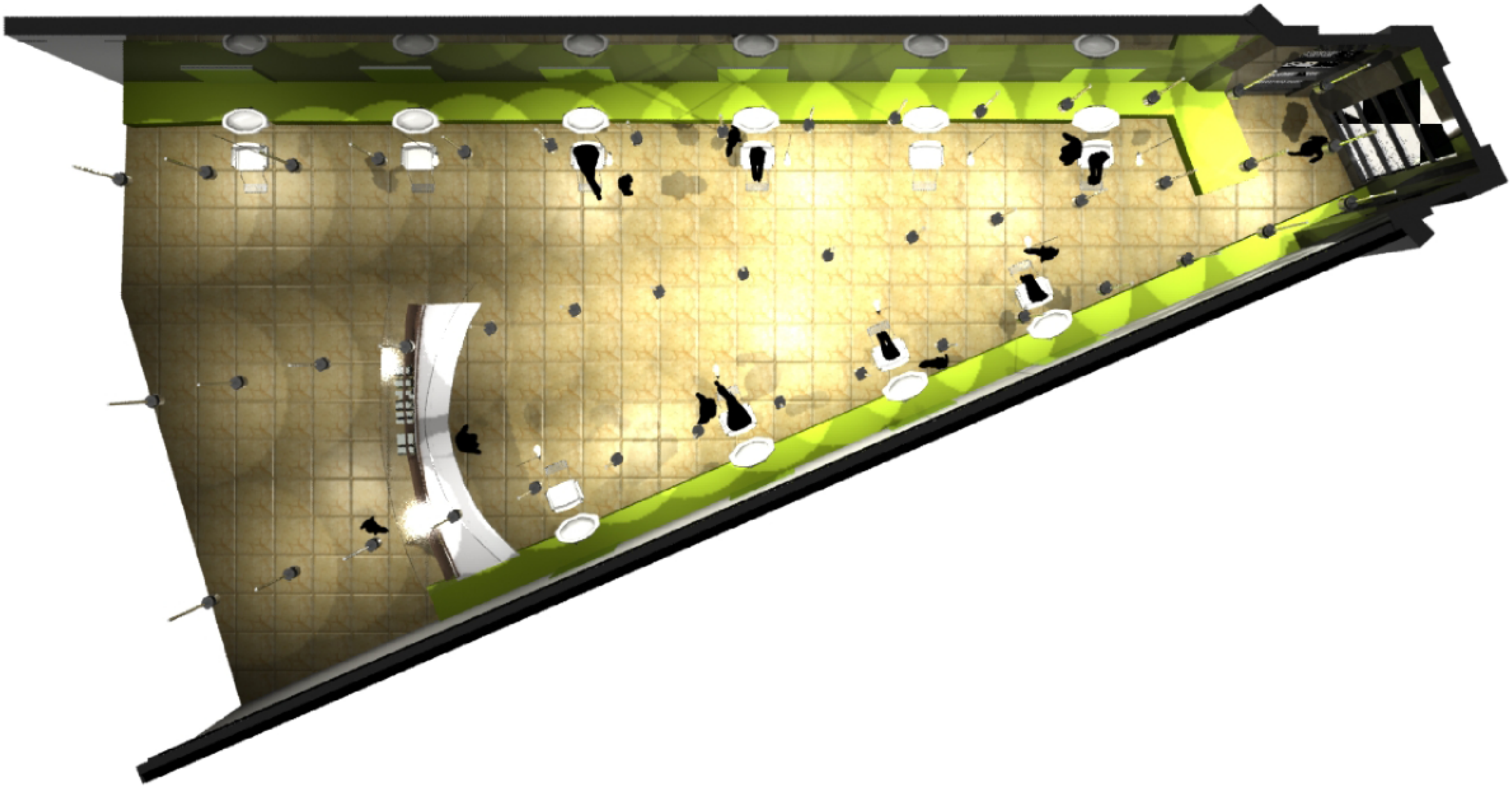




Axonometric Sections earlier in development phase
showing the relationship of Live|Work functions

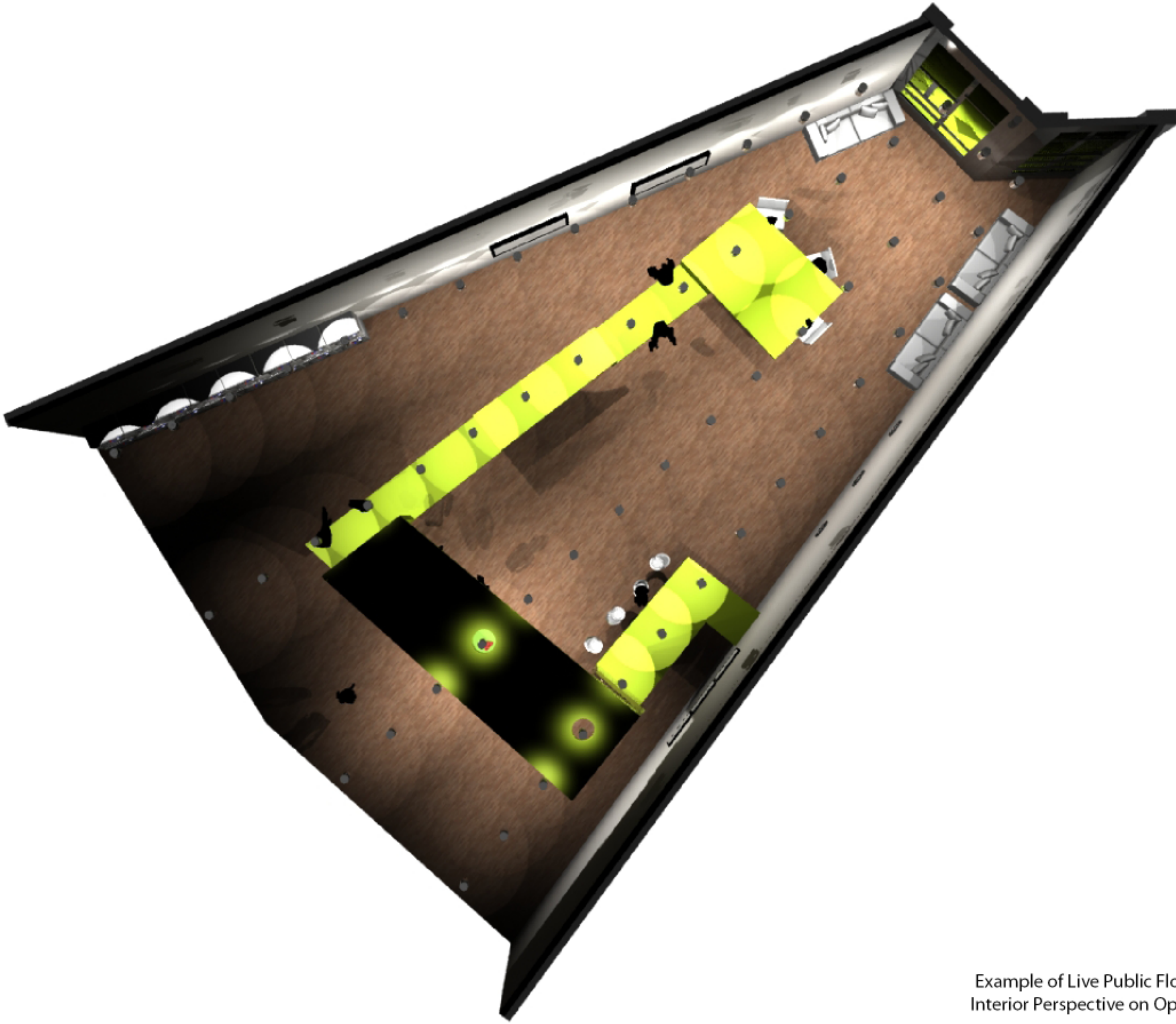


Detailed Floor Plan showing functional relationship of different Live|Work units, as well as circulation path



Example of Work Public Floor Plan and
Interior Perspective on Opposite Page

099



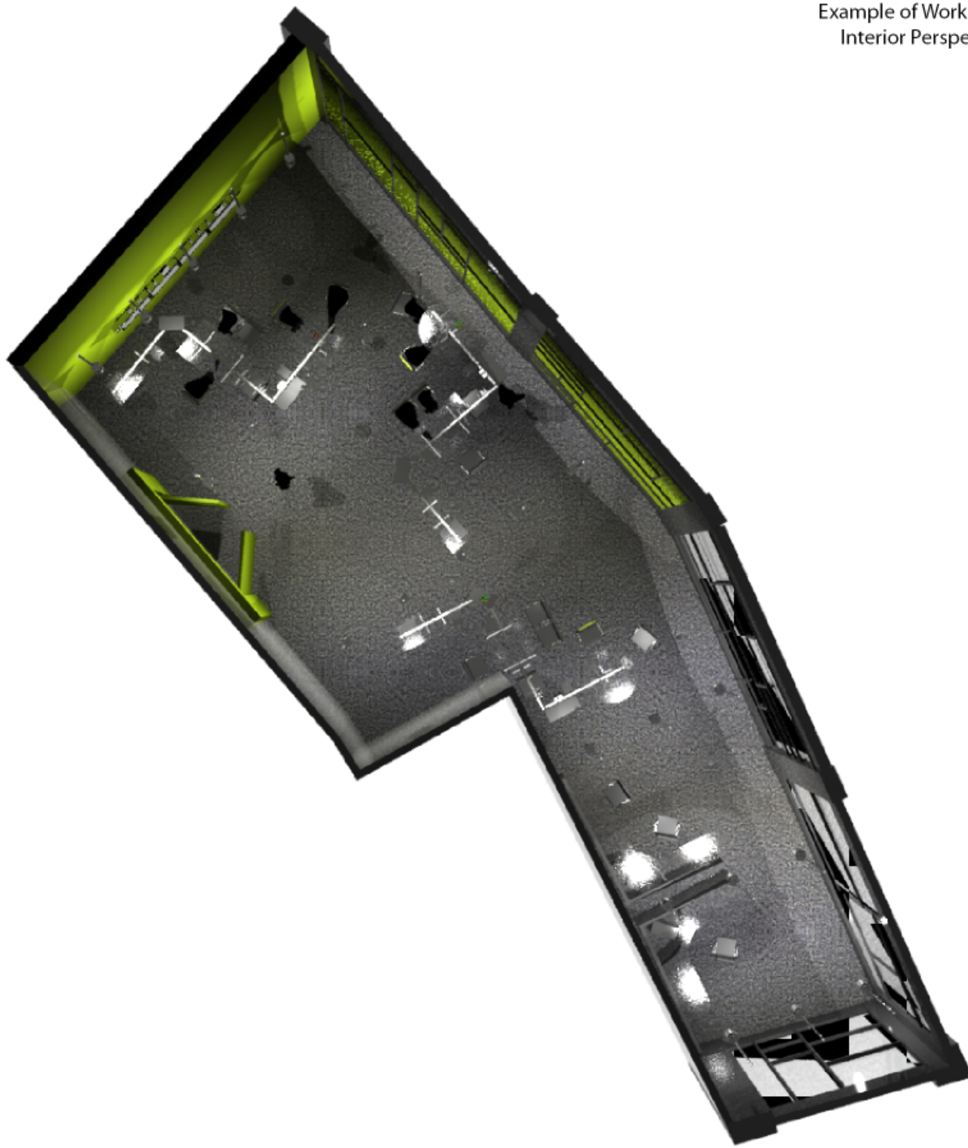
Example of Live Public Floor Plan and
Interior Perspective on Opposite Page


101

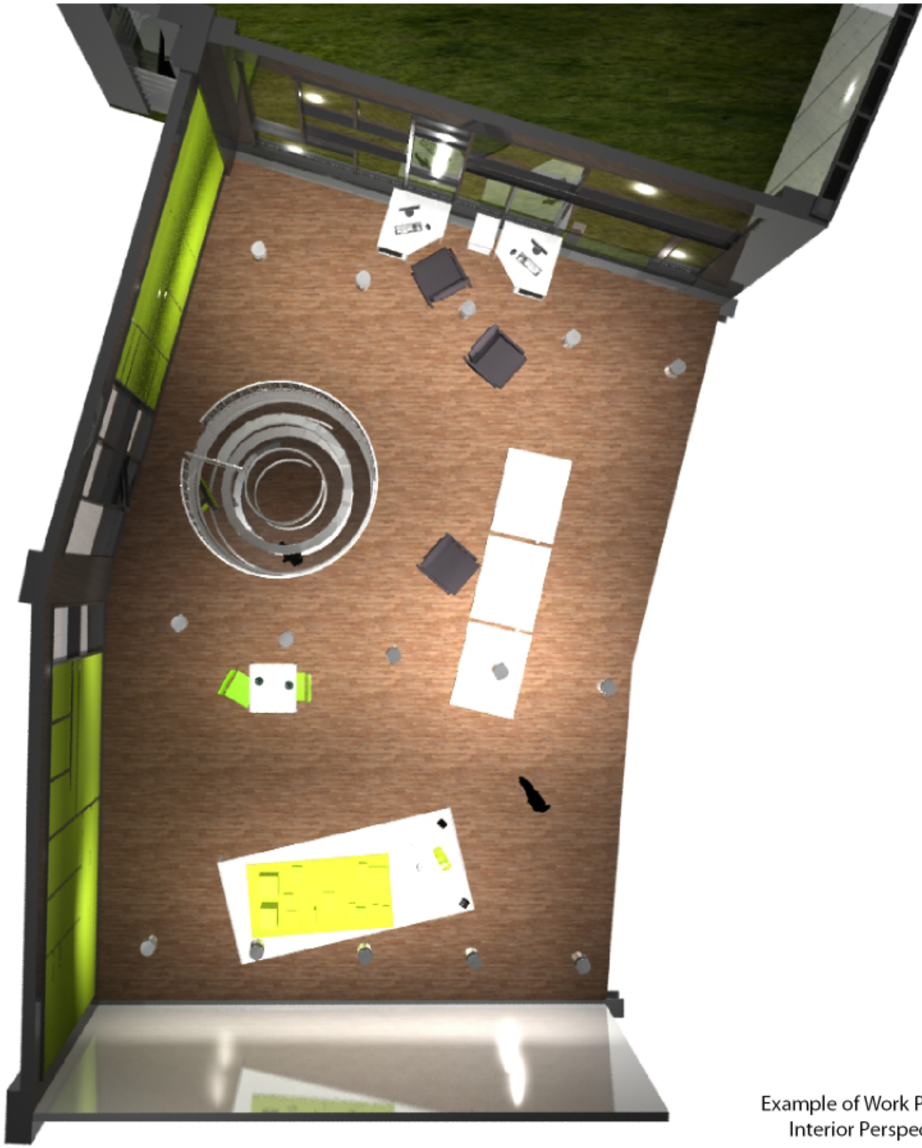
Example of Shared Live|Work Floor Plan and
Interior Perspective on Opposite Page


103

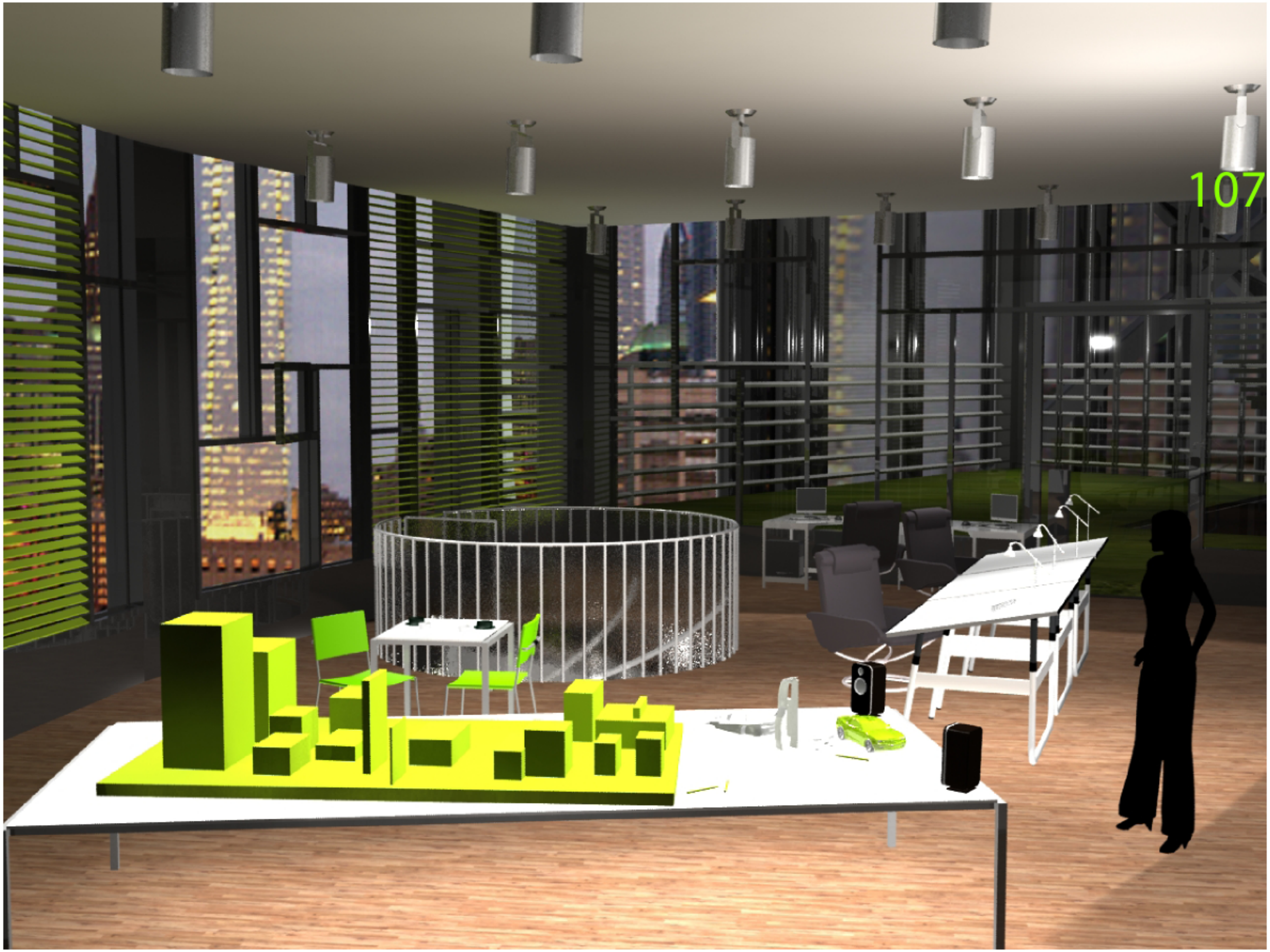
Example of Work Private - Floor Plan and
Interior Perspective on Opposite Page

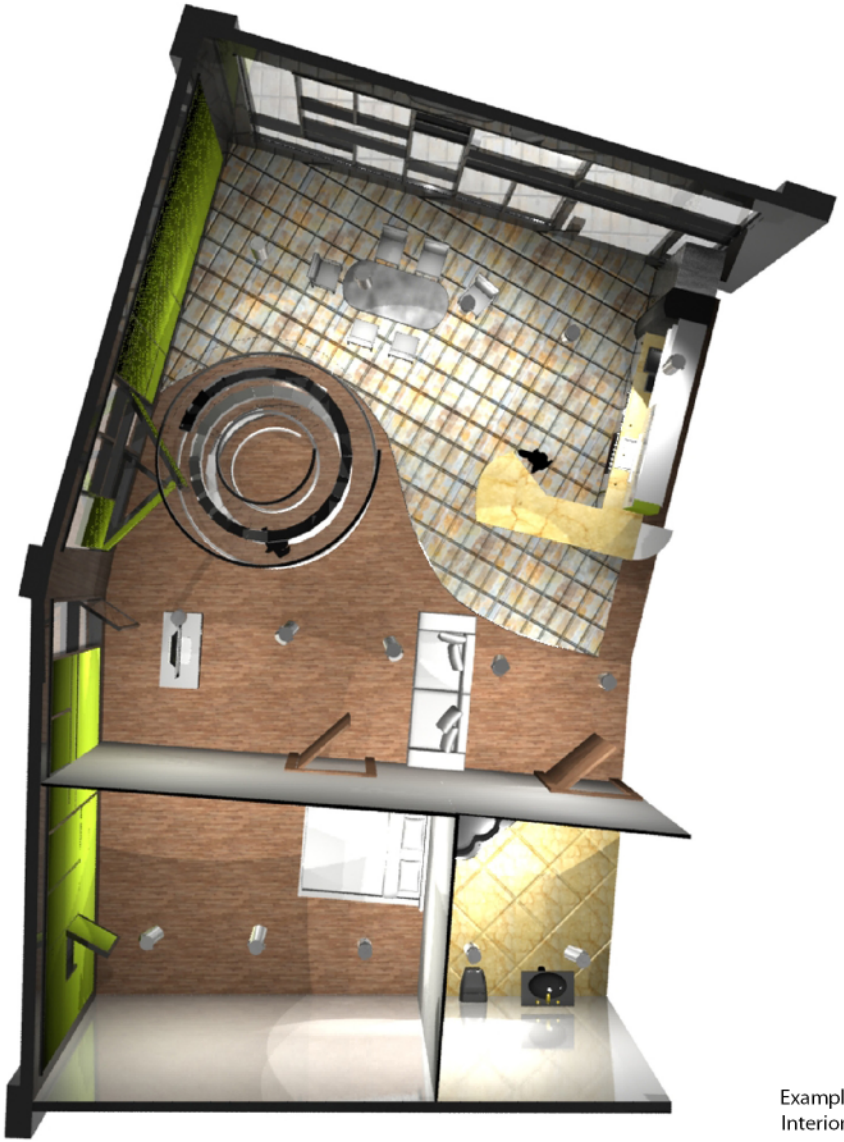



DIGITAL STUDIOS, INC.



Example of Work Private + Floor Plan and
Interior Perspective on Opposite Page





Example of Live Private Floor Plan and
Interior Perspective on Opposite Page

Conclusion Statement

This concludes the thesis design currently. It shows how a building can be the mechanism which transforms around its individual users, as well as a collective. It achieves this by responding automatically based on external circumstances or through the individual choices of its users. Architecture has evolved to the point where it can perform flexibly and more directly to its users, which is the direction this thesis wanted to explore and at least enlighten others to think the same. Obviously at this time the architectural response could not be built economically, but it should suggest a higher level of thinking for architecture today and what it could potentially become in the future. There are still many questions unanswered because of the shear size and complexity of the thesis, but these are relevant issues that should be considered for every building to achieve a higher level of flexibility. This higher level of flexibility would allow an architecture that responds more intimately to time, the environment, and its occupants. Taking pure ideas from nature and through the implementation of ongoing advancements in technology, architecture can and will reach unprecedented abilities to transform; it's just a matter of time and design creativeness...

Special Thanks to
My friends, family, and creative thinkers esspecially
Daniel, Vera, James, David, Sara, Will, John, Mark, Karen, Dan, Stephen, Brandon, Brian, and Cookie Monster

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-Demonstrated the effectiveness of the BedZED facilities and provided information about their design and use.

Braziller, George. Immaterial|Ultramaterial: Architecture, design, and materials. Hong Kong, 2002.

-Various authors, designers, and architects discuss the use of revolutionary materials and fabrication methods and their effects on architecture and its future. It discusses the use of essentially invincible materials, known as ultramaterials and fantasizes a near future with them.

Brownell, Blaine. Transmaterial 2: A Catalog of Materials That Redefine Our Physical Environment. New York: Princeton Architectural Press, 2008.

-This book is a listing of new, innovative materials and fabrications that have the potential to change architectural and interior design.

Dellinger, Dan. Wind – Average Wind Speed (MPH), 2009, NCDC, 12 January. 2010 <http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html>

-Included data for wind speeds in Philadelphia and other cities.

Fisher, David. Dynamic Tower by David Fisher, 2009, Rotating Tower Dubai Development Ltd, 14 December. 2009 <http://www.dynamicarchitecture.net/home.html>

-This website demonstrated and explained David Fisher's patented Dynamic Tower, displaying its unique personal capabilities and economic design.

Henry Ford Museum. Dymaxiom House, 2009, The Henry Ford, 23 February. 2010 <http://www.hfmgv.org/museum/dymaxion.aspx>

-Provided Information about the Richard Buckminster Fuller's Dymaxiom Houses.

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

-James Timberlake and Stephen Kieran discuss the manufacturing methods comparing them to boat, airplane, and car design and emphasize the mass-customization qualities architecture has the ability to create. Assembly and design is envisioned as one through the materialization of architecture and the master role of the architect.

Kolarevic, Branko. Architecture in the Digital Age: Design and Manufacturing. New York, New York: Spon Press, 2003.

-This book discussed the significances of changes in architecture in how buildings are conceived through advancements in technology, digitally, and manufacturing techniques.

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-This book discussed the way space is interpreted through advancements in technology and the ongoing effects of the rapidly growing virtual and digital world. It also explains the ideas of the user acting in a network connected with other users as a networking hub.

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-Malcolm McCullough discusses the seamless integration of digital technology into our everyday lives and connects that to a cultural-appropriate setting.

Mitchell, William J. City of Bits: Space, Place, and the Infobahn. Cambridge, Massachusetts: The MIT Press, 1995.

-William Mitchell discusses the revolution of digital telecommunications in an architectural and urban context as it connects into an information age.

Mitchell, William J. E-Topia: "Urban Life, Jim—But Not As We Know It." Cambridge, Massachusetts: The MIT Press, 1999.

-William Mitchell discusses the future of daily life within the digital era. Live/work dwelling is discussed as the major type of future dwelling.

Mitchell, William J. Me++: The Cyborg Self and the Networked City. Cambridge, Massachusetts: The MIT Press, 2003.

-In this book, William Mitchell discusses how technology has become an appendage to our physical, mental, and psychology beings. He explains the need to change in order to reconstruct our environment to fit within this new context.

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Phaidon Press LTD. 10X10_2. New York, New York: Phaidon Press Inc., 2005.

-Provided design and research stimulation based on precedent and analysis.

Phaidon Press LTD. 10X10/3. New York, New York: Phaidon Press Inc., 2009.

-Provided design and research stimulation based on precedent and analysis.

Sakamoto, Tomoko. From Control to Design: Parametric/Algorithmic Architecture. New York, New York: Ingoprint SL, 2007.

-This book provided analysis of examples where parametric and algorithmic design techniques were used by interpreting once unconceivable forms to now be realized. It briefly discusses the effects of these techniques and how they can influence the future of architecture.

Travi, Valerio. Advanced Technologies: Building in the Computer Age. Basel; Boston; Berlin: Birkhauser, 2001.

-Provided insight on precedents and discussed the integration of computers and advanced technologies in buildings and how they collaborate with users.

The International BMW Website. Joy is BMW, 2009, BMW, 17 December. 2009 <http://www.bmw.com/com/en/insights/technology/joy/bmw_joy.html>

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-Provided wind data for Philadelphia, PA and other cities.

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-Provided information on the Elephant and Castle Eco Tower for the precedent.

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-Provided Temperature and Precipitation data for Philadelphia, PA and other cities.

Worrell Water and Living Machine. Living Machine >> About, 2003, Worrell Water Technologies, LC, 17 December. 2009 <http://www.livingmachines.com/about/>

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