WELLNESS THROUGH ADAPTIVE REUSE

ALA MASTER'S THESIS
NORTH DAKOTA STATE UNIVERSITY

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SIGNATURE PAGE

LINKING ADAPTIVE REUSE STRATEGIES WITH THE WELL BUILDING STANDARD TO IMPROVE BUILDING QUALITY FOR HUMAN WELLNESS

A Design Thesis Submitted to the Department
of Architecture and Landscape Architecture
of North Dakota State University.

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Primary Thesis Advisor   Date

Thesis Committee Chair   Date

TABLE OF CONTENTS

TABLES AND FIGURES

TABLES AND FIGURES

Figure 1

ABSTRACT

The International Existing Building Code (IEBC) was first created alongside the International Building Code (IBC) in 1997 to address health and safety concerns in the built environment based upon prescriptive and performance related requirements. Used as a base code standard by most of the United States, the IEBC ensures that existing buildings that are being altered in some significant way are safe and accessible for all occupants. However, little consideration is given to the effects that the built environment has on human wellness in its entirety. Physical and mental wellness are essential aspects of a healthy lifestyle and are even more important in the development of youth. With that, can the IEBC be supplemented by an additional set of design standards which have been created to promote human wellness?

NARRATIVE

The research of the connections between adaptive reuse and the WELL building standards has a Positivist philosophical framework due to the objective nature of the studies that will be conducted. These studies will aim to collect measurable data of the built environment, compare it to the set of standards by the WELL building council, and make design suggestions on ways to meet these standards. The studies assume an objective reality based on the built environment and the specifications indicated in the WELL building standards. They will also provide a clear set of findings through measurable data.

An immense amount of quantitative and qualitative research must be done in order to verify quality standards within this system of inquiry. Internal Validity will be proven by the data provided by the software used, which is specifically designed for this kind of research. External validity can only be verified if the findings from this research are applicable outside the context of this study. The research that will be done in this project will be conducted abstractly, so the findings should be applicable in any situation. Reliability of the data collected is essential, so multiple studies shall be conducted in order to verify consistency. And overall, credibility can be ensured by cross checking all the findings from this study with the data that was collected.

This project aims to find ways to make the design of adaptive reuse projects better for human wellness by investigating current adaptive reuse techniques and comparing them to the standards established by the WELL building council. These measurements and comparisons will be used to create an inventory of design strategies that will be recorded and tested throughout the research and design process. This inventory will subjugate future design actions and produce new, recycled spaces that are full of life and are beneficial for the human condition.

Across the United States, there are a massive amount of spaces that are being vacated and have been left sitting empty due to changes in the market and professional trends. As a result, buildings with an enormous amount of embodied energy are either being destroyed to clear space for a new development, or they are being renovated using common standards. The WELL Building standard would be able to provide supplemental recommendations to designers to guide them to create adaptive reuse projects which will surpass IEBC's standards regarding human wellness.

The overall audience for this project is the architects of tomorrow who aim to create more sustainable, energetic, inviting environments in their future renovation projects. The immediate audience will be my classmates, instructors, colleagues, and local architects and other professionals who view the thesis projects. I'd like to publish my findings so that any designer can benefit from them.

With the number of vacant buildings in the United States on the rise, my aim is to inspire project owners and designers to reuse more of them instead of opting for new construction, and to ensure that these new recycled spaces promote human wellness.

PROJECT TYPOLOGY

PROJECT TYPOLOGY

Business incubators are spaces designed to help new and startup companies to develop by providing services such as management training or office space. These spaces could be supported by general office spaces for local professionals with an invested interested such as city officials or school administrators who could help facilitate the incubator program. The goal is to create a stimulating work environment for young adults & professionals that is focused on promoting health and wellness, enhancing productivity, and optimizing efficiency in a safe and engaging place. This typology has been chosen for the following reasons:

- The site lacks this kind of space and the benefits from a business incubator and new work space for the city would be felt community- wide
- Creating business incubators for young adults provides an alternative to risky be havior
- This typology encourages and provides space for commerce and learning, which in turn are beneficial for health and wellness

Local profrecssionals and emerging young adults who are interested in business will have a new place to work that is optimized for wellness, productivity, and efficiency. Young adults will have the opportunity to learn about business in spaces tailored to their needs while starting a take-off company of their own. Local professionals could provide instruction for various business-related topics and sponsor the incubator program.

CASE STUDIES

1 LocHal Library

2 Hughes Warehouse

3 Higgins Hall Insertion

1 LOCHAL LIBRARY

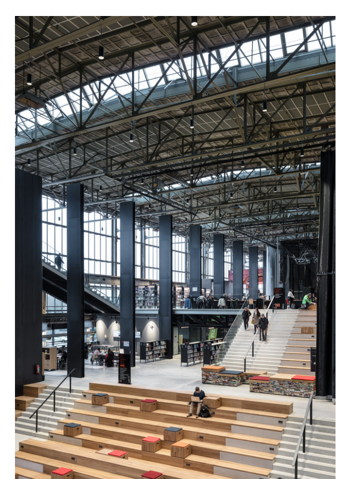


Figure 2

PROJECT INFORMATION

Figure 3

Year Built	Location	Architect	Typology	Ft^2
2019	Tillburg, Netherlands	Civic Architects	Library	36,745 SF

PROGRAM ELEMENTS

- Entrance Hall
- Library Stacks
- Coffee Kiosk
- Conference Rooms
- Exhibition Space
- Children's Area
- Administrative Space
- Seating Areas
- Multifunctional Space

Overview

The LocHal Library is an adaptive reuse project resulting from the conversion of the old Tillburg rail house into an interactive public library that is focused on providing opportunities for the creation of new knowledge. It is a massive volume that houses a variety of spaces that offer visitors the chance to engage with one another, study quietly in comfort, and work on their own personal projects.

The original building constructed in 1932 was used as a locomotive shed. For nearly 80 it served this purpose until being vacated by its tenants. The city obtained the property and held a public bid for a new library. Instead of destroying it, Civic Architects saw the value in the locomotive hall (LocHal), and designed a library and event center that would reuse the structure and implement new finishes and interior partitions. They won the bid, and collaborated with Braaksma & Roos, Inside Outside, and Mecanoo to create an exciting new civic building in the heart of the city. It has been described by locals as "Tillburg's new living room." The design and functionality of LocHal has set a new standard in the world of adaptive reuse.

Figure 4

PROJECT EFFECTS

Environmental

The former use of the LocHal was an industrial storage facility for locomotives before it went vacant. The adaptive reuse of the project has brought new life to its context and removed a significant amount of pollution and hazardous materials from the site.

Social

The city of Tillburg has benefitted immensely from the implementation of the LocHal. It is in the heart of the city and situated directly next to the train station. The Library is open to the public, and has regular community events that attract many locals.

Cultural

LocHal is the home of two cultural institutions in the city of Tillburg, Kunstloc and Brabant C. These two groups are active in the community, promoting arts and culture as well as staging these kinds of events for the public.

DESIGN PRINCIPLES

Massing

One rectilinear mass makes up the entirety of the LocHal, with small subtractions removed from the sides and ends. This provided the original designers a large, open space that could contain large operations. It provided Civic Architects a virtually blank template for adaptive reuse.

Geometry

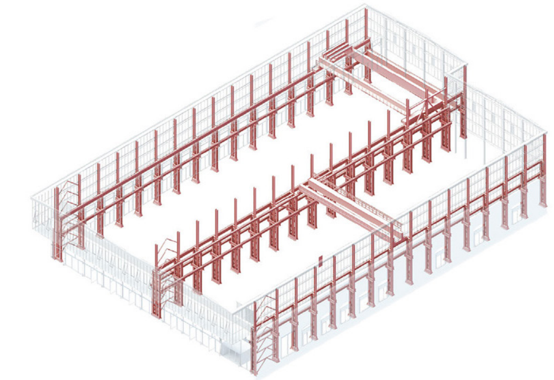
The LocHal building is almost completely orthogonal, with the exception of the stairs, skylights, movable partitions, and furnishings. The dimensions of the volume are 60m x 90m x 15m. Its height is half of its width, and its width is 2/3rds of its length.

Hierarchy

The Lochal has a few different levels of hierarchy. On the exterior, the building is divided in two with the upper levels cantilevering over a colonnade. On the interior, the building has four floors. Changes in materials and function between the floors create another level of hierarchy.

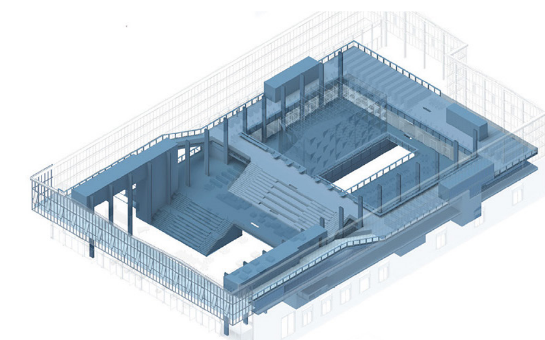
Structure

The 60m x 90m footprint of the building yields a simple structural plan for the building, consisting of three rows of steel colums that support the roof, which is made up of steel web joists that span 30 meters each. Very few additional structural elements were necessary for the adaptive reuse.



Circulation

The LocHal utilizes an open plan, with spaces intermingling everywhere. Occupants have the freedom to move about the entire space, and can even create spaces by moving the hanging fabric partitions.



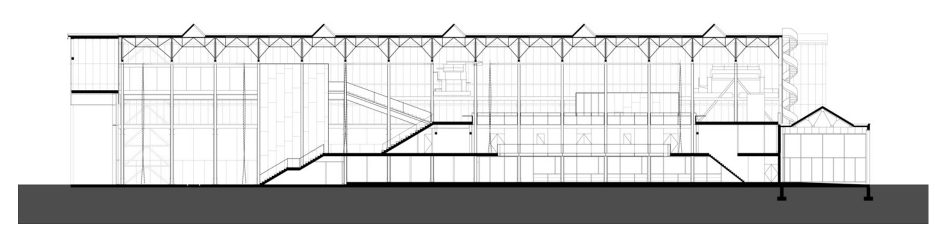
Figures 5&6

Envelope

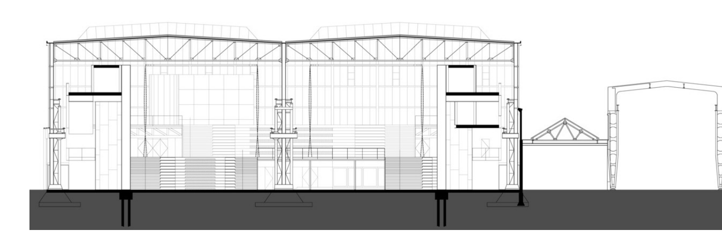
The building envelope is almost completely made out of glass and steel, though a small section of the walls are made of brick. The walls are hung from the steel structure of the building. The large amount of glass provides great views and large amounts of daylight, but it also allows heat in and out of the building easily and increases the chances of infiltration.

Natural Light

Since the envelope of LocHal is almsot completely glass, the building receicves vast amounts of daylight. the dynamic interconnection of spaces within the building creates a playground for the light to bounce around and allows light to penetrate into places that a more divided plan would not allow.



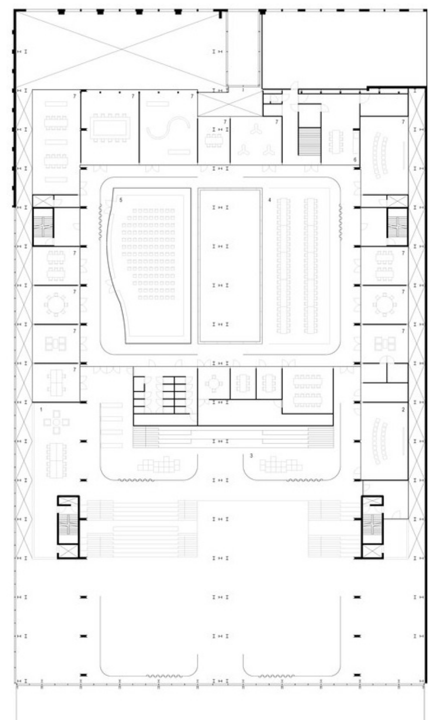
Longitudinal Section



Cross Section

Figures 7&8

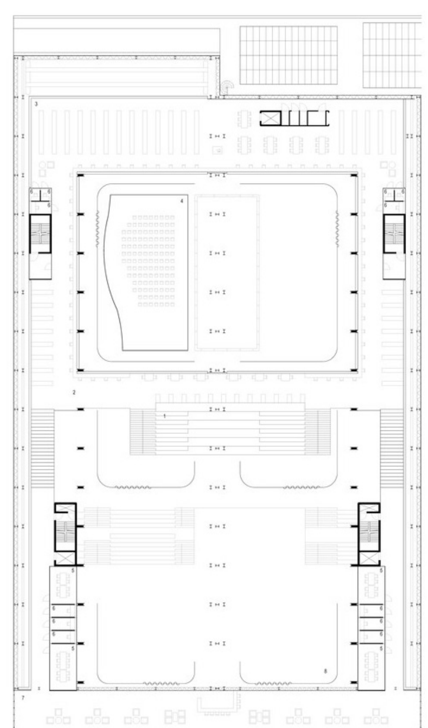
Ground Level



1st Level

Spatial Arrangement

LocHal library has a very open plan that extends to all four levels. The main library stacks are kept on the ground, first, and second levels. Reading and Study areas surround the exterior of the building, with the exhibition spaces and lecture rooms locat-ed in the center. The open envi-ronment is able to accomodate multiple different functions while retaining the character of the building.



2nd & 3rd Levels

Figures 9-11

Figure 12

CONCLUSION

Of all the case studies, LocHal is the best example of an unused building being converted into an attractive new space for the public. The build-ing itself has an important industrial history in the city and the architecture expresses it.

Civic's design considerations were centered on the user experience. The space is designed to be flexible, and to provide a level of adaptability for different functions. Movable furnishings and partitions allow spaces to be adjusted at ease. Six movable textile screens can be used to divide the open space into zones. The screens improve acoustic within each zone and create intimate spaces within the massive volume. Steel curtain walls cover most of the exterior of the building and provide exceptional views of the city and provide generous amounts of daylight to flood the building. The occupants are encouraged to feel at home and to make the space their own. LocHal is a model for an environment that promotes human wellness.

2 HUGHES WAREHOUSE

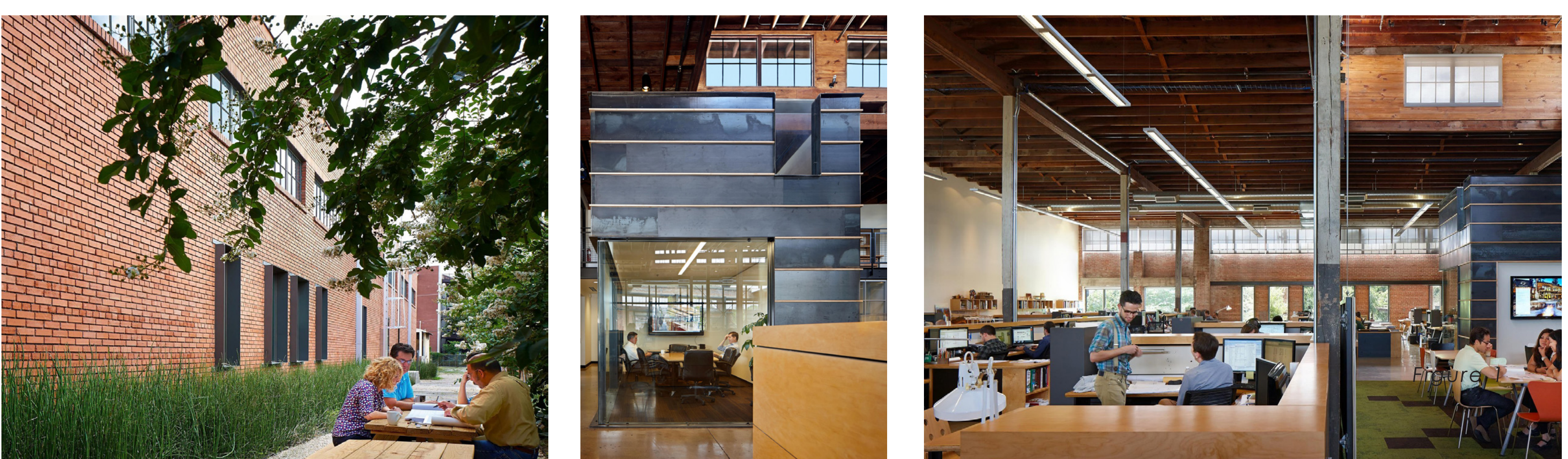


Figure 13

PROJECT INFORMATION

Figure 14

Year Built	Location	Architect	Typology	Ft²
2012	San Antonio, United States	Overland Partners	Office	22,800 SF

PROGRAM ELEMENTS

- Open Office Space
- Conference Rooms
- Work Rooms
- Lobby
- Reception Area
- Break Room
- Collaborative Areas
- Workshop
- Leaseable Space

Overview

The Hughes Warehouse Building had been sitting vacant for a number of years and had fallen into an awful state of disrepair before Overland Partners interveined. Hired by a local developr who had acquired the property, Overland redesigned the Hughes Warehouse to create a bigger office for themselves alongside rentable space for other tenants.

The original building was construced in 1918 and functioned as a storage and distribution center for the Hughes Plumbing Company for several years before being vacated. The adaptive reuse of the building has reinvigorated the area, and even provided a new community space with the addition of a courtyard on the south side of the building. It's energy efficient, with rooftop photovaultaics providing nearly 50% of the building's electricity. Overland Partners sought to preserve the industrial integrity of the building while modernizing the systems and finishes. Materials were salvaged and reused wherever possible. The project has brought new life to the neighborhood and has inspired other architects to look to adaptive reuse as an attractive design option.

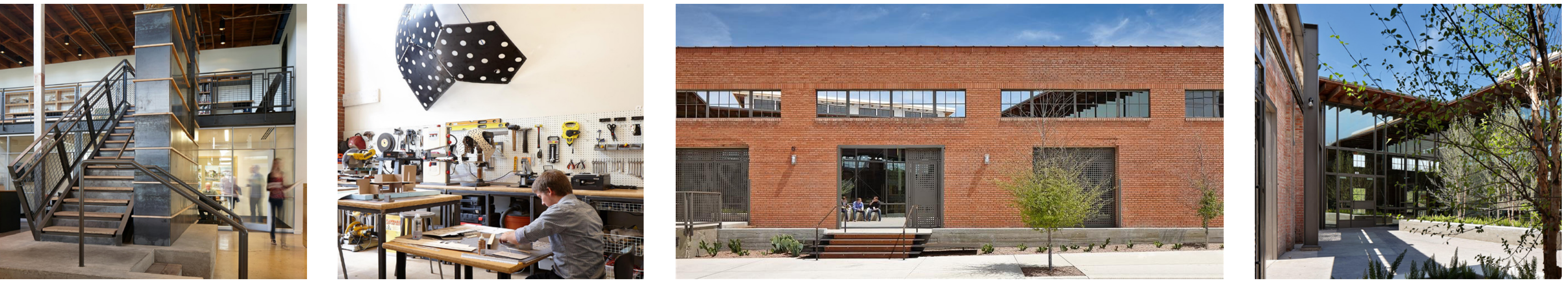


Figure 15

PROJECT EFFECTS

Environmental

The adaptive reuse of the Hughes warehouse building saved a substantial amount of materials from being wasted and revitalized the surrounding area. The building itself uses several sustainable systems to cut back on energy usage, and even has its own solar array on the roof.

Social

Overland Partners is a firm based in Texas that has done work both Nationally and Internationally. Providing a better office for their employees can increase productivity and quality of work, which in turn benefits the future occupants of their designs.

Cultural

The revitalization of the Hughes warehouse was a great success for the city of San Antonio and historic preservationists everywhere. The building was built in 1918 and has been associated with the city for over 100 years.

DESIGN PRINCIPLES

Massing

The Hughes building consists of one rectiliear mass with one diagonal side, surmounted by three, much smaller rectilnear masses that are evenly spaced and portrude from the roof. The south elevation (diagonal side) has mass subtracted in the center.

Geometry

This building is orthogonal, and the south elevation which is diagonal in plan does little to diminish this. The rectilinear theme can be seen in the form, fenestration, furniture, facades, and framework of the Hughes building. Almost everything is strictly composed of 90 degree angles.

Hierarchy

The Hughes building has many layers of hierarchy. Formal hierarchy is represented by the clerestory window banks on the roof. Also, the windows are large on the bottom of the building and get smaller as the sill height increases.

Structure

The Hughes warehouse was designed using an orthoganol grid and built using heavy timber construction with exterior masonry bearing walls. The spacing of the orthogonal grid is 18'-0" x 18'-0", and the ceilings are also 18'-0" tall. The walls are self supporting, and combined with the heavy timber columns support the weight of the roof. Very few new structural members were needed for the adaptive reuse of the project. However, the courtyard has a steel frame around the exterior that supports the steel curtainwall and prevents the otherwise unsupported south wall from crumbling.

Circulation

An open plan office, the new home of Overland Partners has a very loose circulation pattern that allows free travel about the space. Nodes are formed and disbanded at random, and may occur at any place in the office.

Natural Light

A daylight autonomy study was conducted by Overland Partners on their new office space, and they found that 90% of the building area uses daylight as the dominant light source and 77% of the building area allows lights to be completely off during daylight hours (AIA).

Daylight Analysis

West Elevation

Longitudinal Section

Figures 16 -18

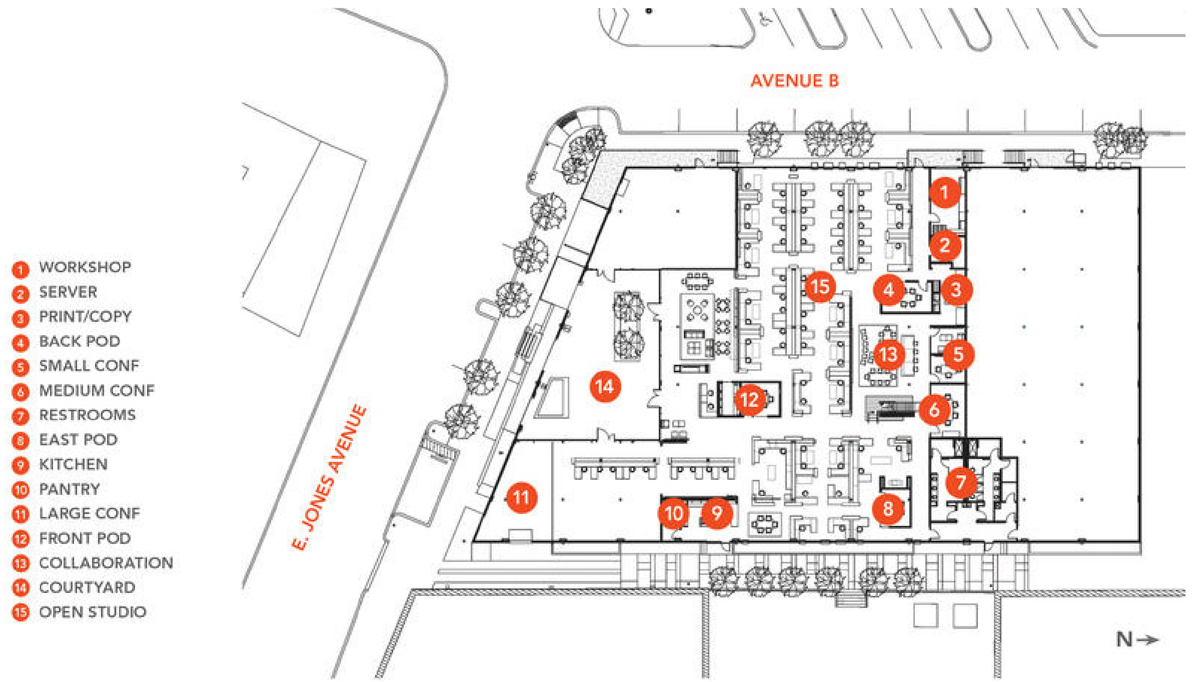


Figure 19

Spatial Arrangements

The open plan format of the Overland Partners office promotes collaboration between coworkers, and allows spaces to be changed to suit different functions if so desired. Rooms with specific functions such as the bathrooms, break room, work room, and so on are arranged around the perimeter of the building with the open office spaces in the center.

Figure 20

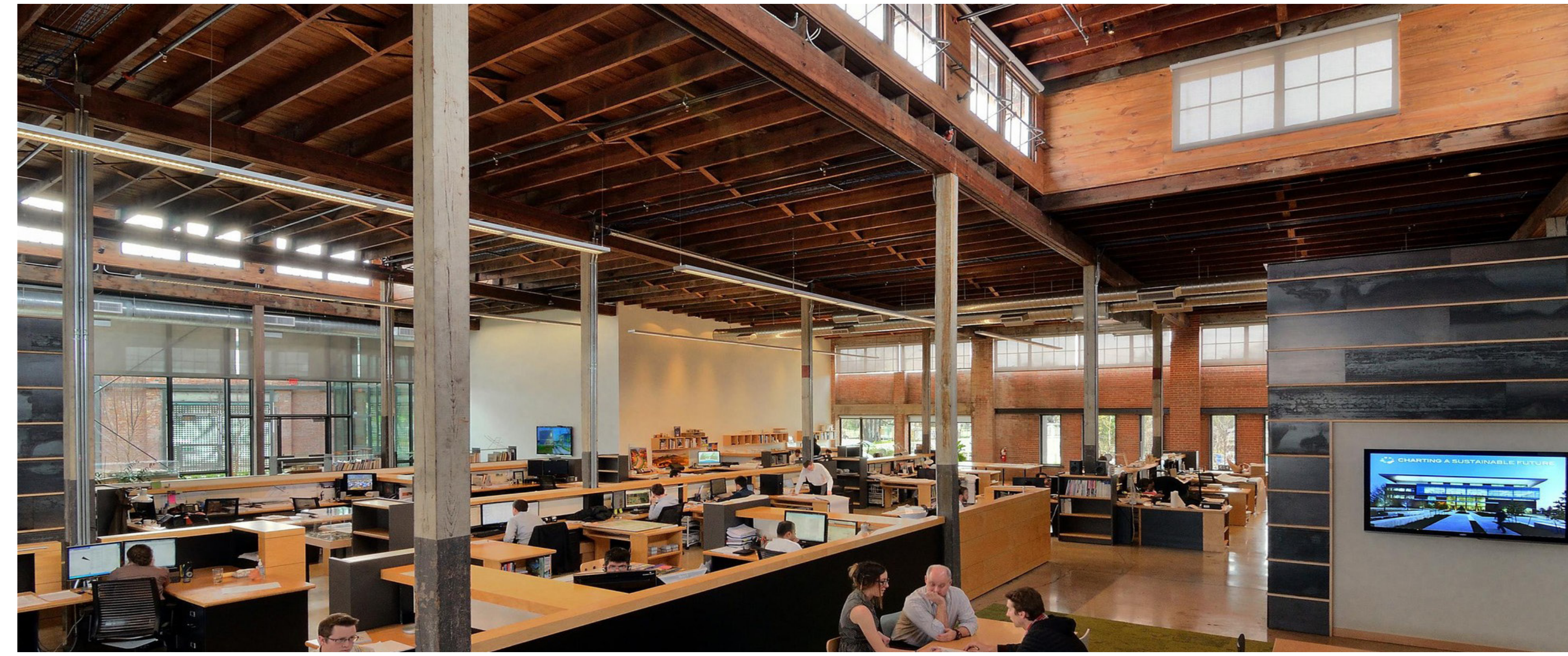


Figure 21

CONCLUSION

Similar to LocHal, The Hughes Warehouse is a historic building that has been updated and converted to fit a different function. A somewhat smaller scale and program than LocHal, designers of the project were able to focus on a more specific set of requirements.

Since the architects were designing the space for themselves, they were easily able to plan a space that would improve their work environment. Overland Partners decided to create an open plan office that would promote collaboration among coworkers and make inner office communication simple. Just like Civic Architects, Overland Partners wanted to preserve the industrial quality of the building while integrating modern features. Efficient active and passive systems have been incorporated into the building to provide sustainability and decrease utility costs. The redesign has also helped to revitalize the surrounding area in downtown San Antonio. Other businesses have since followed suit and hired firms to adaptively reuse the historic buildings of the city.

3 HIGGINS HALL INSERTION

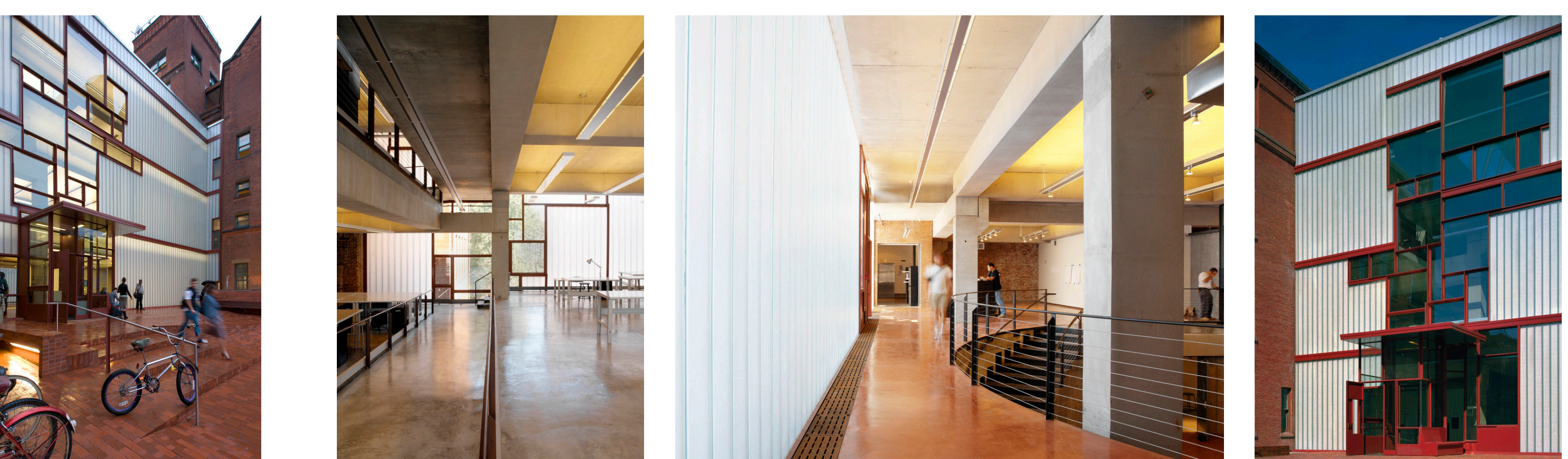


Figure 22

PROJECT INFORMATION

Figure 23

Year Built	Location	Architect	Typology	Ft^2
2005	Brooklyn, United States	Steven Holl Architects	Education	22,500 SF

PROGRAM ELEMENTS

- Vestibule
- Lobby
- Reception
- Gallery
- Lecture Hall
- Classrooms
- Studio Spaces
- Offices
- Roof Terrace

Overview

The Higgins Hall Insertion by Steven Holl Architects reconnects two historic buildings and provides and clear entry to the school of architecture at Pratt University. The misalignment of the floor plates between the two buildings inspired Holl to create a "dissonant zone" that served as the linkage between the north and south wings of Higgins Hall. Using innovative materials, the new insertion illustrates the contrast between old and new in a fascinating manner.

The original complex was built in 1868 and served as the Adelphi Academy for over 60 years. The building was donated to Pratt in 1965 by the wife of John Higgins, a local architect and graduate of the Adelphi Academy. The building was used by the University to house the department of architecture. In 1996, a fire broke out during ongoing renovation work, destroying much of the building. The institute was set back $1.5 million, and several years passed before the renovation and redesign took place. It's history in Brooklyn is extensive, and reviving the building was a great accomplishment for the city of Brooklyn.

Figure 24

PROJECT EFFECTS

Environmental

Much of the brick that was destroyed in the fire that destroyed the original Higgins Hall was salvaged and reused to construct the base for the new entrance and viewing terrace. The building benefits from daylight and uses efficient active systems for heating and cooling.

Social

The destruction of Higgins Hall by the fire in 1996 was a disaster for Pratt University. The new insertion by Holl combined with the adaptive reuse of the north and south wings by Rogers Marvel provided a new school of architecture for Pratt's students.

Cultural

The new insertion has relinked the historic north and south wings of Higgins hall, and it has changed the dynamic of its context due to its stark contrast with the surrounding buildings. Student activity has increased and the building has generated an immense amount of public interest.

DESIGN PRINCIPLES

Massing

Higgins Hall is composed of three rectilinear masses that form an 'H' in plan. The center mass is much shorter than the other two, which are equal in length but slightly different in width and height. Each mass is essentially a separate building, though they are all connected.

Geometry

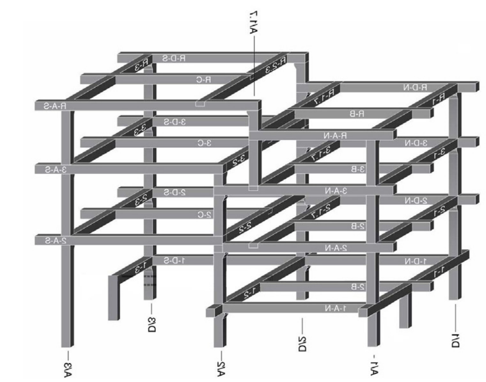
The different sections of higgins hall are all rectlinear, though the floor plats between the north and south wings do not line up. This is highlighted on the exterior of the facades of the Insertion. The overlapping geometry creates a "dissonant zone" between the buildings (Holl).

Hierarchy

Hierarchy among the masses is obvious based on the shear size of the three, but the different materials of the insertion make it prominent among the three. The insertion itself illustrates the dissonance between the two buildings and unites them in an intriguing manner.

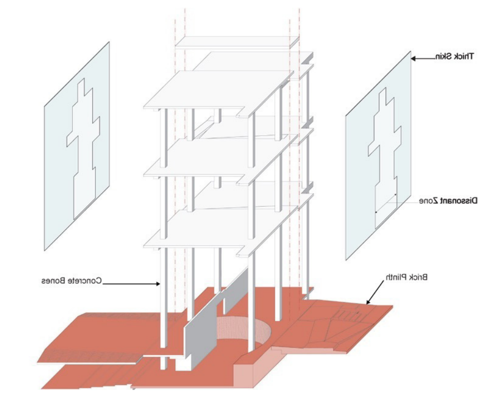
Structure

The insertion project by Steven Holl architects decided to use concrete columns and beams as the primary structure of the. Exterior walls are made of insulated glass planks that are self-supporting. The structure posed a challenge for the engineers at Robert Silman Associates due to the uneven floor plates.



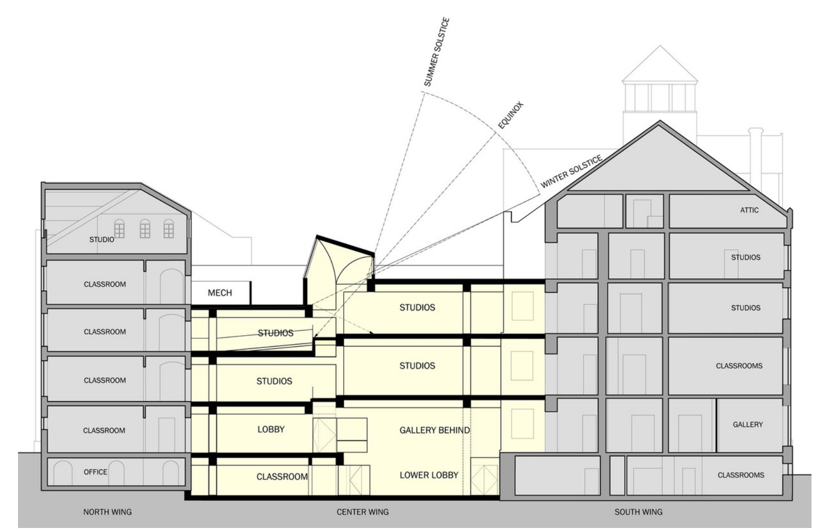
Circulation

The circulation within the Higgins Hall Insertion is interesting due to the uneven floor plates. Movement between the plates at each level is made possible by ramps. The actual stairwells are in the north and south wings of Higgins Hall, so vertical movement within the insertion is impossible.

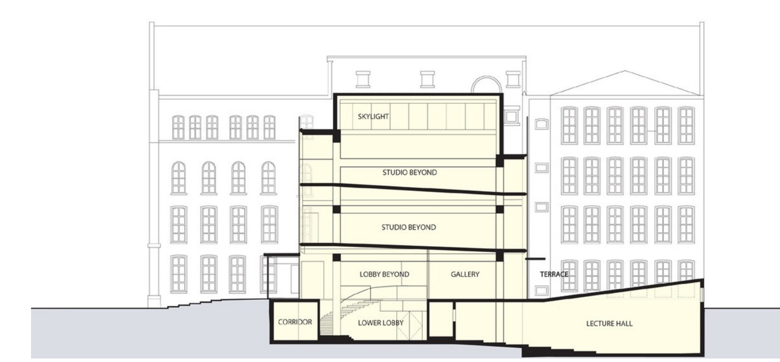


Natural Light

The walls of the new insertion project are made of insulated glass planks which are translucent, and allow soft light in and out of the building. There is also an organically patterned window bank rising from both of the entries with a massive skylight above. This all takes place at the intersection of the floor plates, allowing light to penetrate down to the ground floor.

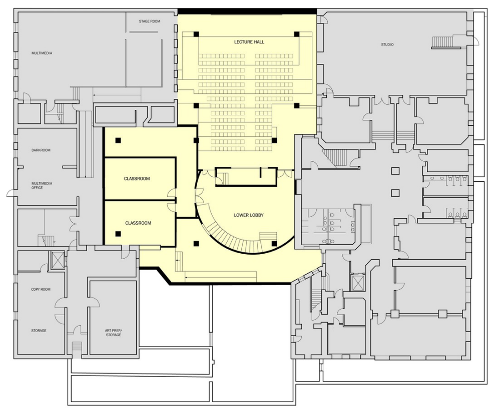


Longitudinal Section

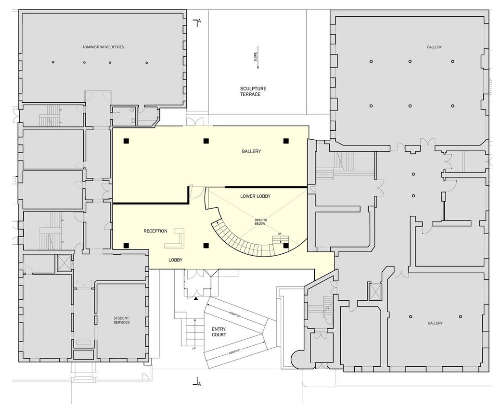


Cross Section

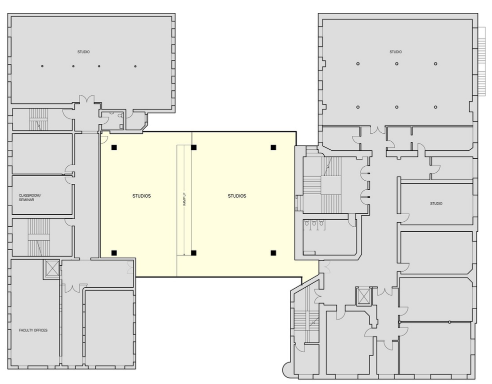
Figures 25-28



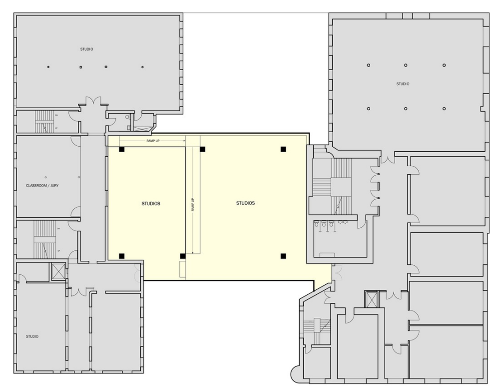
Basement



1st Level



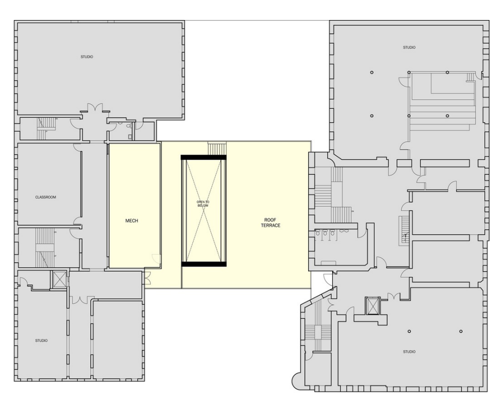
2nd Level



3rd Level

Spatial Arrangements

Classrooms and the lecture hall are housed in the basement with the first level containing the lobby and reception area as well as the gallery. The second, third, and fourth levels accomodate the studio spaces, and have an open plan. A slight disconnect is felt due to the misalignment of the floors, but it creates two separate spaces that remain connected.



4th Level

Figures 29-33

Figure 34

CONCLUSION

Unlinke the other case studies, the Higgins Hall Insertion is not an adaptive reuse project, but a new construction project that links together two important buildings on Pratt University's campus.

Steven Holl paid particularily close attention to the differences in floor height between the north and south wings of Higgins Hall. He used it as his design inspiration, evident on the exterior of the building. Holl was able to take the abstract concept of dissonance and materialize it in the form of a building.

Innovative materials are used throughout the building, including the insulated glass planks that clad the exterior. The planks are self-supporting, translucent, and provide daylight for the building. Open studio spaces allow students to work together on their designs. The differing floor plates make the transition between spaces interesting while in the dissonant zone. The insertion has reconnected the historic Higgins Hall in a way that recognizes its context and provides for its occupants.

CASE STUDY SUMMARY

Every one of the selected case studies was chosen for its relationship with adaptive reuse and its focus on the wellness of its occupants. All of the case studies revitalized buildings that had been forgotten or destroyed. Occupant wellness was a primary design concern for the designers of each project, along with preserving the identity of the building. These case studies supported the unifying idea of the project and showed how wellness through adaptive reuse can be accomplished.

Each case study had different design challenges and programmatic requirements since the typologies varied from project to project. Both the LocHal and the Hughes Warehouse were designed to express the history of the building while establishing a simple, modern environment with new systems and furnishings. The Higgings Hall Insertion unified the North and South Wings of the building and illustrated the disconnect that had taken place between them. All contributed to the revitalization of their surrounding areas by bringing new life to historic buildings. The case studies have shown that adaptive reuse provides an interesting contrast between the past history of the building and the modern redesign that is fascinating for occupants. They have also revealed strategies for adaptive reuse that can be used in simulations in the future.

LocHal, the Hughes Warehouse, and the Higgins Hall Insertion are examples of how aptive reuse projects can improve human wellness. In each scenario, the design strategies used were focused on the occupants and the context of the project.

PROJECT ELEMENTS

Offices and businesses incubators can have a variety of functions, but this speciffic project will be focused on adaptive reuse and the emotional and physical wellness of the occupants. The components to be included are as follows:

1. *Office Incubators* will provide young adults the opportunity to develop their ideas.
2. *General Office* space will allow local professional to work alongside & facilitate the incubator program.
3. *Lounge areas* will serve as public living rooms that occupants can use to converse with one another and form connections.
4. *Dining Areas* for occupants stocked with healthy foods and drinks, potentially owned and operated as an incubator.
5. *A Reception area* and *Secure Entry* allows staff to ensure student safety and monitor visitor traffic.
6. *Ancillary and Circulatory spaces* will comprise the remaining square footage of the mixed use student center.

These components will form a model work environment that will positively contribute to occupant wellness in addition to promoting community and preservation through adaptive reuse.

USER / CLIENT DESCRIPTION

1
2
3
4
5
6

Users

Young Adults
- Any student in the minot area
- Some may have additional accesibility needs
- May need secure storage area for backpacks

Local Professionals
- city officials or school administrators
- Instructors to assist students with take-off
- Investors interested in sponsoring a business

Staff
- Building administration and maintenance
- Receptionists
- Activty leader(s)

Clients

The City of Minot
- Sponsorship from the city would help fund the project and keep the city in touch with its youth.

Minot Public Schools
- The school board would oversee the adminis-tration of the facilities and promote activities for students.

Potential Private Investor/Developer
- Private developers could boost their reputa tion by sponsoring this program.

Figure 35

THE SITE

This project is to be located in a city that has plenty of buildings with potential for adaptive reuse as well as a large student population. This project seeks to improve building quality for human wellness, and to do so through the adaptive reuse of a space. The proposed model work environment would benefit the community by providing a safe and engaging environment that would offer students and professionals a place to work, learn, and develop their business-related ideas. The design will be focused on the physical and mental health of its occupants as well as providing an environement that maximizes productivity and energy efficiency.

Like many other cities across the state, Minot, North Dakota has seen most of its businesses move out the old brick buildings in the downtown area. The variety of vacant building types and sizes offers a myriad of possibilities for adaptive reuse. In addition, Minot has about 5,000 - 7,000 K-12 students in the area as well as roughly 3,000 enrolled at Minot State University. The city only has one rec center, and not many other places specifically designed for the youth.

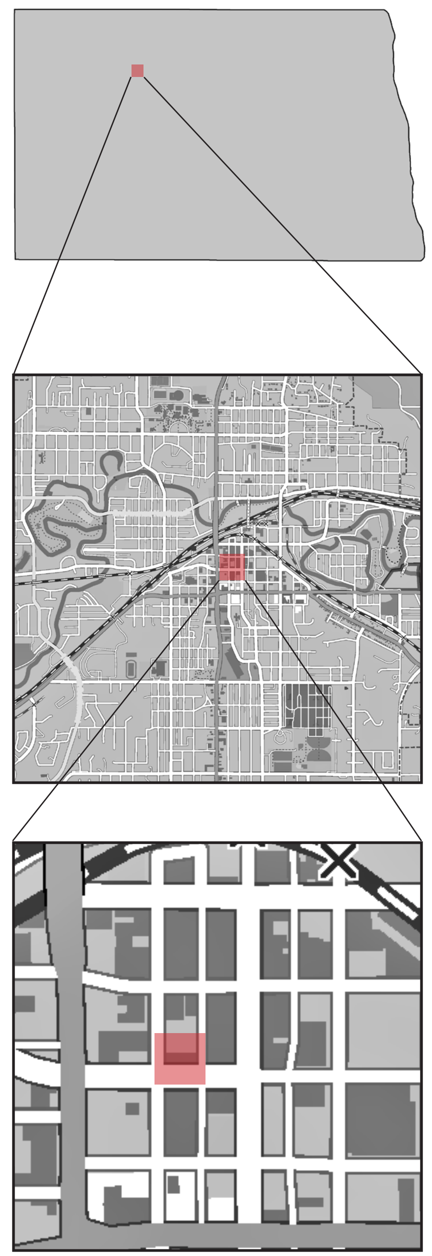
SITE MAPS

Minot is in the northwest part of the state, and typically has hot, humid summer and long winters with lots of snow. Design considerations will take into account these climate conditions.

The site is located just two blocks northwest of Minot's Central Campus, and is centrally located between the schools of the area, making it the most accessible choice for the highest number of students. This was a crucial factor in determining the location for the design.

Other properties in the area include restaurants, apartments, retails shops, pubs, banks and financial centers, museums, and an assortment of other various businesses. All of these are within walking distance of the site.

Minot, North Dakota



Figures 36-38

Figure 39

The chosen property is the former home of the Midwest Federal Savings Bank. The building on this site, known locally as "The M Building" has become a symbol in the community, as it is one of the tallest and most recognizable structures in town. The building is roughly 81,000 square feet, has an open floor plan, and an existing service core that houses most of the necessary building components such as the stairs and elevators, bathrooms, mechanical ducts, and pipe chases. The building was built in 1963 for the aforementioned client, who occupied the two lower levels and three of the eight above ground levels until it they filed for bankruptcy in 1990. A myriad of other tenants of have come and gone through the building over the years, but much of the space has been unitilized for the majority of its lifespan.

PROJECT EMPHASIS

PROJECT EMPHASIS

1 ***Establishing a linkage between adaptive reuse strategies and human wellness.***

Learn and documen the different ways that adaptive reuse strategies can influence a building's environment and in turn the wellness of its occupants.

2 ***Creating an environment that directs the youth of the community towards success.***

Propose a design intervention based on the requirements of the audience and community, with a focus on human wellness and adaptive reuse.

3 ***Integration of innovative adaptive reuse strategies to promote health and wellness in a public building.***

Incorporate the most effective adaptive reuse strategies for human wellness in the proposed design based on the results from research and simulations.

PROJECT GOALS

1 ***Create a catalog of adaptive reuse design strategies that can be used to guide others in their projects.***

Conclusions from research and simulation should be combined into an inventory that other designers can reference in their own designs.

2 ***Promote adaptive reuse and its benefits, as well as the importance of occupant wellness through design.***

Publication of this project should concentrate on the value and significance of adaptive reuse as well as the obligation for architects to design for the people.

3 ***Improve the community of Minot with a design intervention focused on emerging youth.***

A successful design intervention will provide local youth a fun and safe environment designed around their wants and needs and promoting their wellness.

PROJECT GOALS

PROCEEDING

A PLAN FOR PROCEEDING

After completing the thesis proposal, an archetypal model will be developed using Autodesk Revit and Dynamo to test various adaptive reuse strategies in an abstract setting in which the conditions and variables can be alterred and measured. The effects of adaptive reuse strategies can be tested with this model in order to find which strategies provide values that are within the WELL standard ranges. The findings from these simulations will be used to create a catalog of adaptive reuse strategies that benefit human wellness.

Next, a context model of the proposed site will be developed in order to analyze the exisitng conditions. Measurements and photos will have to be taken in order to recreate the building in a digital enviroment. Autodesk Revit will most likely be the software of choice for this process as well.

After conclusions from the simulations are drawn and the contextual model is completed, work may begin on the design solution for the adaptive reuse of the chosen site. Multiple design iterations will be created using the best strategies from the simulations. Analysis within the digital environment and using physical models and drawings will provide a clear direction for the design. Continuous research throughout the process will help create the best solution. The unifying idea will guide the design process.

As development continues, the unifying idea will start to materialize in the design. The goals of the project will become closer to being accomplished, and the connection between adaptive reuse and ther WELL standards will be visible in the design solution.

METHODOLOGY

METHODOLOGY

The research strategy for this project involves the use of literary analysis, case studies, simulations, interviews, and graphic studies. Case studies will add valuable insight into real world projects. All simulations will be done in the abstract to allow for the final design recommendations to be adaptable to almost any environment. Literary analysis and interviews will provide additional information about buildings standards, adaptive reuse design, and human wellness. And finally, graphic studies will be able to illustrate potential problems to be solved and opportunities to be embraced.

Tactics for this project differ between strategies. Case studies and literary analyses will be conducted using scholarly journals and prints, which will provide credibility to the research. Interviews will be done in person and may be recorded either via video, audio recording, or writing. Design simulations will use abstract models in Revit, Rhino, Sketchup, and other programs to measure the desired phenomena. And graphic studies will be done using digital software or by hand. These tactics will ensure that each strategy is investigated thoroughly, and that the findings of the study will meet quality standards.

DOCUMENTATION

DOCUMENTATION

Mediums:
Digital representation
Sketches
Physical models

Design Software
Autodesk Revit
Autodesk Dynamo
Autodesk AutoCAD
Trimble Sketchup
Rhinoceros 6.0

Representation Software
Adobe Photoshop
Adobe Illustrator
Adobe InDesign

Preservation
- Computer files backed up via Google Drive and external hardrive
- Thesis book updated weekly
- Advisor feedback
- Documentation of research

Publication
Hard cover book
NDSU institutional repository

FALL SEMESTER

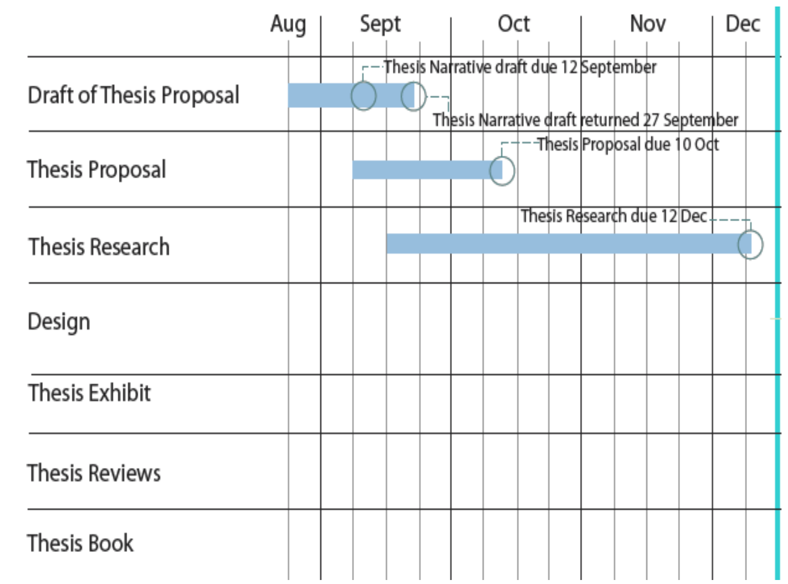


Figure 40

SPRING SEMESTER

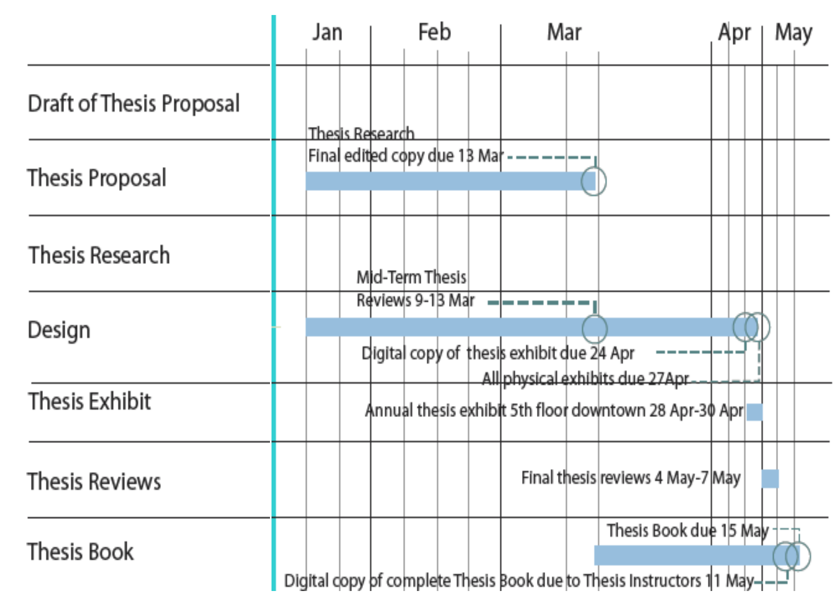
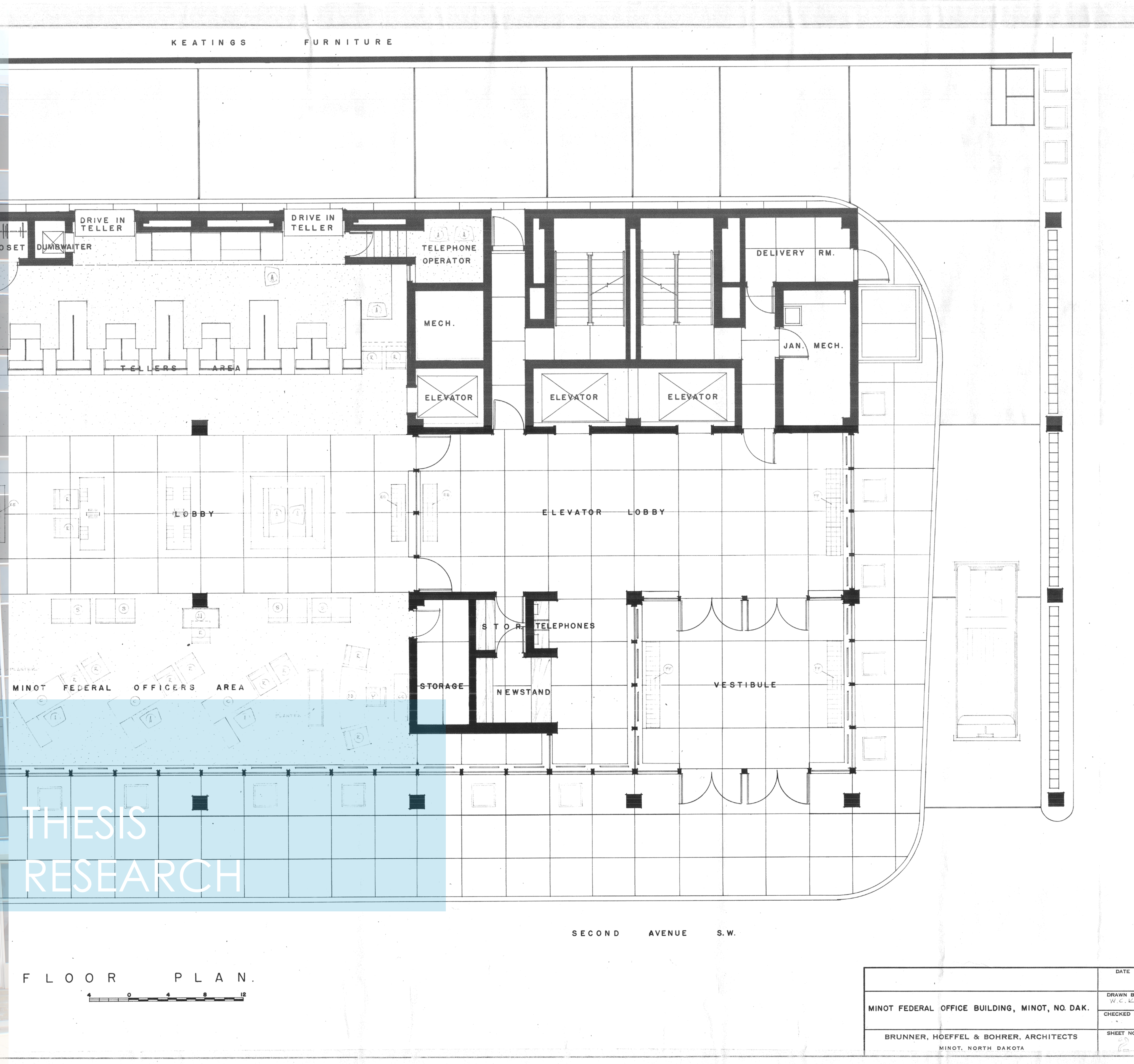


Figure 41

SCHEDULE

THESIS RESEARCH

Figure 42



BACKGROUND INFORMATION

CONTEXT

Architecture has almost always been about designing spaces for the people, but it wasn't until relatively recently in its history that thought was given to the effects that architecture has on the environment around it. Before this, the quality of architecture was judged primarily by its aesthetics and ability to function. Buildings built before the 1920's relied heavily on passive strategies for heating, cooling, ventilation, and lighting. Structures created by the Ancient Greeks used and Romans incorporated thermal mass, solar orientation, shading, and airflow into their designs, using the environment to regulate the level of comfort.

Design continued this way until the dawn of the industrial revolution made it easy for buildings to grow beyond traditional constraints. Inventions such as structural steel, the elevator, the combustion engine, and electricity all made construction cheap, quick, and profitable. These benefits came at the cost of heavy amounts of carbon being released into the atmosphere, the effects of which were unbeknownst to the people of the time. However, most of these buildings still relied almost entirely on passive strategies until the turn of the century, meaning that most of these buildings' carbon footprints were attributed to their construction.

Moving into the twentieth-century, growth continued with the advance of technology. The widespread use of mechanical HVAC systems, structural steel, electric fluourescent lighting, and aluminum framed glazing systems removed many of the restrictions architectures were previously faced with. Floor plates could now be deeper, windows could now be sealed, and buildings could rise much taller than before; all of which were seen as benefits at the time, both in business and to architectural progress. The new "international style" as it would become to be known, would come to define the next half-century. These buildings were seen as the epitome of architectural achievement; a culmination of the collective efforts of all previous architects and their respective contributions which had finally manifested in the sleek, shiny, functional forms of the international style.

On another front, trouble was brewing. In the 1937, an assistant professor of geography at the University of Wisconsin named Glenn Thomas Trewartha wrote a book titled *An Introduction to Weather and Climate*. In this book, Trewartha coined the term "greenhouse effect." This prompted a small group of scientists to begin looking further into the effects that humans had on their environment. It wasn't until the 1970s when a national energy crisis prompted in depth climate studies and energy analysis across the nation. In 1977, the U.S. Department of Energy was created to manage the situation, and soon after several other committees would be created to help regulate energy uses and educate professionals about sustainability. These included the Sustainable Buildings Industry Council (SBIC, 1980), the Committee on the Environment (COTE, 1989), and the United States Green Building Council (USGBC, 1993).

This report aims to correct some of those issues. The workflows that have been developed for this study have been developed specifically to assist in the remediation of this problem.

SOCIAL CONTEXT

Across the United States, new construction has always been favored by the public over renovations. The new amenities and aesthetics that new construction have to offer are generally seen has much more attractive, and therefore lucrative for business endeavours. The City of Minot is no exception. Minot has multitude of building stock that is suitable for adaptive reuse, much of which is located in the downtown area. Minot has made an effort in recent years to revitalize its downtown, and adaptive reuse of old brick buildings is becoming increasingly trendy, and therefore profitable for redevelopment. Mixed-Use buildings have become popular in the U.S. as they offer multiple avenues of profit and benefits for the community. Adaptively reusing and existing structure for a new mixed-use development would re-establish a building with its community, reduce the building's energy use, provide a new center of commerce within the city, and save construction materials from being wasted.

CULTURAL CONTEXT

In recent years, contemporary art, fashion, and design has began to place more value on resuing the old. A new sense of "living in the moment but holding onto nostalgia" has made it cool for old items, clothes, furniture, cars and thankfully, buildings. The combination of new, sleek materials with the older, dated materials has become aesthetically pleasing in the eyes of both the public and designers. This affords architects the perfect opportunity to capitalize on adaptive reuse. Architects can persuade owners to renovate and reuse in order to reduce energy use and emissions while creating a new, exciting environment that is profitable for their business.
Now more than ever, sustainability needs to be seen as 'cool' and any ways that architecture can help achieve that are valuable. It is our responsibility as designers to lead this charge.

HISTORICAL TIMELINE

1914

A wave of new designs featuring flat rooves, sleak lines, and pure forms comes to be known as modernism.

1927

A young architect named Mies van der Rohe designs the Villa Savoye, prompting the birth of the international style.

1930s

The widespread implementation of air conditioning and electric lighting frees designers from previous constraints.

1977

The U.S. Department of Energy is created in response to a national energy crisis that has lasted half of the decade.

1993

The U.S. Green Building Council (USGBC) is formed, ushering in a new area of sustainability and conservation

Figure 43

PHILOSOPHICAL FRAMEWORK

All of the information that has been collected using the positivist approach has defined a clear end goal for this thesis. Through an extenisve amount of research, anylsis, and simulation, a practical workflow has been produced to help identify the optimal adaptive reuse strategies for twentieth century architecture. Using this process, existing buildings will can be evaluated to asses their efficiency and energy performance. The same workflow and process will be implemented to design a sustainable adaptive reuse project in the area. The workflow that has been established along with the findings that have been discovered could be extremely beneficial to architecture, if it is adopted. The ability to be able to quickly evaluate building performance criteria in today's industry is an indespensable skill.

THEORETICAL FRAMEWORK

The research of this project has slightly changed the theoretical framework, due to the simple fact that buildings vary greatly from case to case, and findings a "one size fits all" set of strategies simply does not work. Though it would be nice to have this sort of catalog, a variable set of action was taken to establish a workflow that could determine which strategies might be best in each case. This workflow uses the popular design software Revit, as well as the additiional softwares associated with it called Dynamo and Insight. Dynamo is a computational logic program that allows mutiple iterations to be made rapidly. Insight is a cloud based web service from autodesk used for evaluating project performance criteria. Using these programs in tandem, determining the most effective adaptive reuse strategies for each project is possible.

COMPUTATIONAL DESIGN

INTRODUCTION

While studying architecture at NDSU, a variety of new programs, software, and techniques have become available for architects. Of these, none have quite captured my imagination and intrigue than the new practice of computational design. This involves the use of data and logic in the form of graphic coding, which results in an algorithm that can carry out a function specified by the user. Computational design takes the relatively new practice of parametric modelling to the next level, as it allows the rapid generation of multiple different models with parameters that are determined by the user. In order to make sense of all of this, research has been done into the different kinds of computational design and their benefits and drawbacks. This project focuses on the design program Revit, which has an integrated computational design software within, called Dynamo. Revit also has a cloud based performance criteria service that will be discussed later in this study, but made the decision to use Revit and Dynamo much more alluring. This section of the thesis will seek to clarify the technical jargon of computational design, as well as illustrate how an algorithm is produced using visual coding.

DESIGN TERMINOLOGY

- Algorithm:
  - a process or set of rules to be followed in calculations or other problem -solving operations, especially by a computer.
- Computational Logic:
  - the use of logic to perform or reason about computation.
- Generative Modeling:
  - an iterative design process that involves a program that will generate a certain number of outputs that meet certain constraints, which are set by the user.
- Iteration:
  - repetition of a computational procedure applied to the result of a previous application, typically as a means of obtaining successively closer approximations to the solution of a problem [design].
- Parametric Design:
  - a process based on algorithmic thinking that enables the expression of parameters and rules that, together, define, encode and clarify the relationship between design intent and design response.
- Visual Programming:
  - visual programming language is any programming language that lets users create programs by manipulating program elements graphically rather than by specifying them textually.
- Workflow:
  - the sequence of industrial, administrative, or other processes through which a piece of work passes from initiation to completion.

Figure 44

- Workflow:
  - the sequence of industrial, administrative, or other processes through which a piece of work passes from initiation to completion.
- Node:
  - a point at which lines or pathways intersect or branch; a central or connecting point.
- Code:
  - a set of instructions forming a computer program which is executed by a computer. It is one of two components of the software which runs on computer hardware, the other being the data.
- Data:
  - the quantities, characters, or symbols on which operations are performed by a computer

Figure 45

DYNAMO

For this project, it was important to find the quickest, most readily available design simulation programs so that it could potentially be implemented by other architects in the field. Autodesk Revit has become the industry standard for design development and construction documentation, and has countless tools integrated within it that can help make design easier and more logical for architects. Dynamo is the computational design program integrated within Revit, and its versatility as a design tool is exceptional. Dynamo uses visual programming as its language to graphically generate an algorithm that is based on coding. Being able to see each input, or "node" on the design canvas makes it easy to understand how the algorithm is actually operating at a fundamental level. Other programs such as grasshopper employee a similar visual programming language that produces comparable outcomes. The visual programming language is relatively easy to understand after using it for short length of time. It makes sense for our profession, which is characterized by the ability to communicate graphically as well as the attention to detail. Dynamo nodes are essentially small coding blocks that can be linked together to create an algorithm.

VISUAL PROGRAMMING: PARAMETRIC BOX

As a design element, the simple box is the most fundamental form at an architect's disposal. In keeping with the versatility that this project seeks to achieve, demonstrating this simple, versatile form will provide a basic introduction to the world of computational design and visual programming. The algorithm used to create a parametric box uses very few code blocks (nodes), and therefore makes it easy to explain the basics of this otherwise seemingly complex field. The resulting algorithm that has been developed for this project will be discussed in the next secition, but in order to comprehend the visual programming language, this brief graphic demonstration is necessary. An immense amount of research was necessary to begin to understand the advanced capabilities of this program, but the basics are incredibly simple, and can be understood by just about anybody,

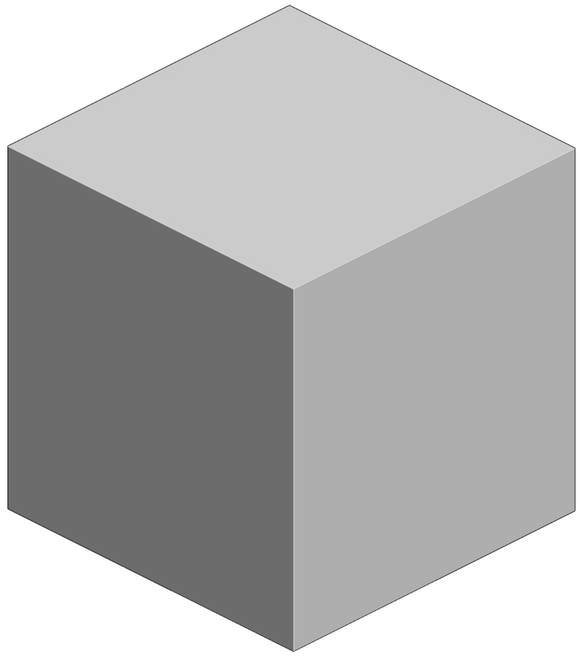


Figure 46

This is the overall script for the creation of a parametric box using visual programming within the Dynamo workspace. In total, there are only ten code blocks needed for the creation of this algorithm. It may look complicated, but beneath each node, basic math is the driving force beneath the surface. The following discussion will break down this script piece by piece to assist the learning process.

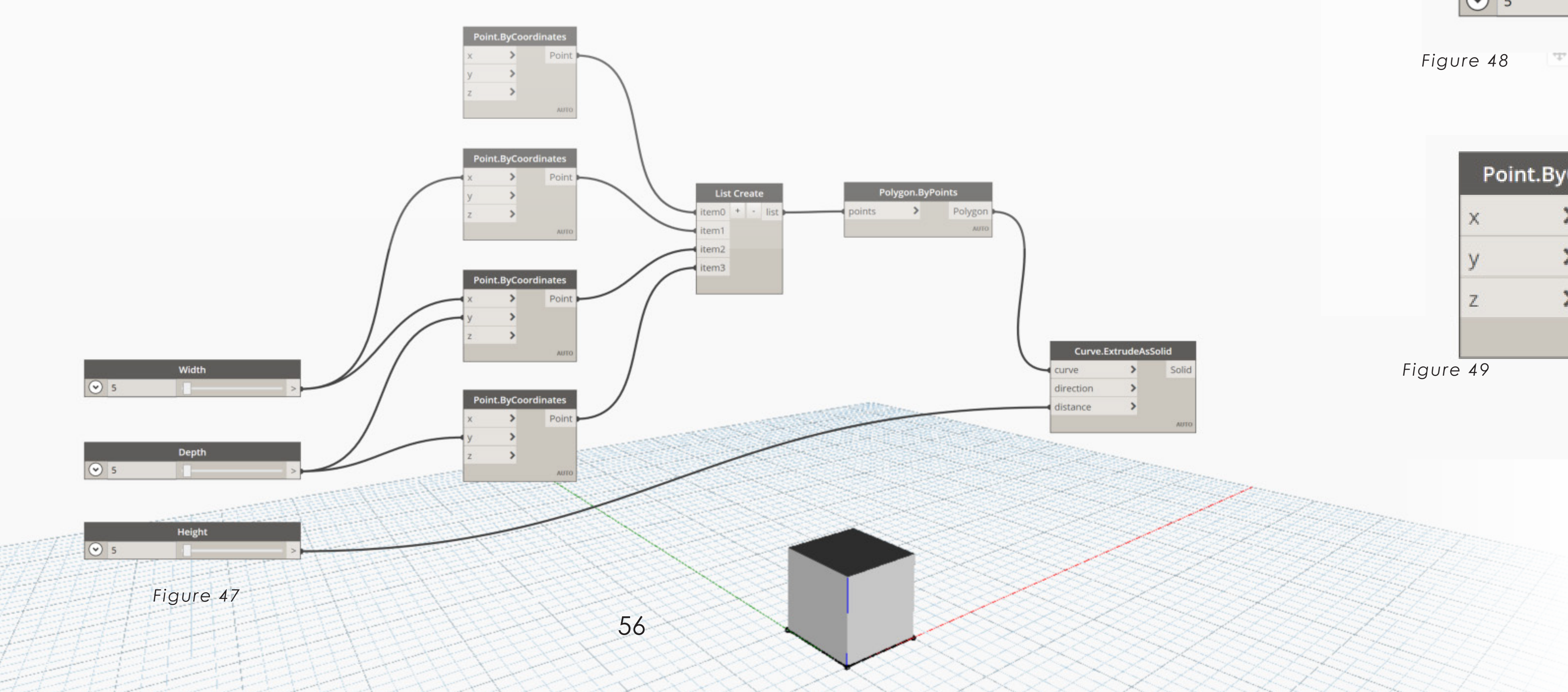


Figure 47

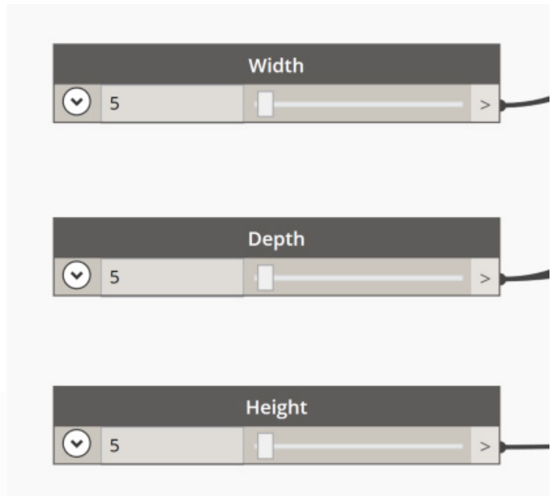


Figure 48

To begin, we know that a box is a three-dimensional object in space, so we can start by create our three dimensions. These are the parameters for the box. Since the box is being created in a digital environment, the units are arbitrary. The limits of each of these parameters can also be specified. Though we have our dimensions, we must define the points in space for the to exist.

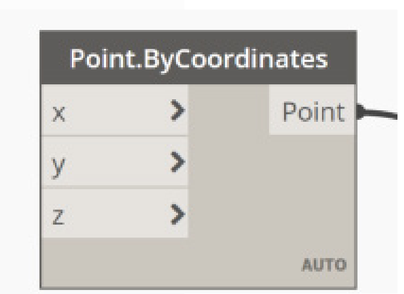


Figure 49

'Point by coordinate' nodes allow the user to define the place for the box to exist. Four of these nodes are needed in this algorithm to create the box. The first one defines the origin point of the box, The second and third define the width, and the third and fourth define the depth. Now, a connection is needed to link together each of these points.

The points are grouped together to prevent further coding from misinterpreting the order of computation. the first item on the list in this case is the origin, the second, third, and fourth are used to generate the 2-dimensional polygon (rectangle) that will be used as the base curve. The list items are grouped together in order and used as an input for the following 'polygon by points' node, which produces lines connecting the points, forming a rectangle at the defined base point.

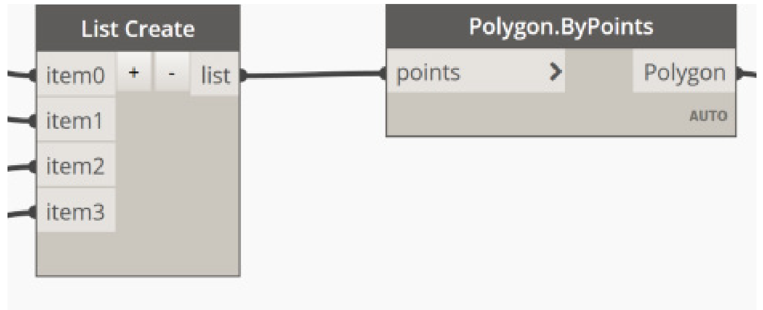


Figure 50

Finally, to give the box its height, an extrude node is used. Dynamo has several different extrude nodes, but this specific one extrudes a specified curve as a solid, given a set distance and direction. This node would allow any curve to be extruded, but in this case it is just using the polygon geometry that we have supplied. With that, the box is complete.

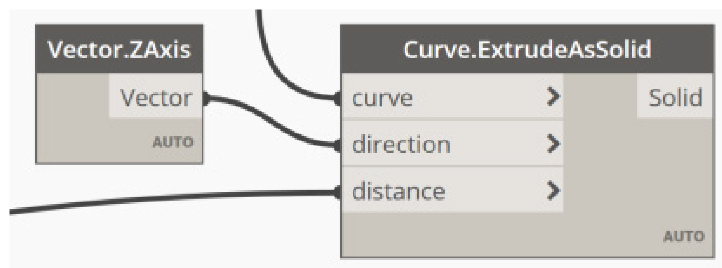


Figure 51

Dynamo allows users to view their model in real-time, making it easy to understand what is happening at every step along the way. Users also have the ability to put Dynamo in manual mode, which allows the parameters to be changed without the display model updating. This is useful for more complicated scripts, which allows the algorithm to be updated without the program freezing at every step along the way. Selecting the individual nodes on the canvas will highlight the area of the display model that it pertains to. This is one of the most basic scripts for new users, but it is a useful model to comprehend the visual programming language.

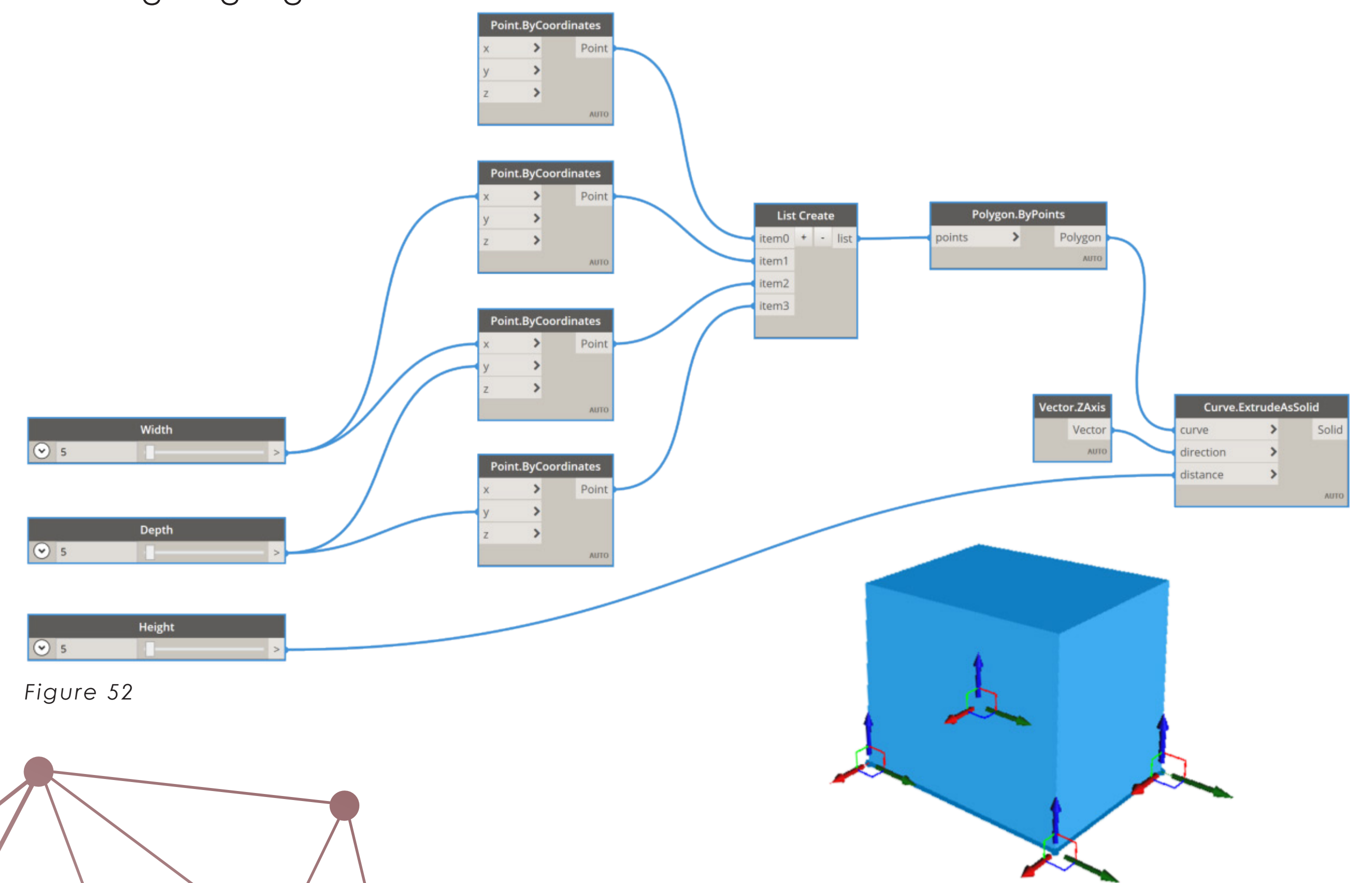


Figure 52

DEVELOPING A WORKFLOW

REVIT, DYNAMO, INSIGHT

The choice to use the Autodesk programs for this study instead of others was influenced by a number of factors. First and foremost, Autodesk has long been the industry standard for design development, and each year they are developing new tools for architects to become more informed on their projects. Next, the capability and versatility of the programs in question made them stand out among others. Knowing that other designers will have access to the same tools that are used in this study is a satisfying notion. Autodesk Insight is integrated into Revit and allows project's performance criteria to be analyzed in the cloud while further design continues. The time of each full performance analysis varies depending on the level of detail of the model in question. The models that the algorithm develops are simple enough that each analysis usually takes less than ten minutes. The graphics at each level of this workflow are consistent with one another since each of the programs is developed by Autodesk. All of these factors made it an easy choice to use these programs versus others that have similar capabilities. The workflow to be discussed uses scripts based on the work from the Autodesk community, Dynamo users, and personal contributions. This workflow maximizes both design efficiency as well as providing advice on further energy saving strategies.

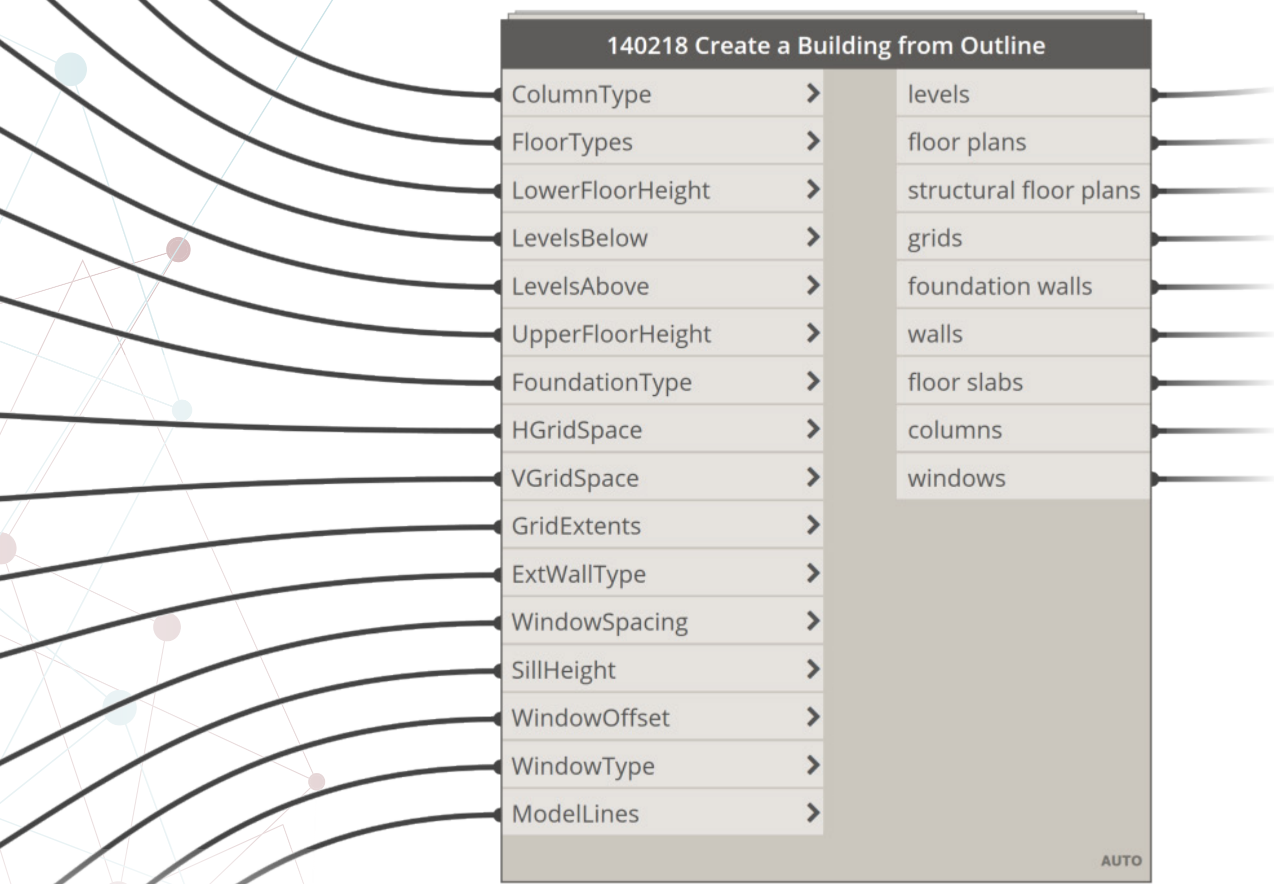


Figure 53

DEFINING THE PARAMETERS

Keeping the input parameters simple for this project was critical in order to make the rapid generation of schematic models possible. In order to do this, I used a node developed by a fellow Autodesk Refinery User (Beta product testing group) with modification focused on the generation of an energy model alongside a considerably developed Revit model. The set parameters on the surface of this node are listed in the graphic above. These parameters allow a "footprint building" (a building that is a single, vertical extrusion from its footprint) to be developed with different wall, floor, window, and support types, values and dimensions, as well as the generation of plans, 3D views, and an analytical energy model which can be sent straight into the Insight cloud. Before this workflow was developed, this type of graphic documentation and performance analysis may have taken countless hours during a design stage in which pay may not even yet be guaranteed. The outputs on the right side signify the creation of the elements in the Revit workspace.

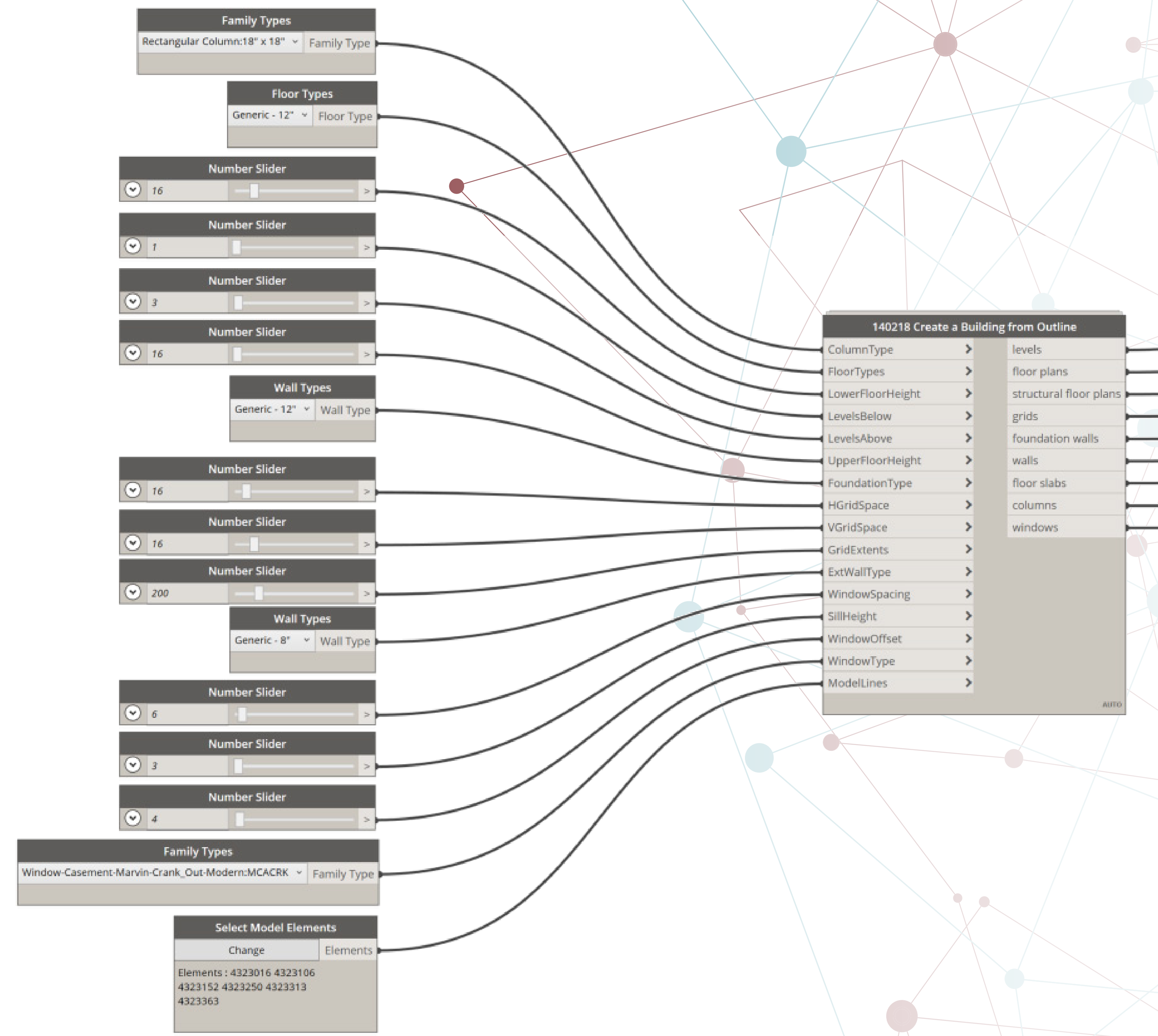


Figure 54

The variable inputs listed above allow each parameter to be changed rapidly. Wall, floor, and column types can be created within Revit and selected in Dynamo. The user must then trace the existing building footprint in the Revit workspace before returning to Dynamo. There, the parameter can be specified before the computation is ran. Once initiated, it will take a moment for the two programs to process. The resulting model in Revit is now ready for to be sent to the insight performance analysis cloud.

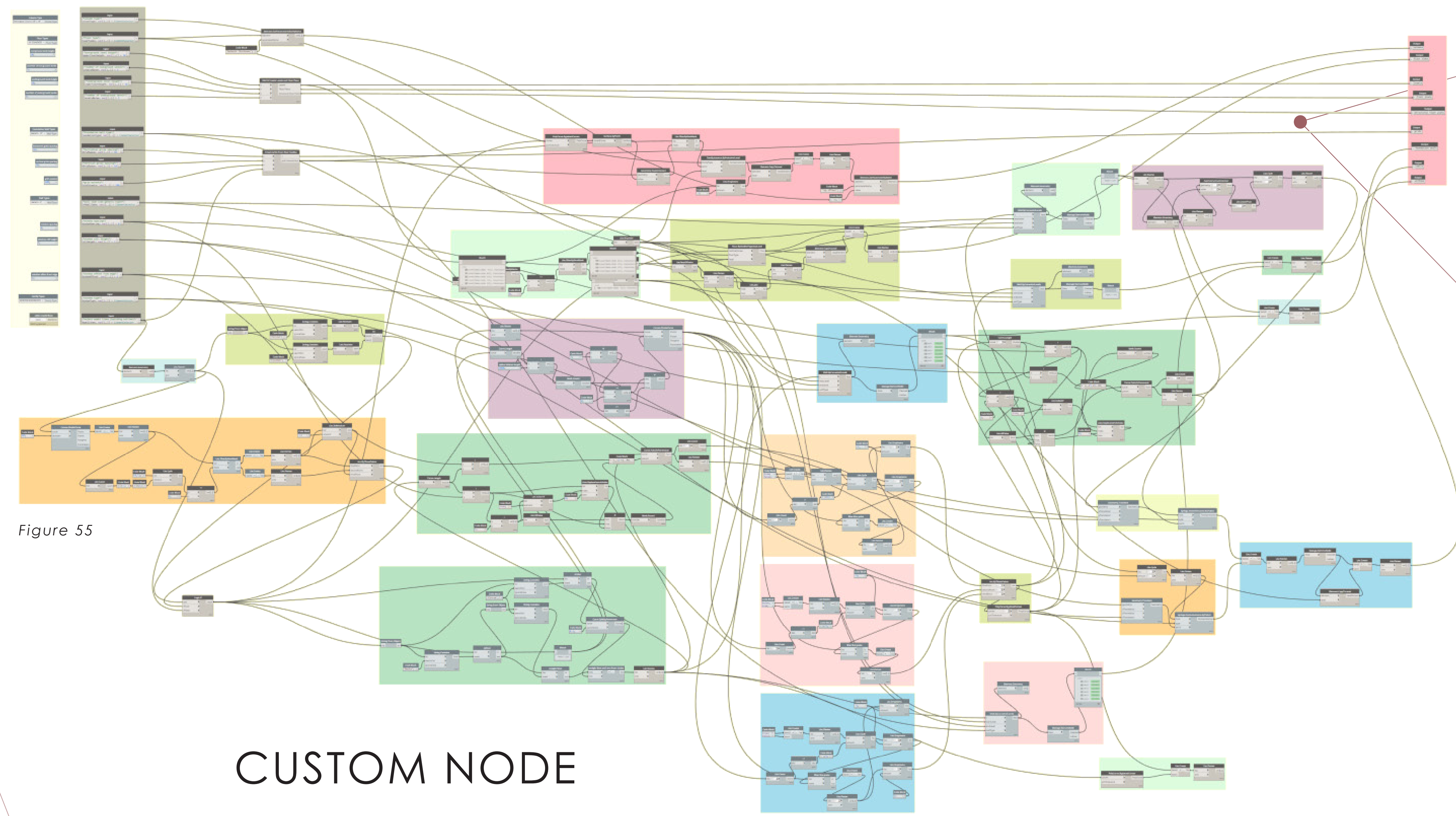


Figure 55

CUSTOM NODE

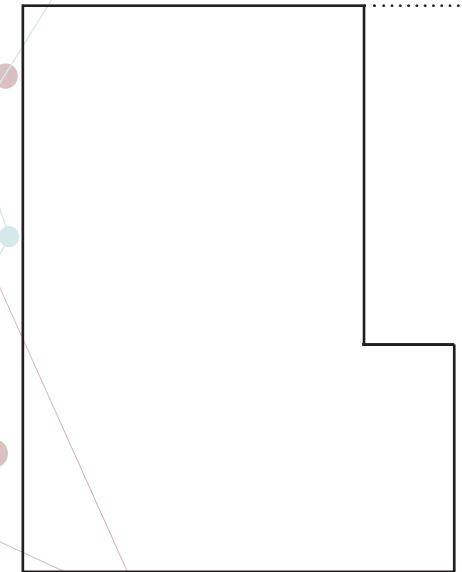
This is the inside of the custom node that was displayed on the previous page. Each individual color group is a different element (converting model lines to spline curves, developing floor plans and grid in Revit, etc.). Though only capable of creating simple, buildings, this node is very powerful as it allows models to be made in quick succession, and multiple analyses to take place at the same time. It is worth noting now that the work displayed above is a modification of an existing design script created by Tom Figlehorn of the Autodesk Refinery group.

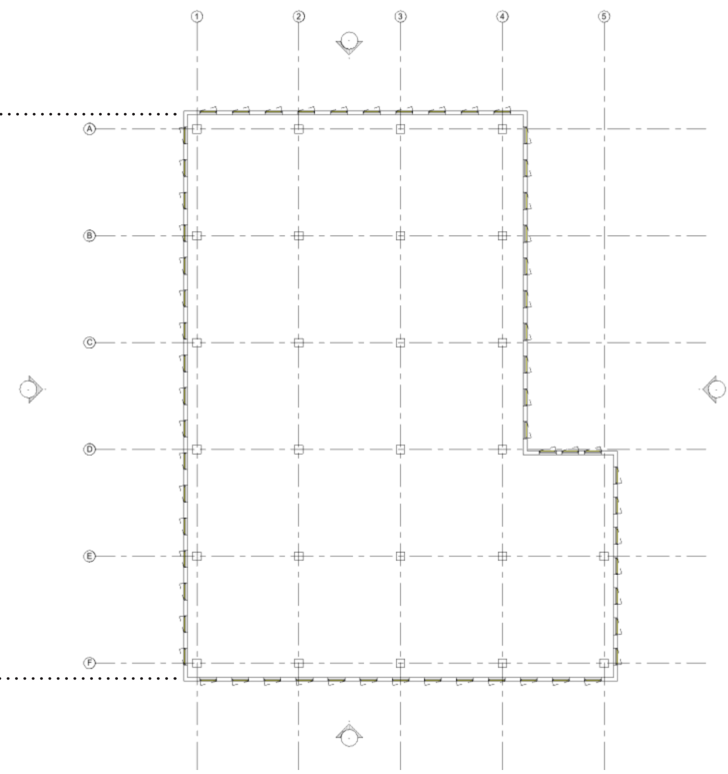
Not only can this script generate quick models, it creates a set of design documents at the same time. This alone can save a huge amount of time, and further integration of sheet creation and view integration therein is surely capable, though this script is not equipped with such features at the moment. Further parameters can also be added in order to create the level of detail the user desires, but in keeping with the versatile ideology of this thesis, only the illustrated parameters have been used. Everything shown in the diagram above is happening beneath the surface of figure 14. Making the custom node as user friendly as possible makes it easy for those that are unfamiliar to understand.

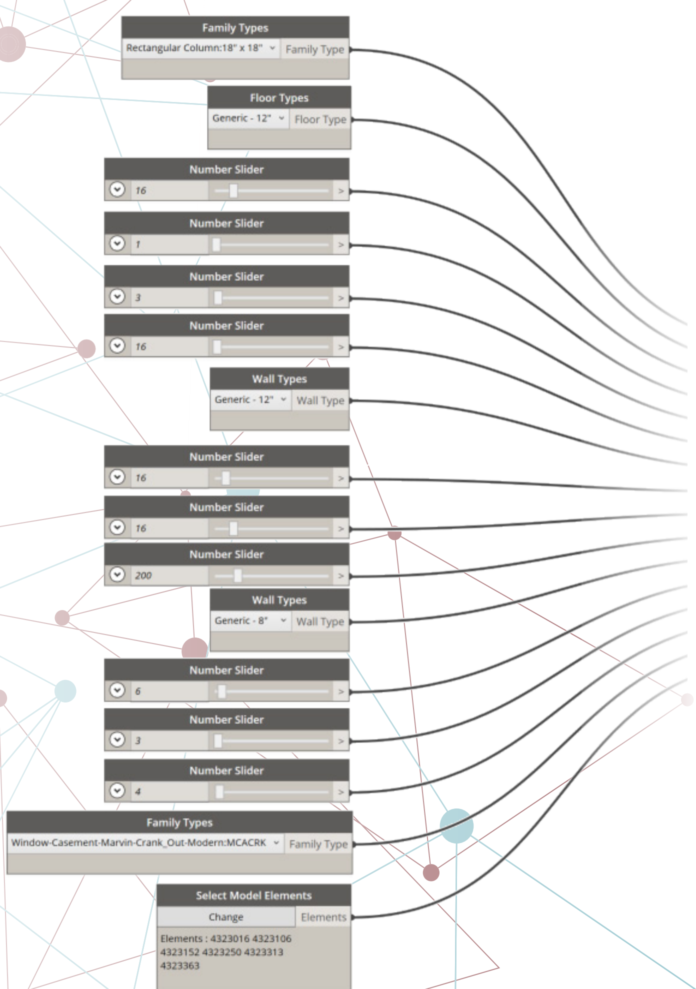
PERFORMANCE ANALYSIS: SIMULATIONS

SIMULATIONS

In order to test whether this workflow functions as intended, a multitude of simulations have been ran using it. This report includes the documentation and analysis of five of these studies. Each simulation has relatively simple building elements such as generic floor and wall types in order to represent the versatility of the building envelope. The project location and conditions vary in each simulation as well and can be manipulated at will within Revit once the Dynamo paramements have been set and the script has been processed. These simulations are the basis for the findings of this study, alongside the development of the Revit, Dynamo, Insight workflow for adaptive reuse. Using this workflow to comprehend a building's strengths and weaknesses makes sustainable renovation a much more realistic objective for each renovation project. Using a set of standards from an outside institution provides a level of external validity for each project as well.







Figures 56 -58

SIMULATION 1

The first simulation uses a simple footprint with one jog. There are 3 total above ground floors and 1 lower level. Floor to floor heights are 16’-0”, and the envelope consists of 8” exterior walls, 12” foundation walls, and operable windows. This is an extremally typical building form and design for the upper Midwest, making it suitable to be the first tested and documented.

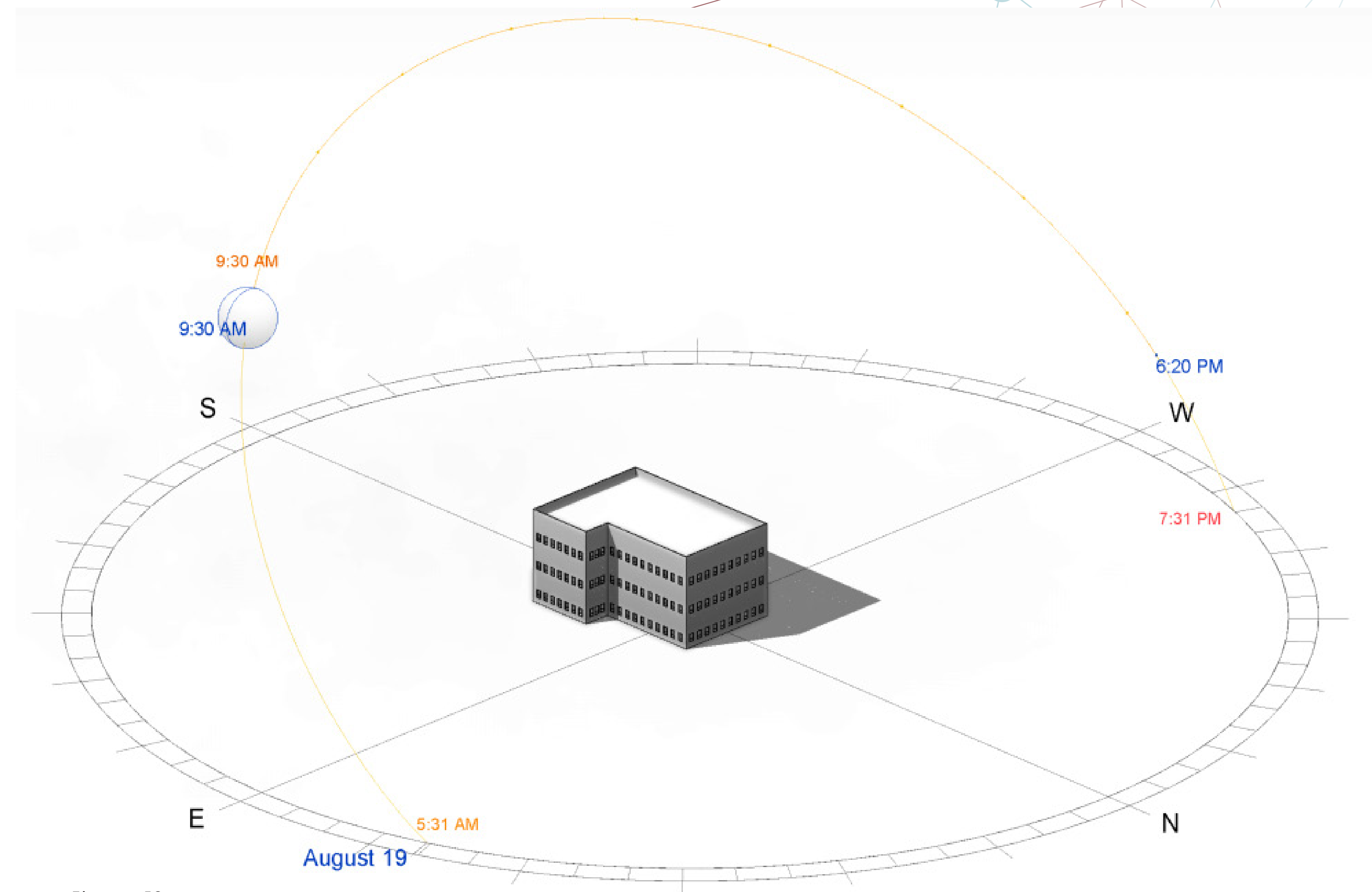
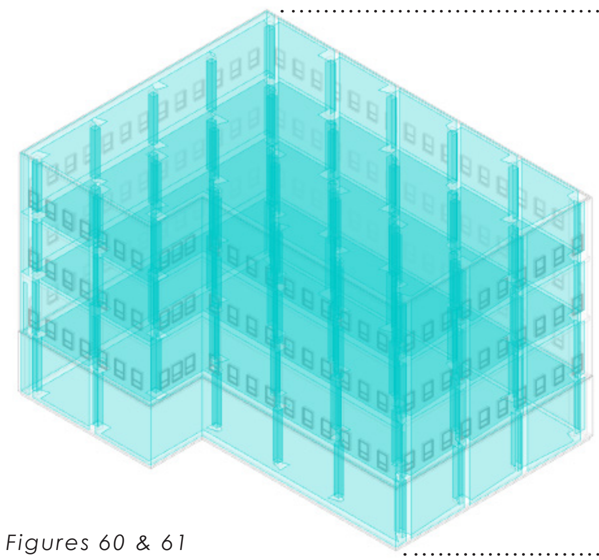
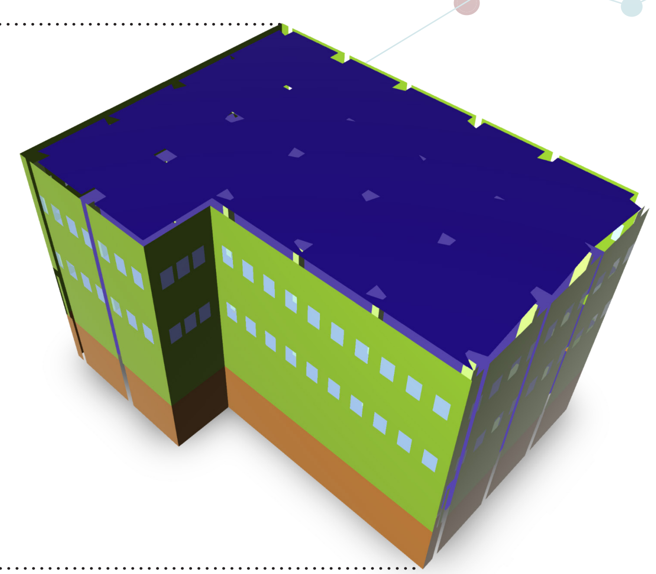


Figure 59

3D REVIT VIEW





Figures 60 & 61

ANALYTICAL MODEL INSIGHT MODEL

The analytical model provides the basis for insight to run its performance analysis. The buildings is divided into zones(spaces) and surfaces (walls, floors, supports). Each elements' specific properties can be viewed within the Insight interface. This model was very generic and showed that the workflow could indeed be used successfully to evaluate a building's energy analysis.

SUMMARY

The insight performance analysis showed that this building's energy analysis is low, but there is room for improvement. At \$22.7/m²/yr, this building's costs are manageable, but not near levels that have become standardized by many sustainability groups such as LEED, ASHRAE, and WELL. This projects specific performance criteria is discussed in the following section of this report. Cost could be reduced by increasing insulation, using mor efficient systems, or cutting down on the number of punched openings (but not specifically the fenestration area) within the building envelope.

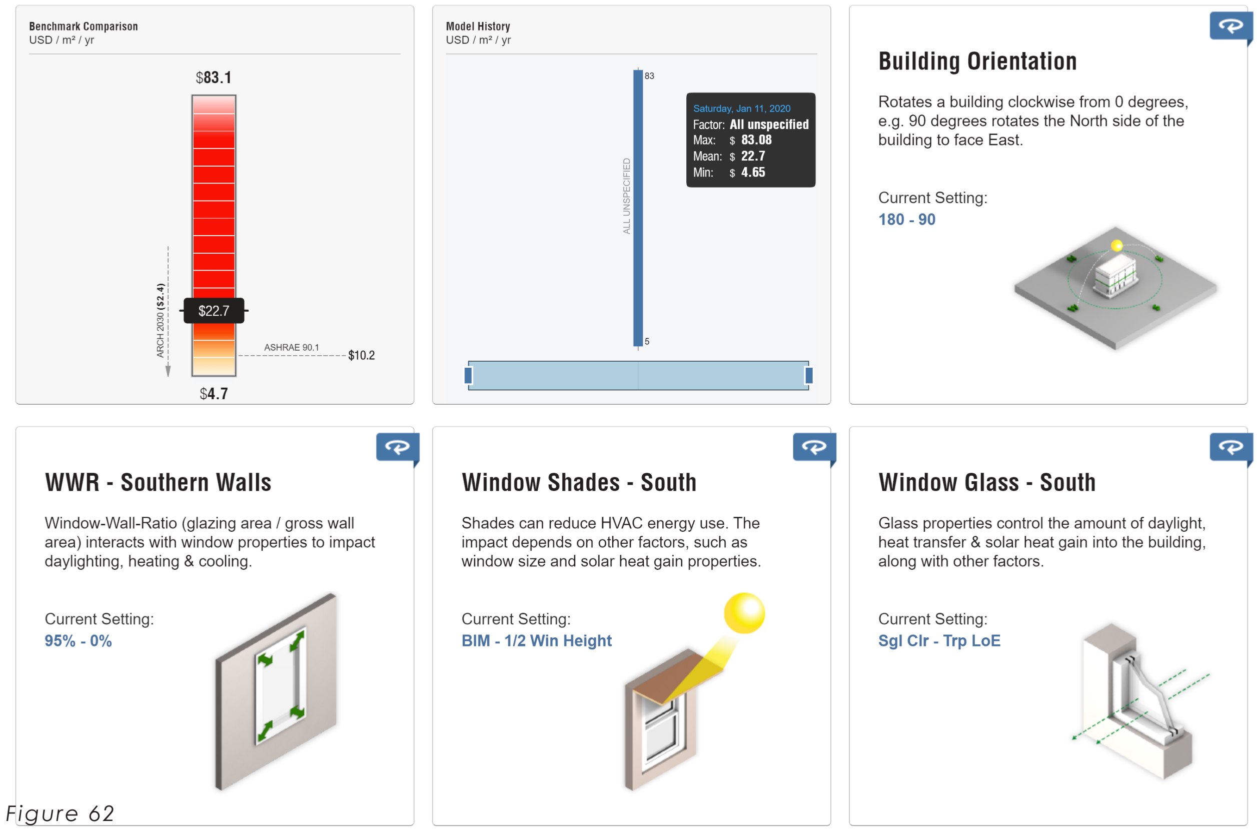
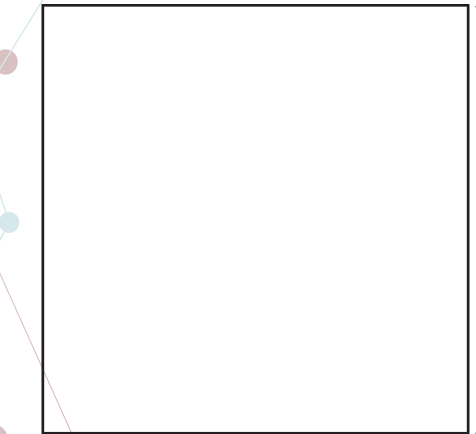
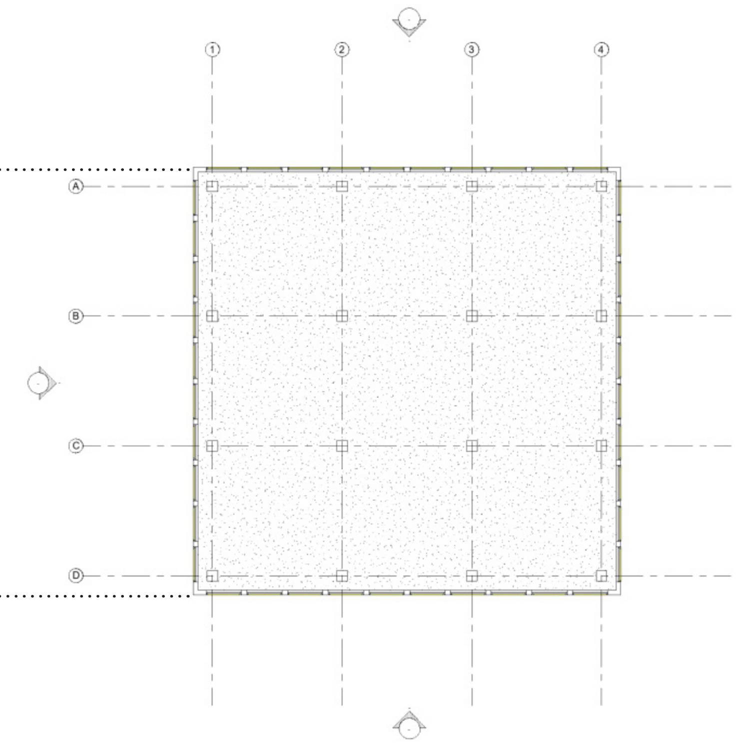
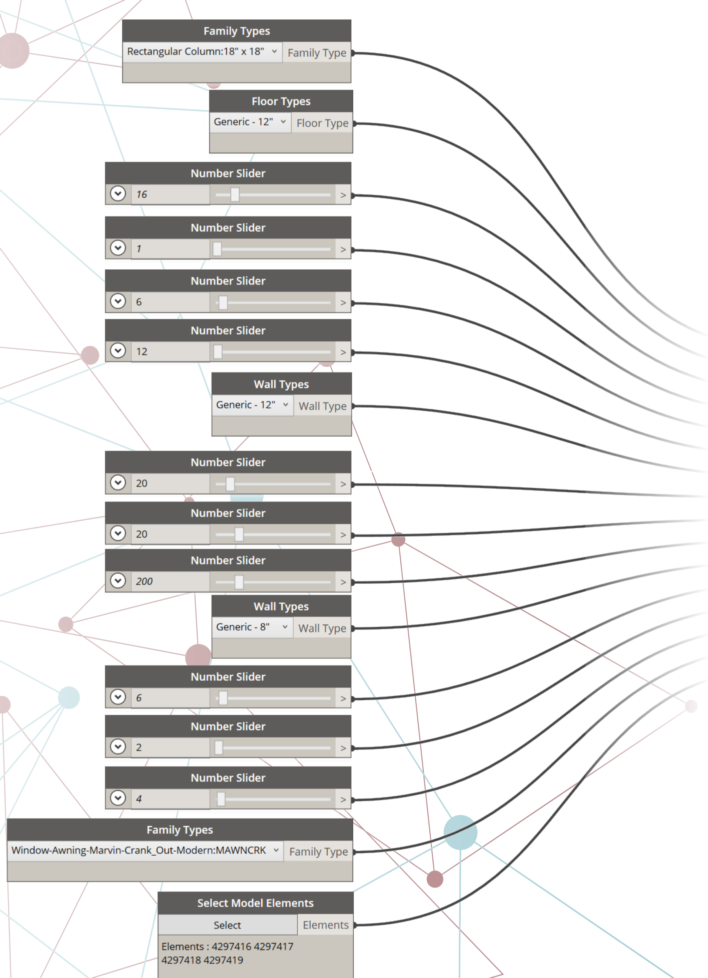


Figure 62







Figures 63 - 65

SIMULATION 2

Simulation two uses a square footprint There are six total above ground floors and one lower level. Floor to floor heights are 12'-0" above ground and 16'-0" below ground. The envelope consists of 8" exterior walls, 12" foundation walls, and operable windows. This form and design is also extremally typical in the upper Midwest, although many may not be this tall unless in a downtown area of one of the larger cities.

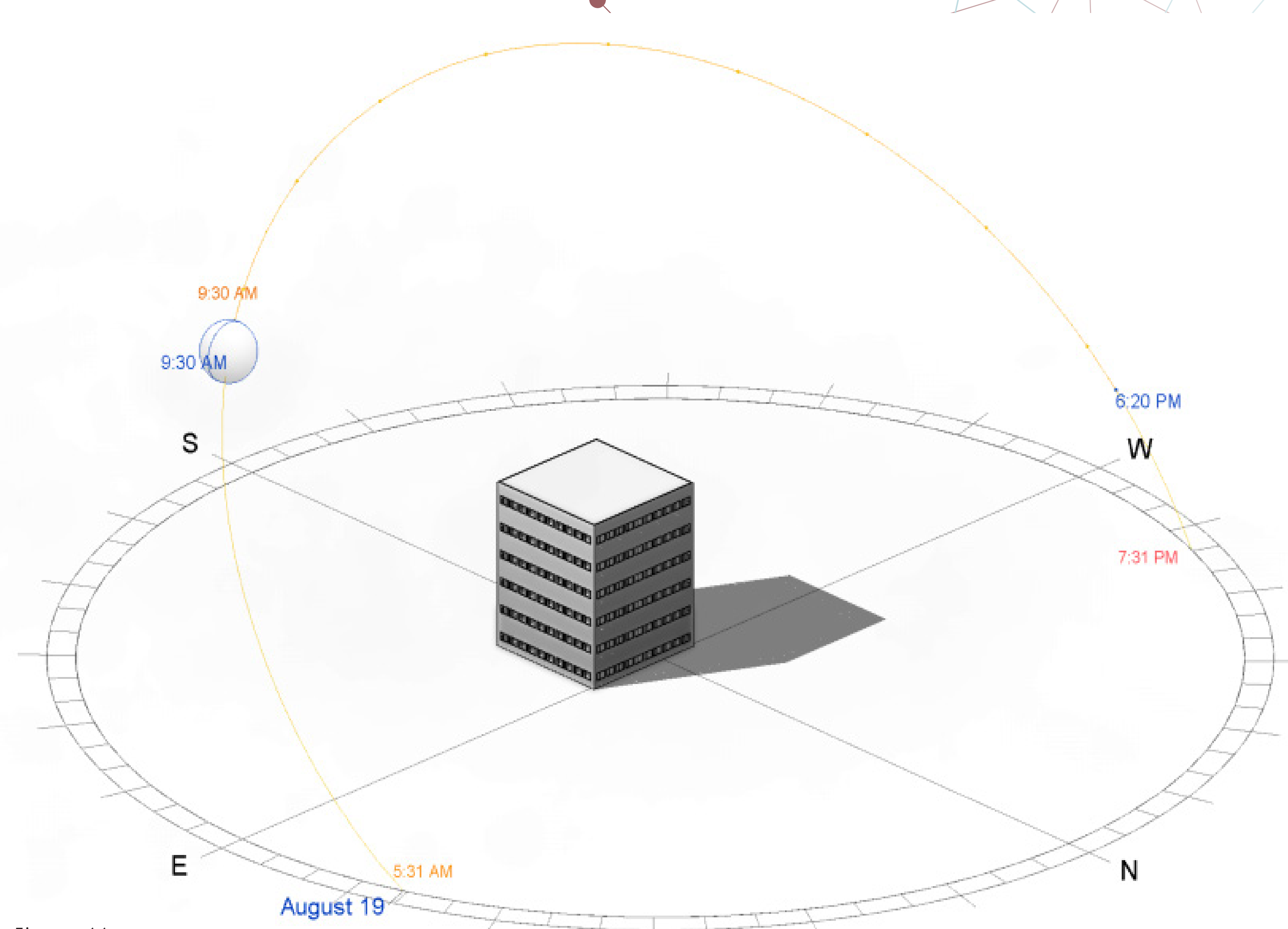
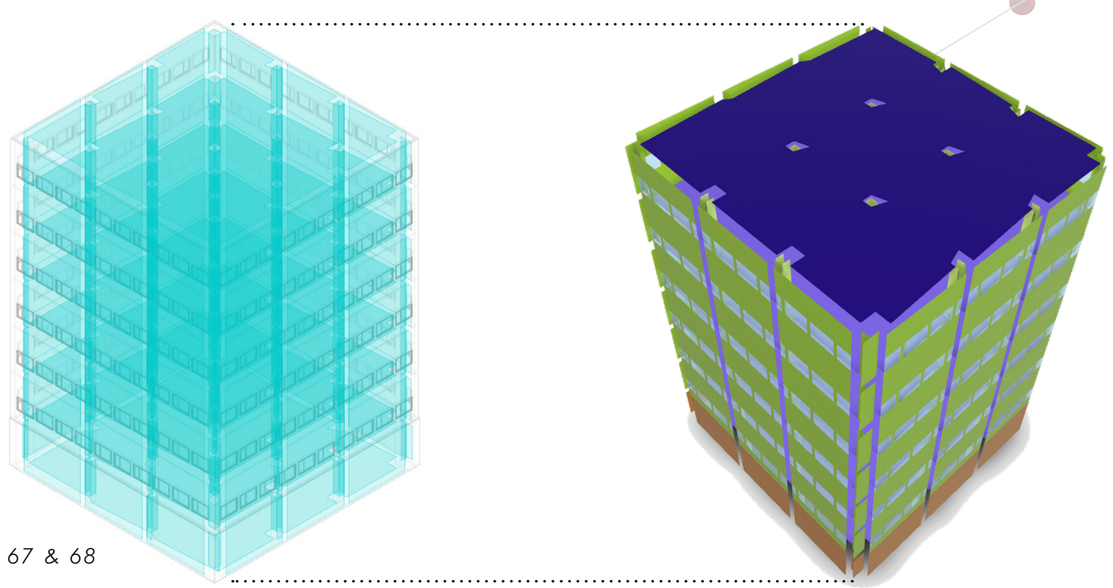


Figure 66

3D REVIT VIEW



Figures 67 & 68

ANALYTICAL MODEL INSIGHT MODEL

The box low-rise form is the perfect archetypal model for American architecture. This form has become a staple due to the popular ideas and styles employed by famous Architects such as Mies van der Rohe and Le Corbusier. This building has a moderate fenestration area and a very proportional footprint.

SUMMARY

Although the form is very logical, this building still has moderate energy bills, at \$21.7/m²/yr. Insight points out the most obvious factors right away. As indicated below, we can see that both our walls and roofs are uninsulated, and there is a high amount of infiltration through the openings. This allows us to plan for better insulation and sealants to prevent heat and air from escaping, wasting energy and money.

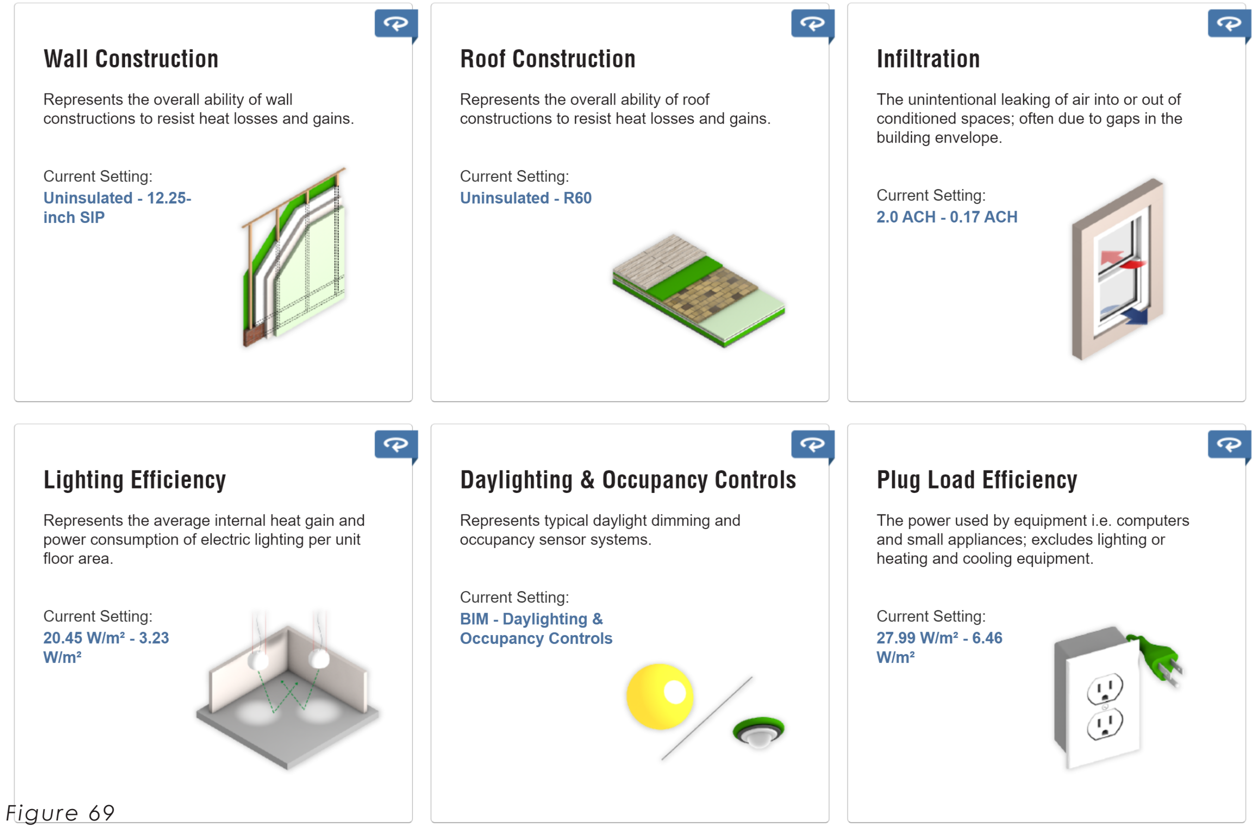
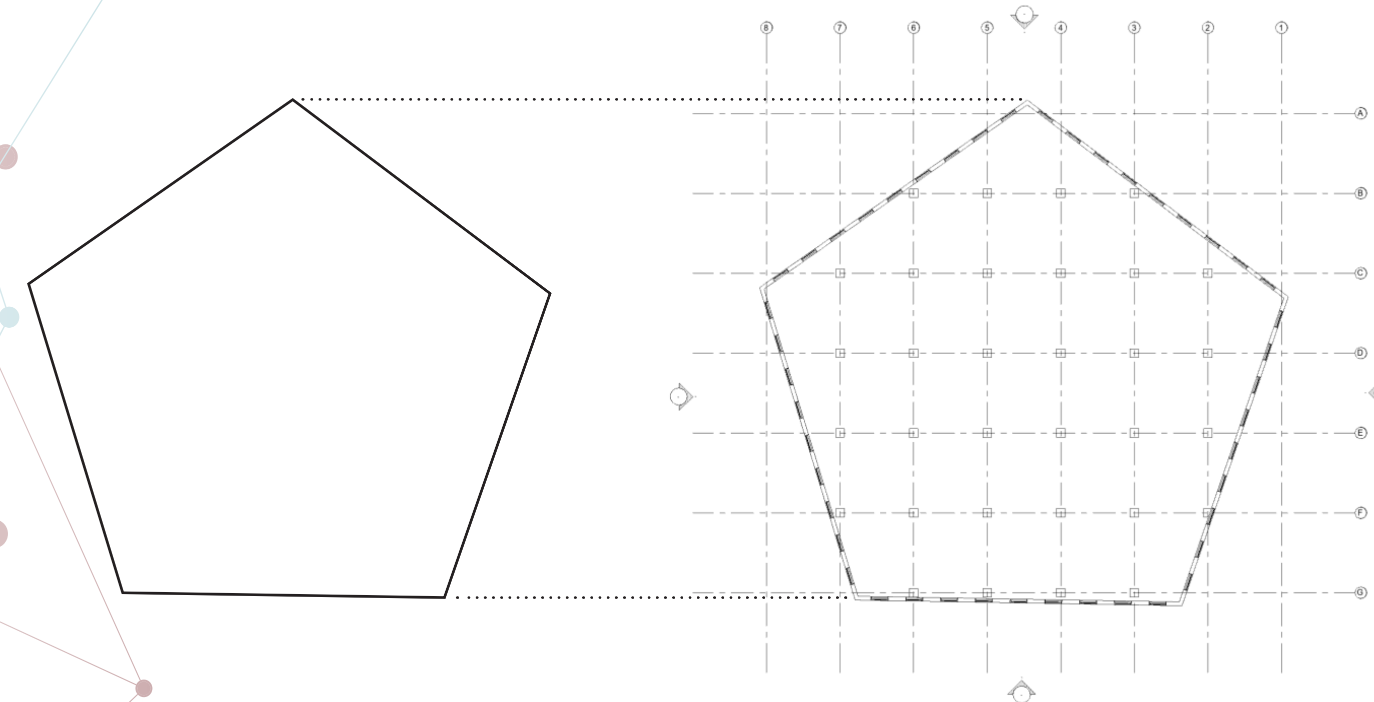
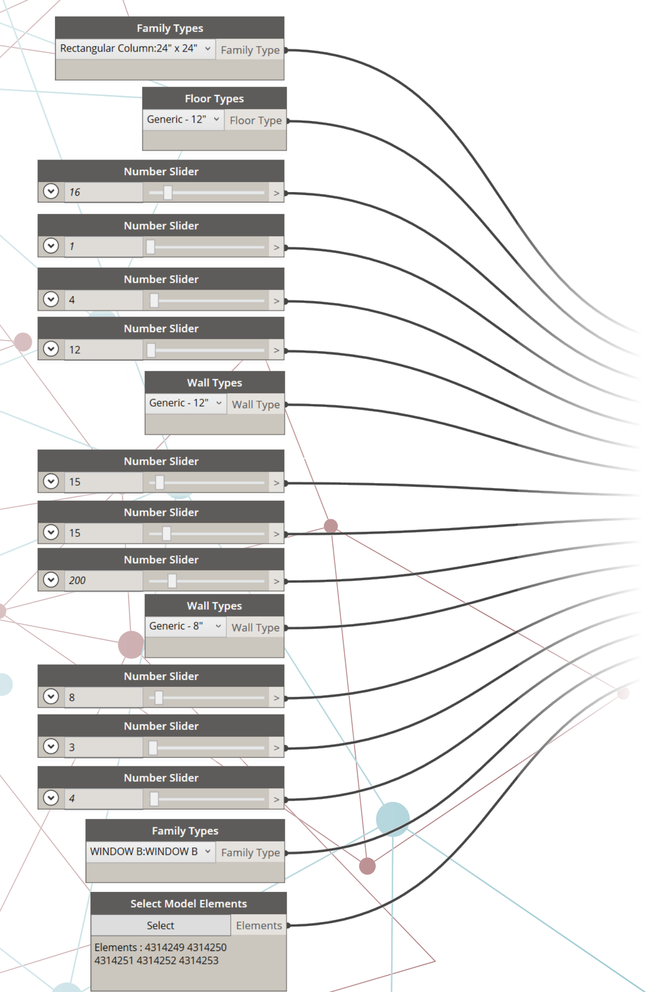


Figure 69





Figures 70 - 72

SIMULATION 3

Simulation three uses a unconventional form; a pentagon. There are 4 total above ground floors and 1 lower level. Floor to floor heights are 12'-0" above ground and 16'-0" below ground. The envelope consists of 8" exterior walls, 12" foundation walls, and small, fixed windows. This building form is somewhat atypical, making it import to the versatility aspect of the workflow itself. It shows that all polygons, not just the rectilinear ones, can be used within its constraints.

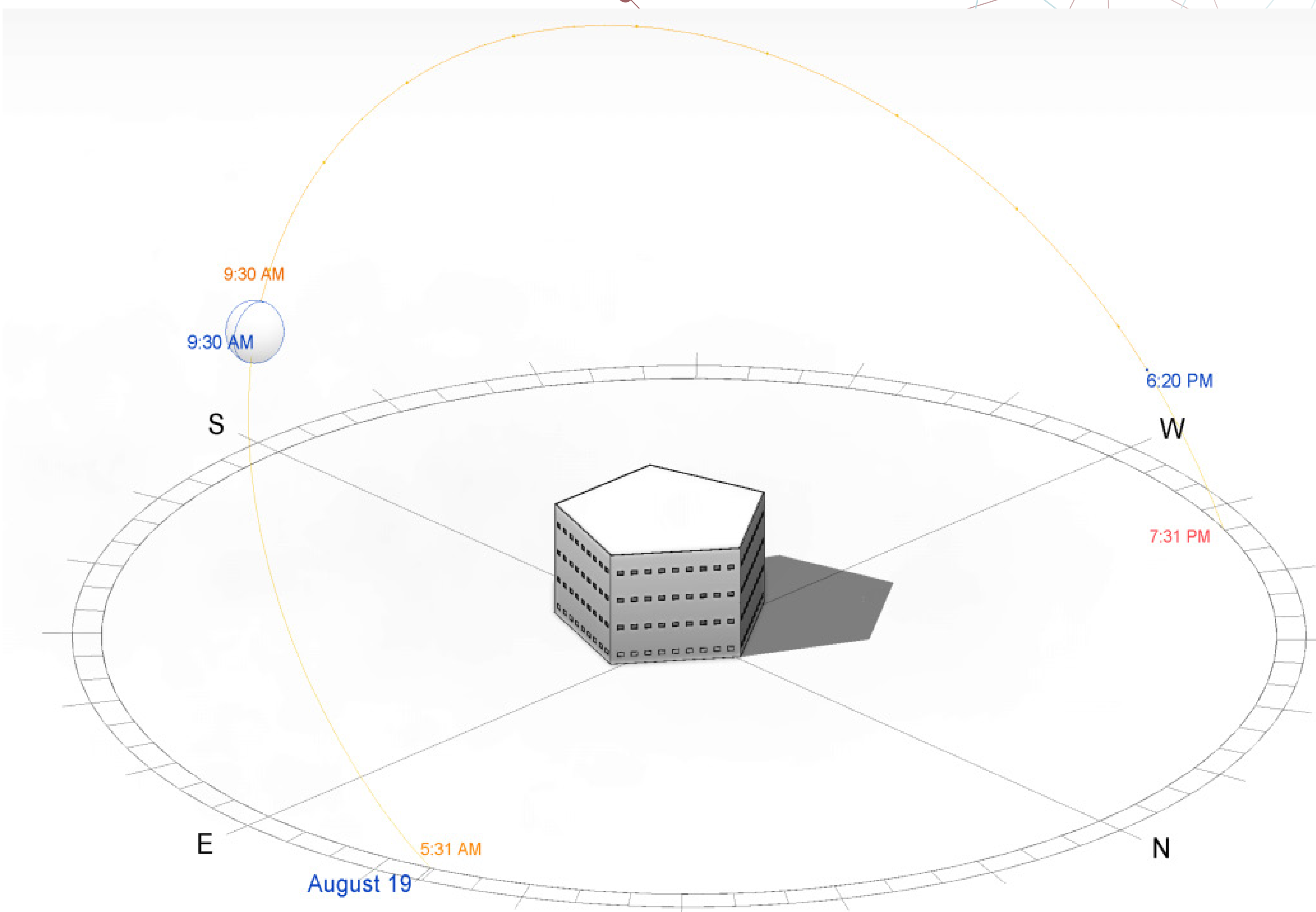
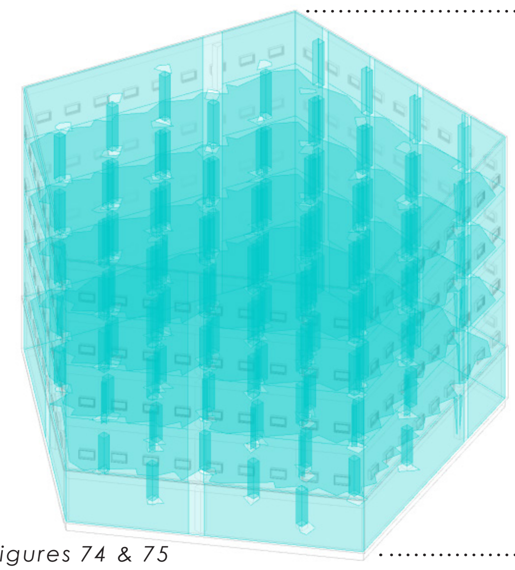
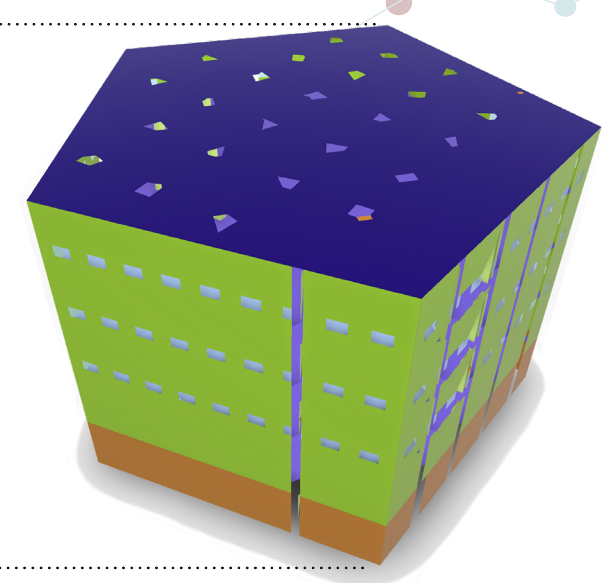


Figure 73

3D REVIT VIEW





Figures 74 & 75

ANALYTICAL MODEL

INSIGHT MODEL

Using the same floor and roof types (still uninsulated) and only changing the form and fenestration, we can observe a change in the building's performance. Isolating variables allows us to test specific strategies, in this case the form.

SUMMARY

The pentagon form is in itself more efficient than other, more typical forms such as the box or the single jog. At \$18.2/m²/yr the pentagon is much more efficient than the first two simulations. Insight provides options for innovation within the project's design. Suggestions for an efficient, ASHRAE rated heat pump as well other energy saving systems such as roof mounted photovoltaics and an efficient hours of operation schedule.

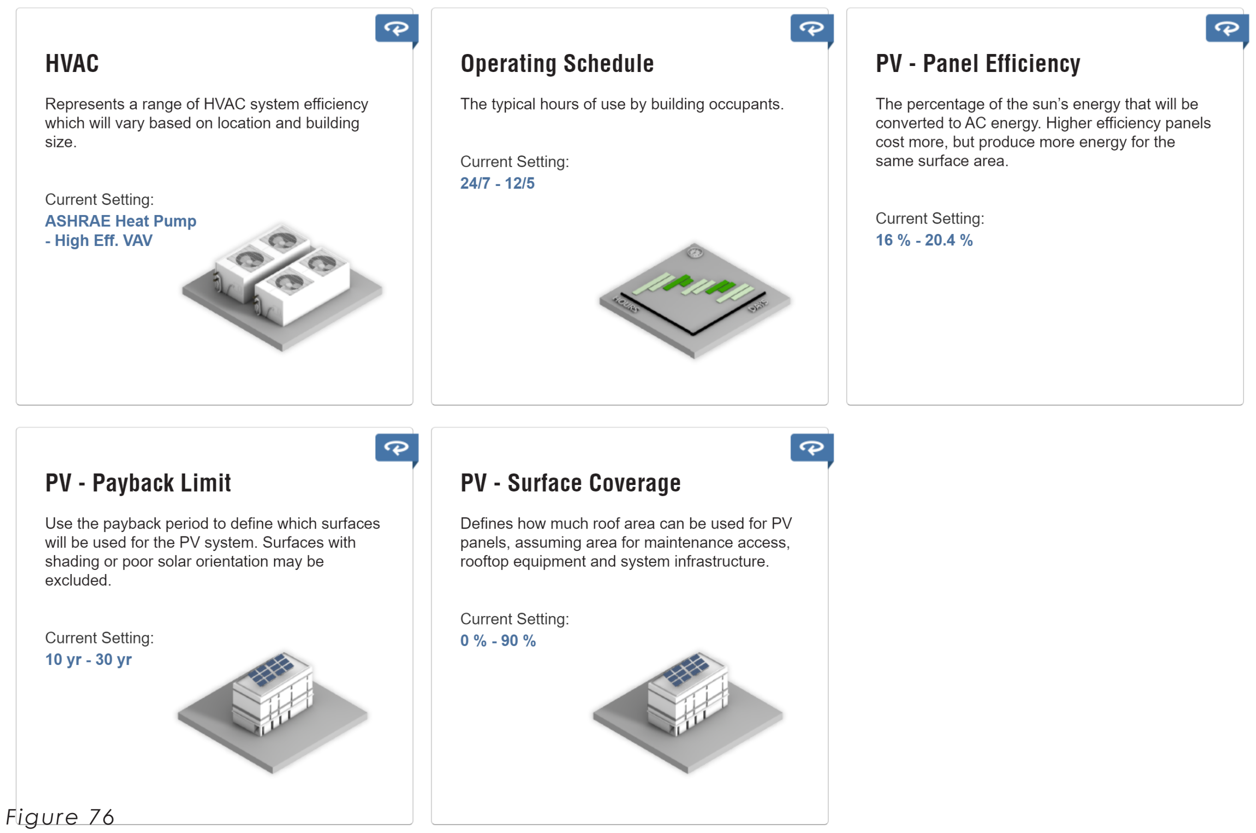
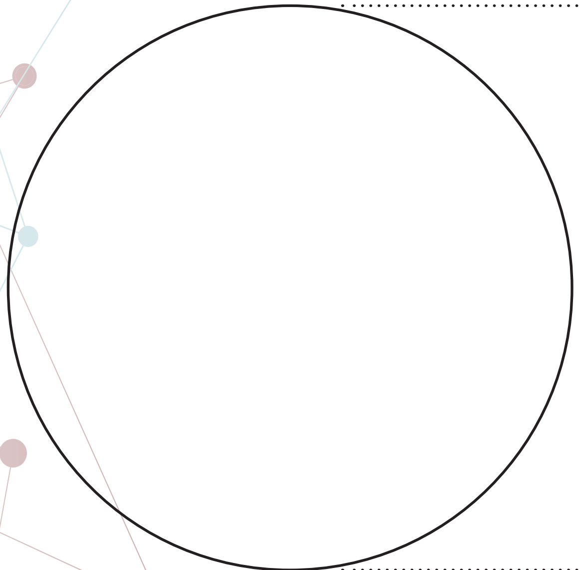
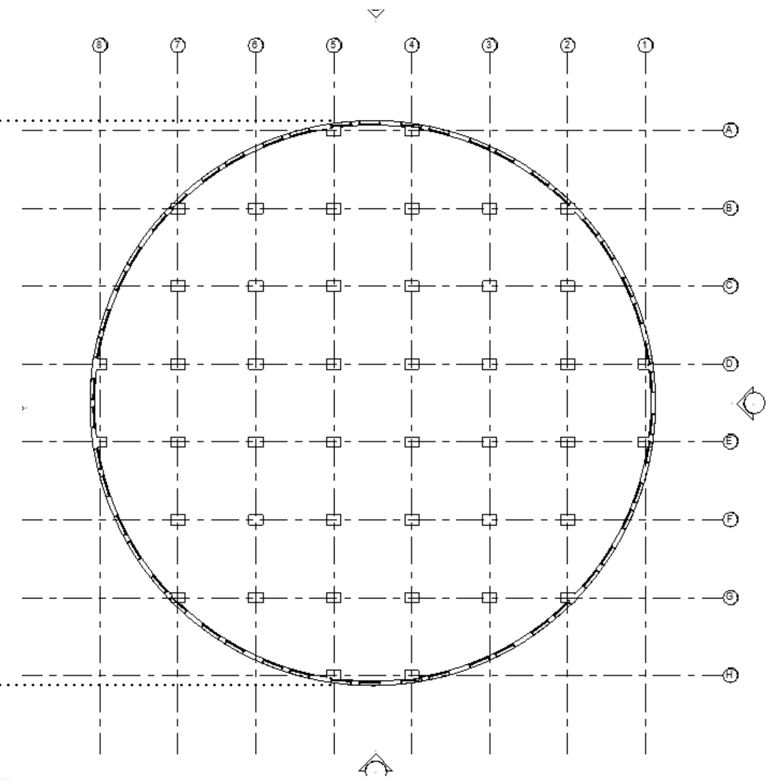
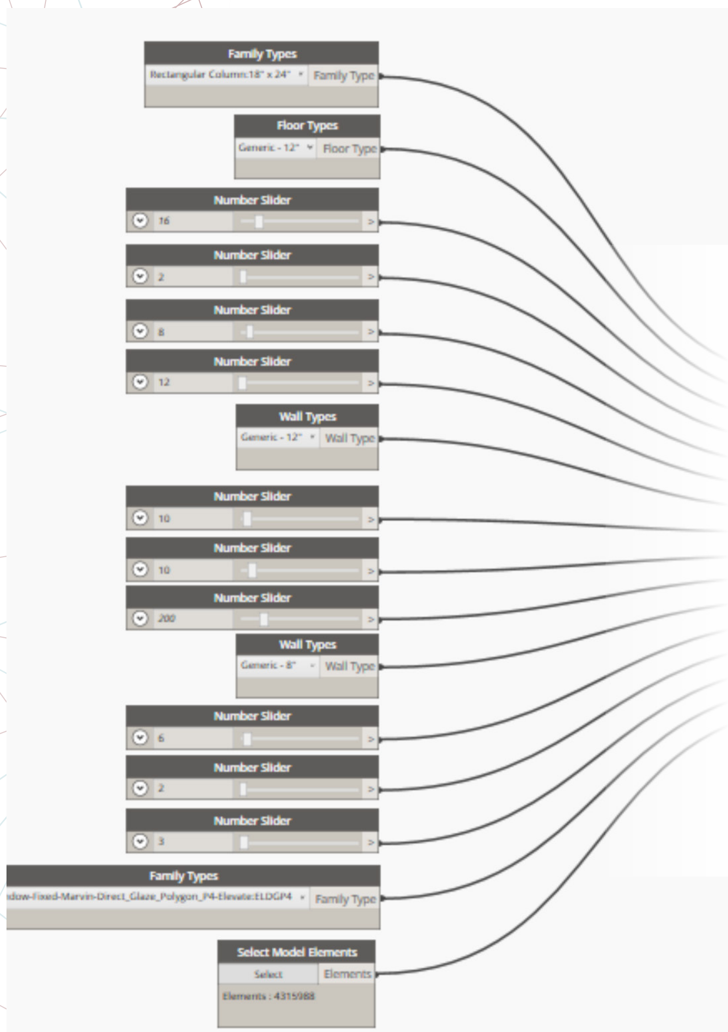


Figure 76







Figures 77 - 79

SIMULATION 4

The fourth simulation uses a cylindrical form, the likes of which are almost unhead of in the upper midwest, but are more common in other regions. There are 8 total above ground floors and 2 lower levels. Floor to floor heights are 12'-0" above ground and 16'-0" below ground. The envelope consists of 8" exterior walls, 12" foundation walls, and irregularily shaped , fixed windows. This building form proves that curvy building footprints will work within the workflow's constraints as well.

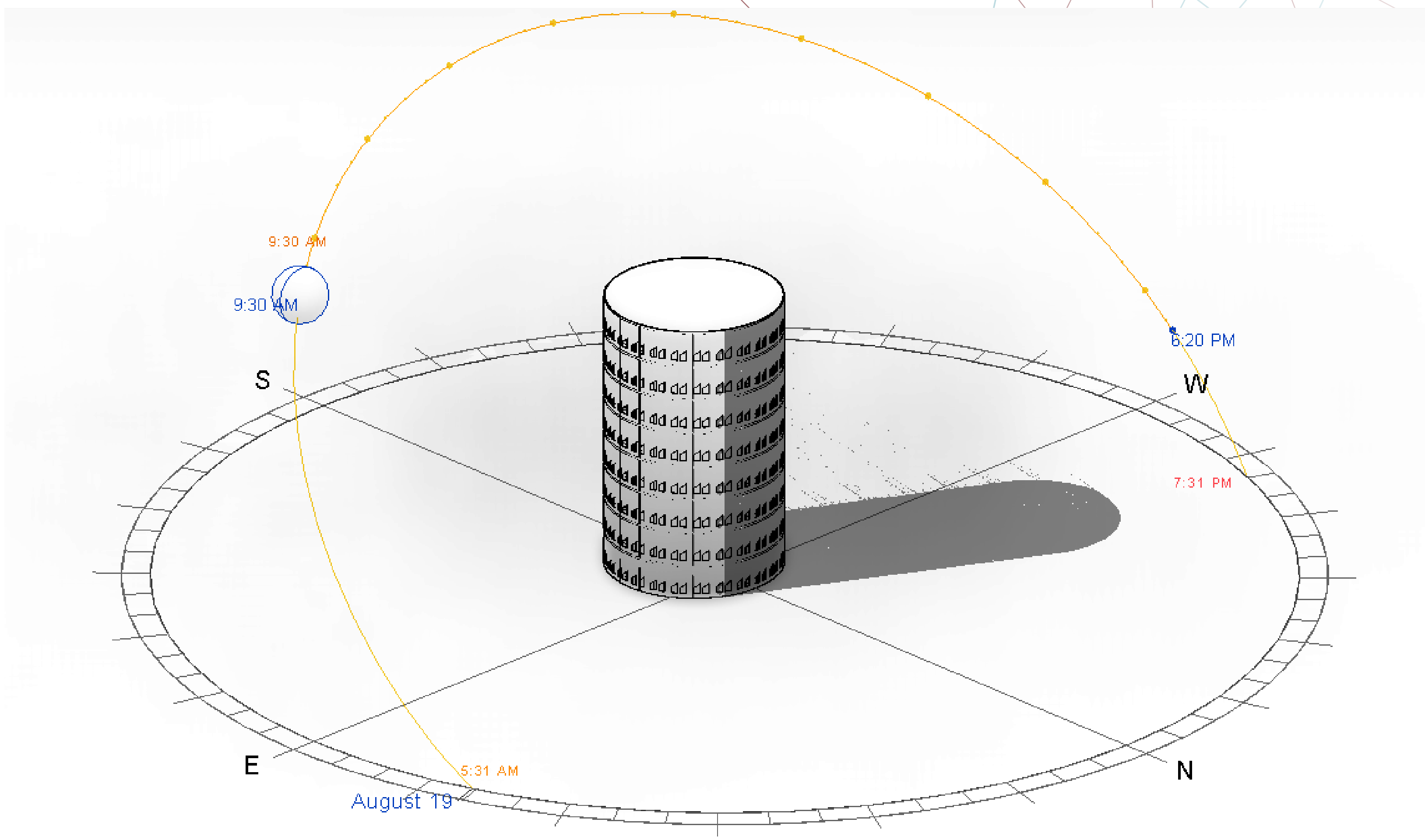
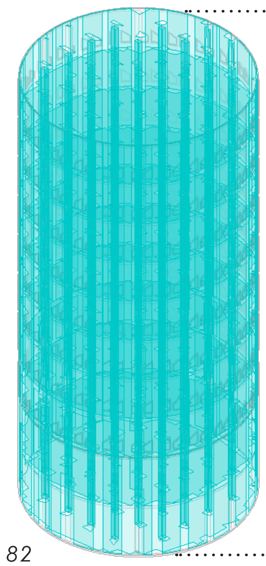


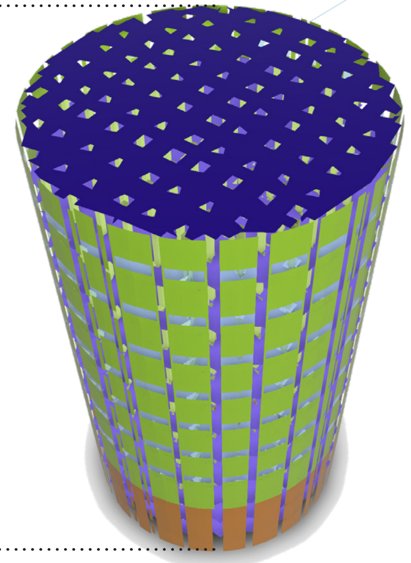
Figure 80

3D REVIT VIEW

Figures 81 & 82



ANALYTICAL MODEL



INSIGHT MODEL

The cylindrical form is the first curvilinear form that has been attempted with this workflow. As anticipated, there were no problems. I was slightly concerned that the conversion of model lines to spline curves within dynamo would not function properly, but there were no errors.

SUMMARY

Like the pentagon, the cylinder is an incredibly efficient form, and just as uncommon, if not more. The two forms have similar costs, with the cylinder coming in at \$19.5/m²/yr. The cylinder has double the amount of floors, however, and a much larger fenestration. Wind loads are very minimal on this form as it is inherently aerodynamic. There is also a large number of structural bays which could act as thermal bridges and further decrease the building's efficiency.

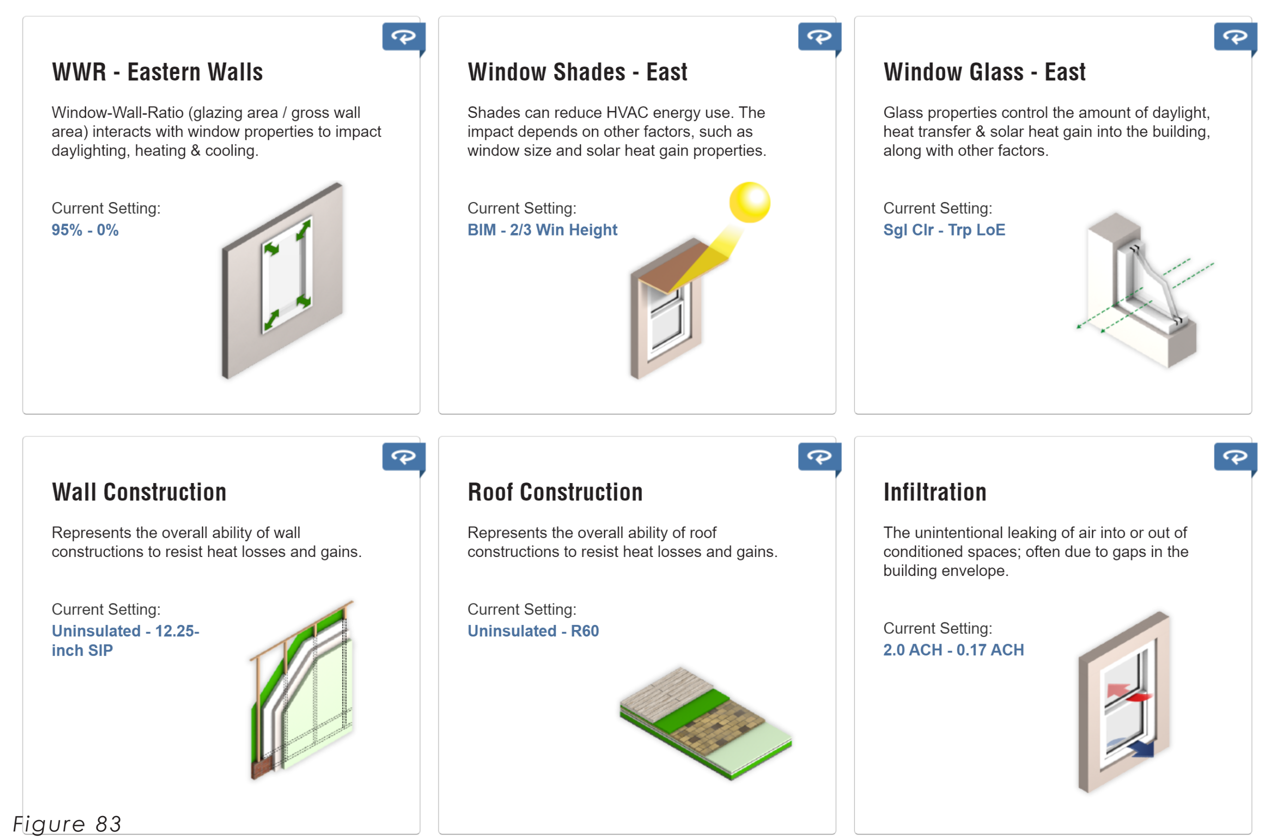
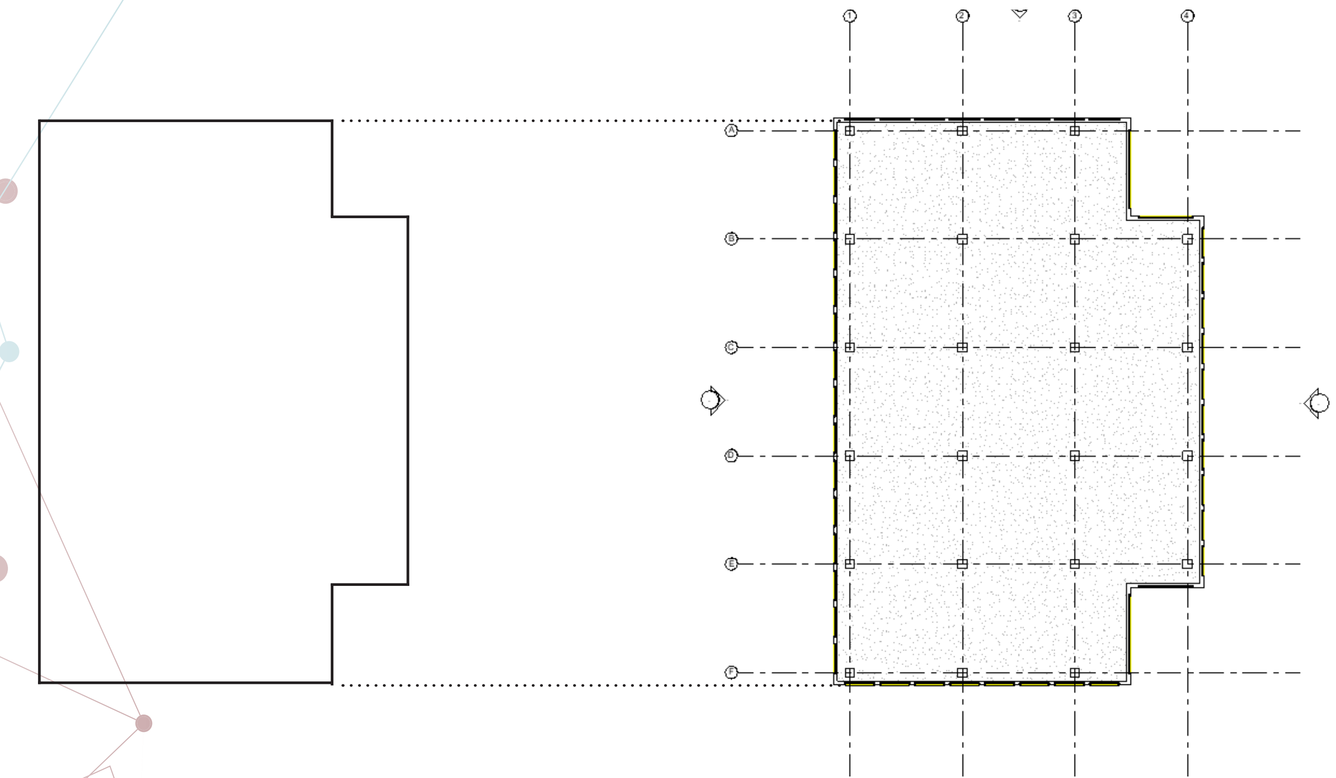
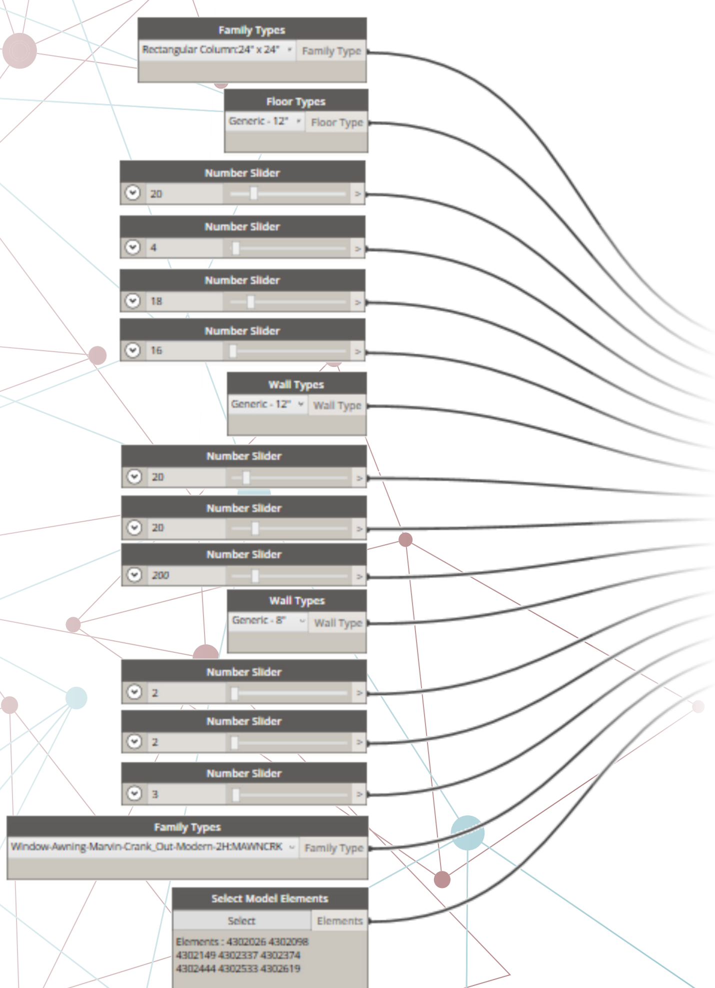


Figure 83





Figures 84 - 86

SIMULATION 5

The last simulation uses a typical rectilinear form with one symmetrical jog. There are 18 total above ground floors and 4 lower levels. Floor to floor heights are 16'-0" above ground and 20'-0" below ground. The envelope consists of 8" exterior walls, 12" foundation walls, and operable ribbon windows. This building form is very common in the more heavily populated cities in the U.S.

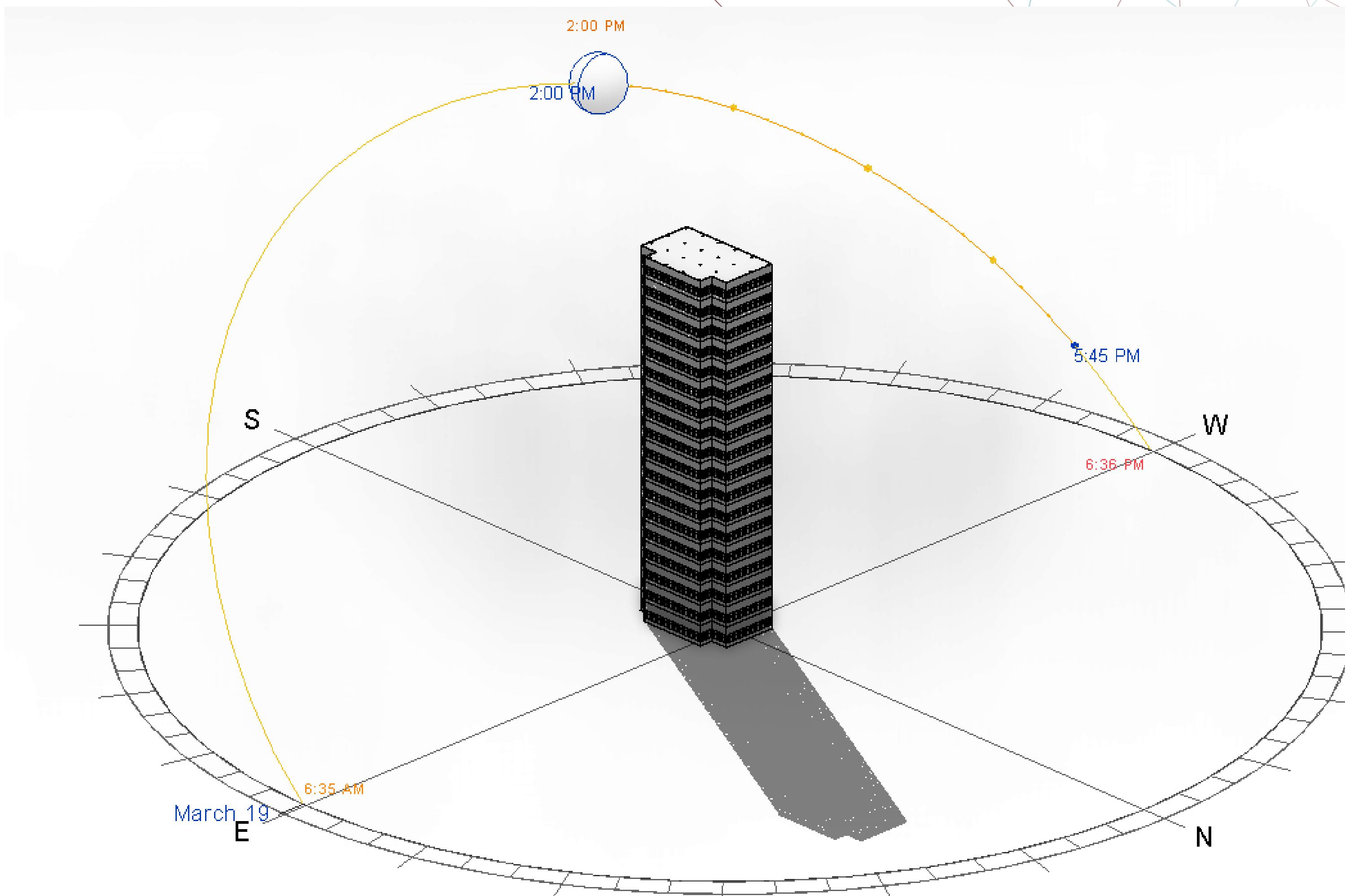
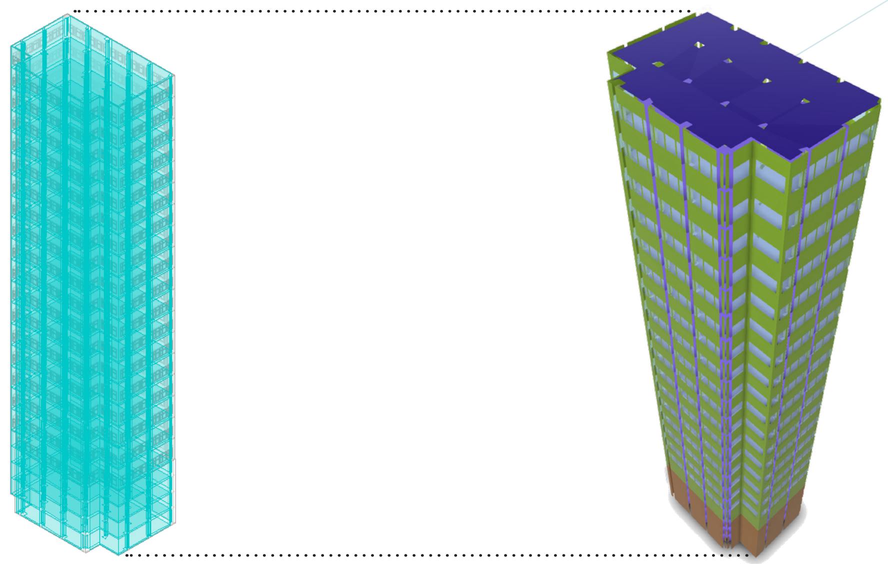


Figure 87

3D REVIT VIEW



Figures 88 & 89

ANALYTICAL MODEL INSIGHT MODEL

This model is consistent with many of the mid-rise developments of North America. Ribbons windows were used to mediate between full-glass envelopes and regular punched openings. The large, uninsulated surface areas of the envelope have increased the energy loss of the building.

SUMMARY

With the specified parameters in mind it is easy to understand why energy costs are at \$23.3/m²/yr. With no insulation, energy is leaking out of the building like a sieve. Insight shows us that rotating the building may improve the buildings performance, something that may dramatically affect many of the design consideration thereon. Of course, this would only apply to new construction. Insight also provides individual analysis of each of the elevations in the four cardinal directions. Recommendations are given for the walls and openings to improve the building's performance.

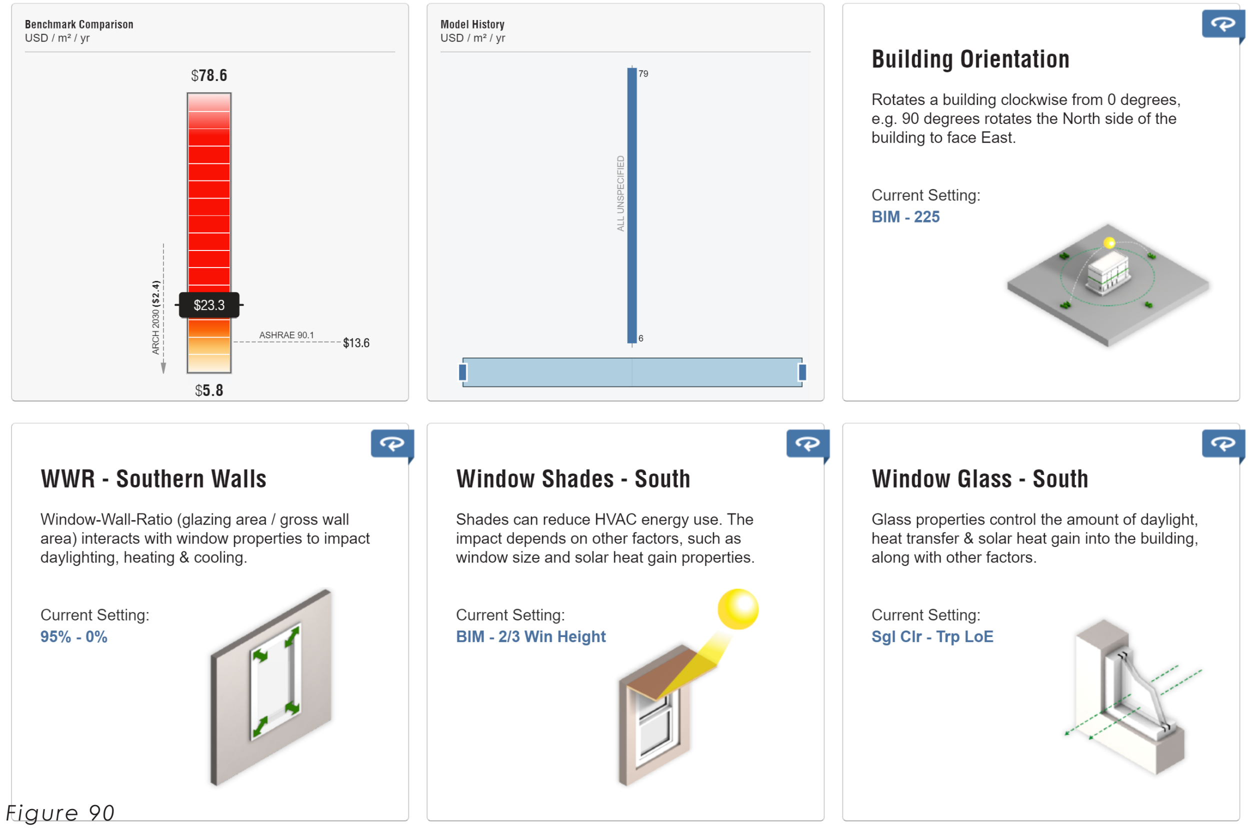


Figure 90

PERFORMANCE CRITERIA: STANDARDS

WELL BUILDING STANDARDS

The WELL Standards provide the framework for this project's performance criteria. After a model is tested, and the diagnostics have been calculated in Insight, the values can be compared to each individual standard to check its performance. From here, the variable inputs and dynamo can be changed to make the most efficient building possible for the basis of design. Other designers are not limited to the WELL Standard, they can use this workflow to test their project's performance against standards like LEED as well.

In modern buildings, there are a number of similarities that make adaptive reuse a bit easier than buildings of other time periods. These buildings share similar mechanical systems, materials, organizations, structural systems, and so on. This means that similar adaptive reuse strategies can be used on each project, limiting the amount of time designers need to spend searching for the correct solution to optimize their project. There is no one correct solution, which is why the Revit-Dynamo-Insight is so important to determine which solution is the best.

WELL BUILDING STANDARD CATEGORIES

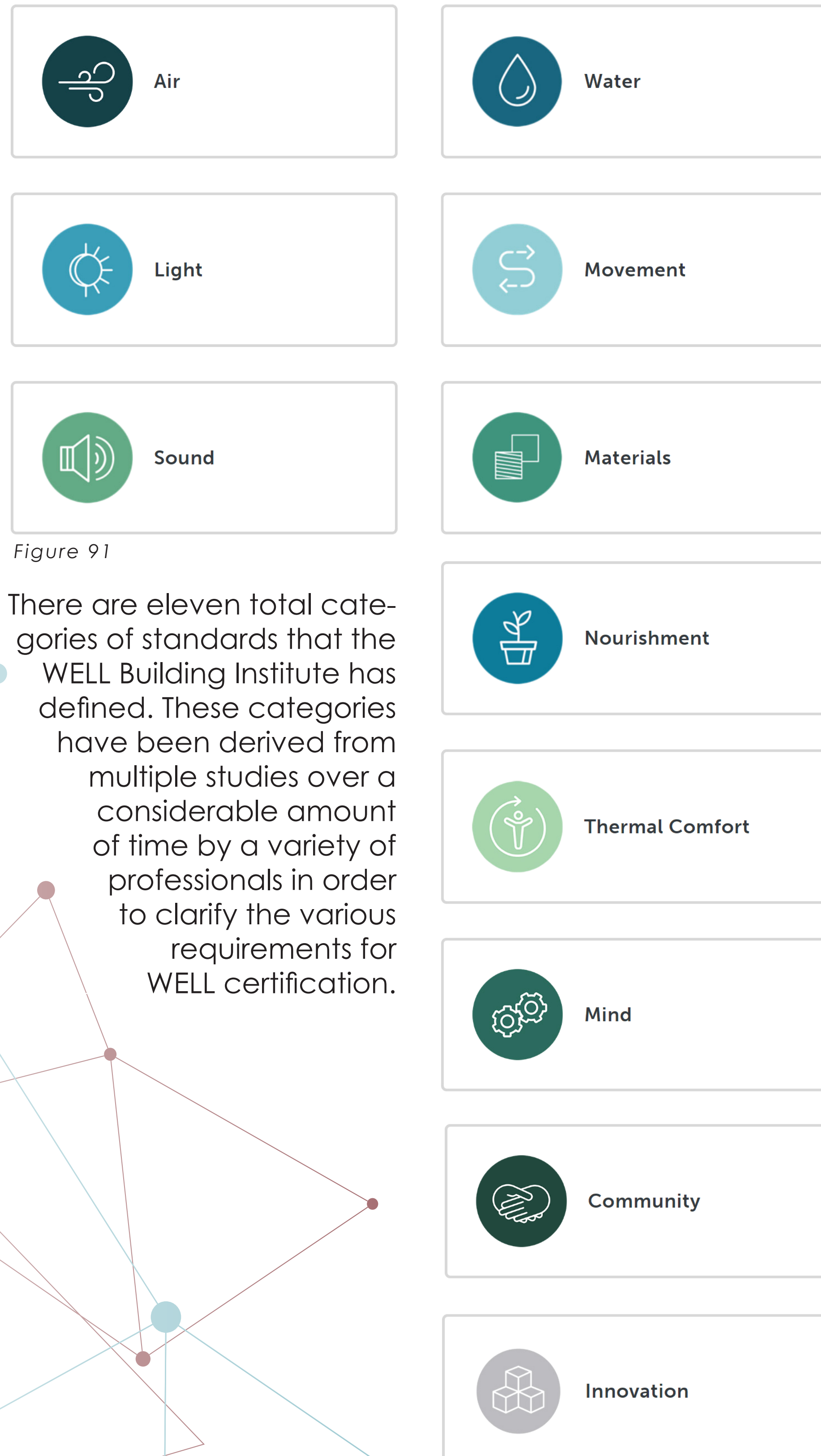
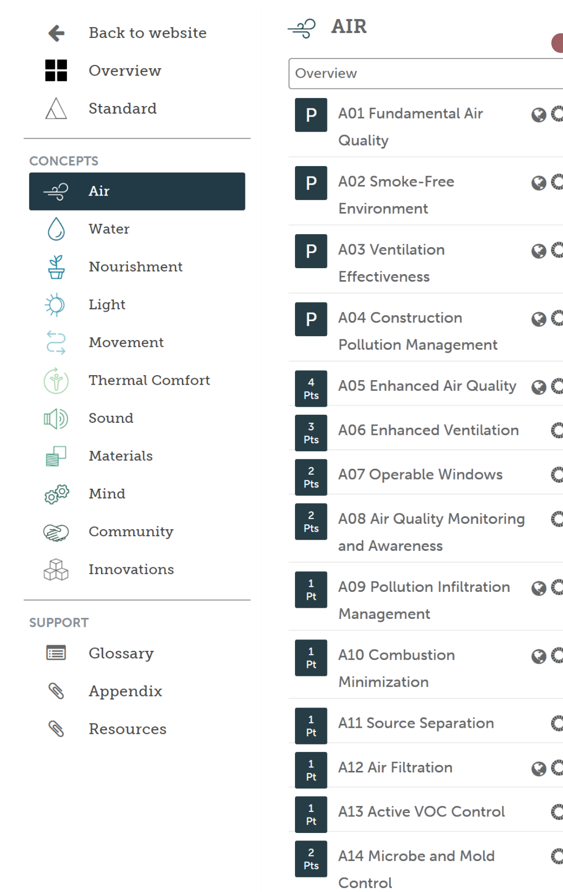


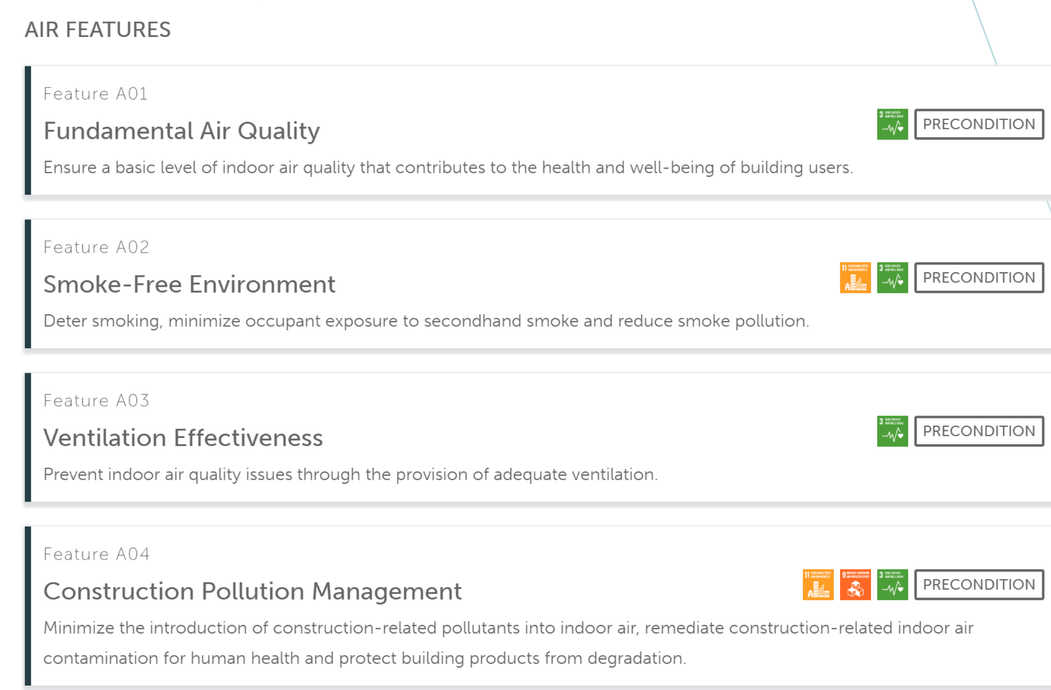
Figure 91

There are eleven total categories of standards that the WELL Building Institute has defined. These categories have been derived from multiple studies over a considerable amount of time by a variety of professionals in order to clarify the various requirements for WELL certification.

CRITERIA - AIR



Each of the categories has a very specific list of criteria and benchmarks, with points associated to each one that must be met in order for a project to gain WELL Building certification.



Figures 92 & 93

RESEARCH RESULTS

CONCLUSIONS

After spending a great deal of time researching adaptive reuse strategies, the Well Building Standards, computational design, and performance analysis simulations, I found it necessary for a user-friendly workflow to be created. This was further reinforced after practicing adaptive reuse in the professional world with Zerr Berg Architects located here in Fargo. Earlier it was indicated that performance analysis is often overlooked due to the amount of time it takes, often during a phase in which work is not yet guaranteed. In this case, it is incredibly important to not spend too much time in this phase, as it wastes valuable company resources. At the same time, it is of almost greater importance to be able to produce accurate, clean, and convincing drawings rapidly to secure the work at stake. Therefore, it became critical to develop this workflow, and to test it within a professional context to confirm its validity. Fortunately, A synthesis of design tools has made the success of this workflow possible.

Initially, a different outcome was desired within this research, but early findings helped to inform the correct hypothesis and the resulting conclusions from its tests. The overarching desire for usability and accessibility of the products of this research was also achieved, as the workflows will be made available through the Autodesk Refinery Beta.

From the studies within this report, it is now understood that a visual programming approach can be used to aid in a project's performance analysis. The workflow will be used within my future design, as early as possible to place an emphasis on sustainability and conservation. The workflow is very adaptable itself and can be modified to suit specific parametric requirement in future projects. This makes the workflow itself one of the most important products of this research, along with the actual findings that the workflow has been designed to produce.

The WELL Building Standards have provided a vast amount of knowledge as to what elements affect occupant wellnes, and at an incredibly specific level of detail. From this research, the project has a much more guided sense as to what wellness is, have to achieve it with architecture, and how it can be analyzed.

Together, the research of adaptive reuse, the WELL building standard, and computional design have created a strong foundation for the basis of a design later on in the project. After using this knowledge to select a site, the research can then be applied to create an adaptive reuse project which maximizes occupant wellness.

LITERATURE REVIEW

Title: Buildings and Stories: Mindset, Climate Change, and Mid-Century Modern
Author: Mark Thompson Brandt

OVERVIEW

"A global attitude adjustment that strongly prioritizes sustainable rehabilitation of our existing resources over new creation is required in order to meet critical climate change and other environmental targets (Brandt 2017)." An impassioned architect and conservationist, Mark Thompson Brandt's is well established in the field of adaptive reuse. His article offers insight into the necessity of architectural sustainable rehabilitalion and adaptation, specifically pertaining to the buildings of the Mid-Century Modern period (~1945-1975). Brandt points out the emergence of new sustainable initiatives across several different areas of the both the global economy and professions, and hypothesizes that the rehabilitation and rejuvination of modern-era buildings willl become the major focus of the architectural field for the next few years.His points on sustainable renovation, the value of existing resources, and the need for an attitude adjustment in regards to climate change are in keeping with the ideology of the theoretical premise of this thesis. Many of Brandt's motivations for his article are the exact same as the ones for this thesis. Though some of his points are simply conjecture, many of them are rooted in thorough research and anaylsis of social and economic trends and the green movement. The article offers a considerable amount of information about the building explosion in the mid-century modern period as well as the movement towards green initiatives, but it fails to offer much persuasive evidence for the need of radical change. This does not diminish the argument or the cause, but it does help reveal the areas of weakness in the arguments for conservation and sustainable renovation.

CHANGE OVER TIME

Like everything else in the world around us, buildings are subject to a vast amount of change over time. These changes usually happen when buildings take new ownership, change functions, become outdated, or are alterred in some other respect. Some may be hesitant when presented with change; building owners may be wary of renovation costs, conservationists may argue that change is destructive, and others may not be comfortable with something new. (Brandt 2017) refers to British Architect Edward Hollis's Book *The Secret Lives of Buildings* in his article, describing a passage in which Hollis tells us that change over time is good for buildings, and even helps to preseve them:

> *Buildings are less portable than stories, but there are significant parallels between their modes of transmission…. Each alteration is a 'retelling' of the building as it exists at a particular time – and when the changes are complete, it becomes the existing building for the next retelling. In this way the life of the building is both perpetuated and transformed by the repeated act of alteration and reuse….For stories and for buildings alike, incremental change has been the paradoxical mechanism of their preservation….They have endured in a way that they would have never done if no one had ever altered them.*

Hollis and Brandt's shared values and progressive ideology presents a formidable argument to the opponents of change. Buildings would not be able to survive as functional working spaces if they are not modified to fit the needs of the times or new functions that the building might take on. These changes do not serve to diminish the history of the building, and in fact supplement it by writing a new chapter. Changes often serve to help the community and the people who own and occupy the buildings. For these reasons, architectural change over time is a powerful force.

LITERATURE REVIEW

UBIQUITY & FLAWS OF MID-CENTURY MODERN

After the second world war, America's economy was booming. Troops were coming home, starting families, and returning to work, which created a surge in the amount of jobs in the United States, particularly in the construction industry. In the design field, new architectural trends in the modernist styles rewarded the use of functional architecture and the open plan, and scorned the use of ornamentation and frivolous design embellishments. Leaders in the modernist field such as Le Corbusier, Walter Gropius, and Mies Van Der Rohe adopted Louis Sullivan's theory "form follows function" as moral principles and applied it in their designs. Their simple, practical forms with open plans and clean lines set a new precedent in contemporary architecture, and a wave of new buildings designed in the modernest style began to sweep the country. Technological advancements and changes in social trends created a movement away from natural materials and encouraged the use of new, experimental materials and building systems in these designs, in keeping with the 'fast-forward' expansion of the times. Many of these systems and materials are unsustainable, irreplaceable, harmful to the environment, and/or cause the building to perform poorly in energy expenditure. This has left us with a built environemt that is full of "a very large stock of unsustainable historic modern-era buildings that are coming to the end of their natural life-cycle(Brandt 2017)." The good news is, the simple form, open plan buildings of the modernist style were designed with multiple functionality (or adaptatation) in mind, and therefore make it much easier for retrofitting and adaptive reuse than buildings designed using other architectural styles. Brandt reasons that the sheer volume of mid-century modern era buildings approaching the end of their normal life cycle will cause increasingly more architects to face the fact that adaptive reuse is a key element of their work. These findings and additional research have narrowed the focus of this thesis to mid-century modern buildings.

LITERATURE REVIEW

A CHANGE OF MINDSET

Technology and changing social trends have made it easy for us to take our planet for granted, and to forget that we only have a limited amount of resources. It wasn't until the early 2000's that real widespread news of the evidence of climate change began to reach U.S. citizens. Even so, many have not made any kind fo changes in their lifestyles to help reduce our species' carbon footprint. Brandt reasons, and many agree, that this is the only real way to delay or avoid the inevitable disaster of climate change. "Our existing resources should play greater roles in the full range of accommodation solutions going forward... We know in North America that our existing structures, most of which are mid-century modern buildings, consume more than a third of our energy and half our natural resources (Brandt 2017)." As time goes on, sustainable ideology will continue to progress, and an increasing amount of people will see the value of 'going green.' Education, time, and active intervention are the only ways that we can successful change socio-cultural mindest.

CONCLUSION

The necessity and possibilities of sustainable renovation are very apparent after reading this article. After pondering how to facilitate change, it became apparent that the most effective ways to influence change usually involves profit for the investor. Rarely are projects built that have a negative pro-forma, if ever. For these reasons, finding a way to make adaptive reuse for wellness a profitable endeavor has become another seconday objective of this thesis.

Title: Twenty-First Century Sustainable Performance for Mid-Century Modern
Author: Z Smith

OVERIVIEW

Mid-century modern buildings comprise a significant portion of today's overall building stock, especially in the United States. These buildings were built during a time period when ernergy was cheap and plentiful and little was known about its contributions towards climate change. For this reaason, these buildings perform significantly worse than buildings of comparable size built before or after this period, consuming much more energy. Replacing these buildings entirely does not make sense architecturally, economically, or environmentally, as the amount of energy needed for the materials and construction for this to happen is substantially more than simply performing 'deep energy retrofits.' The benefits of this strategy are twofold; architects are able to preserve the good characteristics of these buildings (adaptable space, functional design, modern features) while improving upon the areas in which they are lacking (energy use, unsafe materials, sterile environments). Every building is unique in its own regard, but many of them that were designed during the mid-century modern era of architecture (~1945-1975) share similar characteristics, which are defined by their utilitarianism. The "no frills" design ideology means that as far as renovation architecture goes, these buildings are as close to a blank slate as you can be without creating new architecture. All of this supports the theoritical framework of the thesis by re-establishing the need for sustainable rehabilitation, showing its benefits, and demonstrating the amount of opportunities that mid-century modern buildings have to offer.

MID-CENTURY MODERN

"Mid-Century Modern buildings form a significant fraction of the existing building stock in North America and Europe. In the USA, they comprise approximately 25% of the buildings and 21% of the total floor area of commercial buildings... (Smith 2017)." This statistic alone goes to show the sheer amount of buildings that were created during this time period and the amount of untapped potential that they have for adaptive reuse, in which new, vibrant environments can be designed to improve human quality of life. Mid-century modern buildings were built in a period between 'passive' and 'active' design strategies. Buildings built before relied on thermal mass, passive ventilation, and natural light and views using moderate amounts of glazing. Even after electric lighting became widepsread, the heat generated by incandescent bulbs made their operation limited. This limited the area of floor plates to the extents that fresh air and daylight could penetrate from the exterior. This meant that lighting, heating, and cooling had to be controlled by mechanical devices such as louvres or blinds that could be controlled by occupants. Some of these strategies were lost at the introduction of modern design, when air conditioning, flourescent lighting, and advanced curtain wall systems freed designers from previous constraints. Mid-century modern buildings would now (more often than not) have sealed facades, often with a high amount of glazing, with heating and cooling actively regulated by mechanical systems. This new architectural movement allowed the open plan to flourish, but caused a signficant increase in energy use, both in terms of material production and refinement as well as building heating and cooling. How could we go backwards? The answer is simple; we weren't paying attention... until now. This thesis aims to help correct some of the problems with these buildings. They do not deserve to be torn down, as they offer an incredible amount of architectural heritage and functional space that is perfect for adaptive reuse.

LITERATURE REVIEW

HIGH ROAD, LOW ROAD

"In his book How Buildings Learn, Stewart Brand sorted the building environment into what he called 'high road' buildings – those that make into architectural magazines and win awards – and 'low road' buildings – everyday buildings that make up the bulk of the building stock (Smith 2017)." Most architects share this view. When arguing for renovation and reuse versus demolition and new consstruction, it is easy to argue for the 'high road.' These buildings were designed by famous architects or have gained notoriety for some other reason and thus must be preserved. This is a weak reason for reuse when compared to the climate change predicament, and in reality these buildings make up a small portion of the building stock. Therefore, the adaptive reuse and sustainable rehabilitation of the 'low road' buildings is much more critical to the reduction of carbon emissions and energy consumption. Two separate studies were conducted, one of a 'high road' building and one of a 'low road' building. The 'high road' building in the study was the Pan American Life Building designed by SOM. In this renovation, great care was given to preserving architectural heritage as well as improving the envelope, energy use, and the interior environment. The 'low road' building was the Lamar Headquarters in Baton Rouge Louisiana. There, the design team who won the competition focused on preserving the best qualities of the building and enhancing the experience for the occupants. Both projects successfully retained the architectural character of the building while improving energy consumption, carbon emissions, and the conditions of the interior environment. Although the primary foci of this thesis are adaptive reuse, wellness, and sustainability, care must be given to the existing architectural conditions that are presented in each renovation project. It is important that we learn from our past and do not completely erase it, and this article has helped to re-establish that within this thesis. A state of balance must exist to improve our built environment.

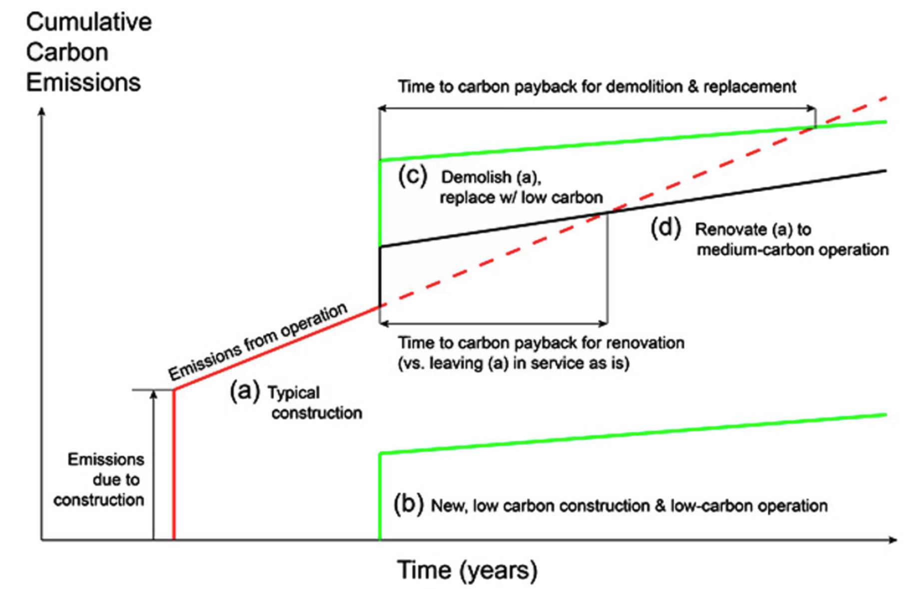


Figure 94

CONCLUSION

Mid-Century modern buildings are such a large part of the built environment that making drastic changes to them alone ('deep energy retrofits') the United State could significantly reduce the amount of energy it uses. This would be a notable feat in the fields of sustainability, since experts reason that residential and commercial buildings are responsible for around 40% of carbon emission. They also figure that the extraction, refinement, manufacturing, and transportation as well as the operation of the equipment needed to install materials for new building construction accounts for another 8-10%. This means that at the current rate, new construction roughly costs between 13-50% of a buildings total energy cost throughout its entire lifespan, which also places more importance on the necessity of adaptive reuse and sustainable rehabilitation. A return to the use of passive design strategies must be used in tandem with modern building systems, materials, and technologies.

LITERATURE REVIEW

PROJECT JUSTIFICATION

Wellness and Adaptive Reuse were never things that were very important to me prior to begining my architectural education at NDSU. Throughout this process, we have been taught not only design and drafting, but also how to design more functional, inviting, and safe spaces that are aesthetically pleasing. This isn't always easy in the face of today's market, and most people are still reluctant to accept the fact that occupant wellness is one of the most critical measures of a building's sucess.

Economically, adaptive reuse and occupant wellness pay dividends, both in terms of cost and carbon footprint. Designing new is fun, but reusing the valuable materials and spaces that vacant buildings has to offer is more responsible and can be very profitable, if the design is done properly. Communities love to see familiar places in a new light, especially when they have exciting businesses within them and contemporary finishes mixed with the existing architecture. Using the correct adaptive reuse strategies can significantly reduce energy use and utility bills. These benefits make sustainable reuse just as lucrative as new construction, if not more. It should never be excluded from the design discussion.

The Revit - Dynama - Insight Workflow that this thesis has developed could be useful tool for other architects in the profession as it allows the rapid simulation and analysis of climatic conditions, building elements, and energy use. This tool can be used for new cosntruction just as it can be used for renovation projects or adaptive reuse. Designers gain valuable information regarding the building's performance, issues present on the site, costs, and a plethora of other statistics that can be used to inform a design.

Minot in particular could significantly benefit from adaptive reuse, particularily in the downtown C3 zone. These once bustly streets became deserted at the advent of the shopping mall, as walking from store to store outside was seen as a way of the past. Due to this, this zone suffered; businesses closed, streets cracked, crime increased, and so did vagrancy in the area. Downtown became a nasty and unsafe place to be. Over the last decade, city officials have noticed the value in the existing buildings in the city center. At the time, businesses were few and far between, with most activity attributed to the residents living above the closed shops. Money was poured into a clean-up effort and new, trendy businesses such as “Off the Vine” and “The Starving Rooster.” With this, more businesses have decided to rehabilitate these old buildings and celebrate their features in their new home. The downtown area could once again become a fun and safe place for families to come and spend money to support their local businesses.

A new, model work environment here could help the community in a number of ways. Lower levels would offer companies an exciting new place to conduct business at one of the city's most notable locations. Upper floors can be programmed for just about anything. The existing parking ramp on the site was designed to have a multilevel building on top of it, creating a blank slate for new construction just across the street. This area is completely void of green space, and could also potentially benefit from a pocket park, plaza, and/or outdoor event space located in the center of the city. The underground / grade level parking facilities both on site and directly south of it are identical, and are more than an adequate for the current amount of parking, and that of the future development of the site, another fantastic reason for the development of this site. Minot has been trying to gain an identity for years. Bringing back the ‘M' could be the great first step.

ure 95

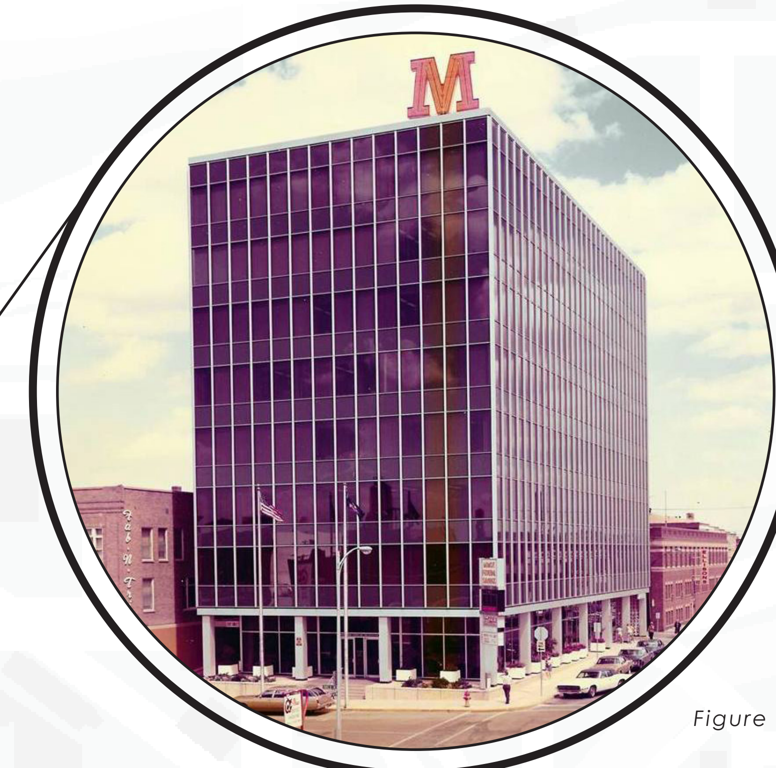
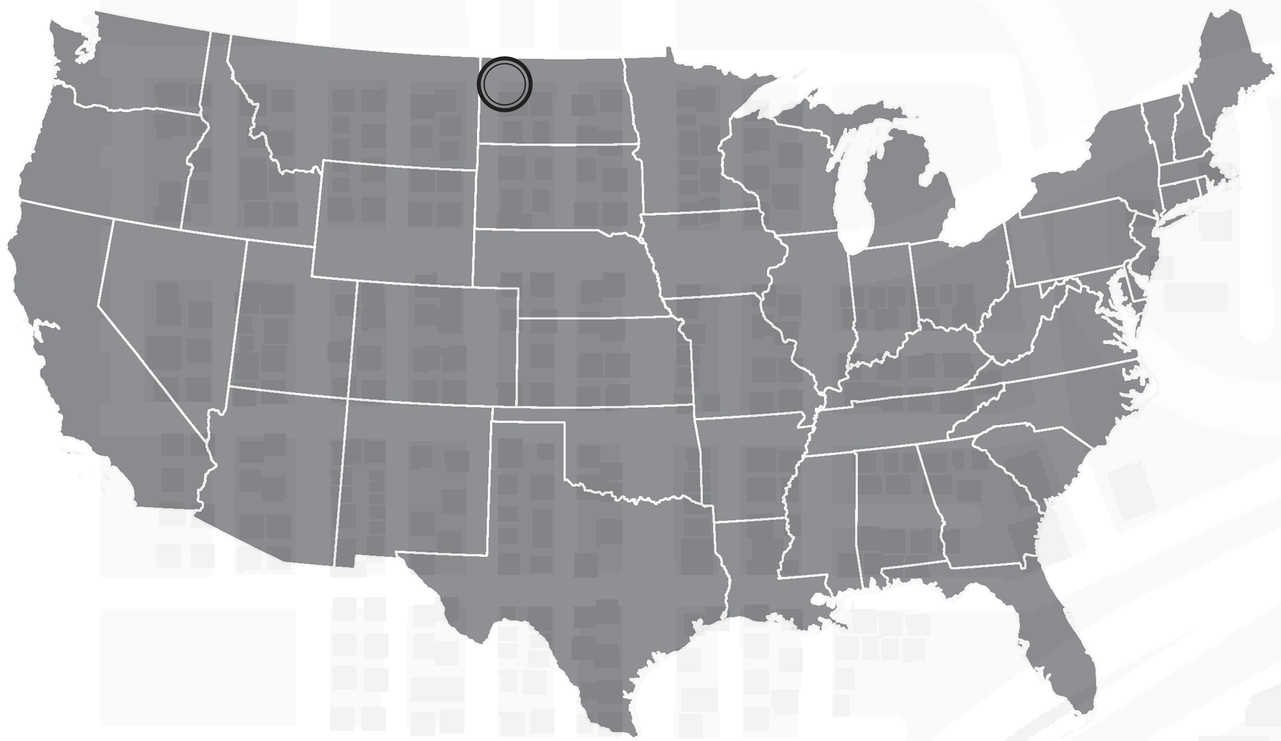


Figure 96

Site Analysis

123 1st St. SW
Minot, North Dakota 58701

CITY & STATE INFORMATION



Minot, North Dakota Demographics and Land Information
Land Area: 17.45 square miles
Elevation: 1,621 feet above sea level

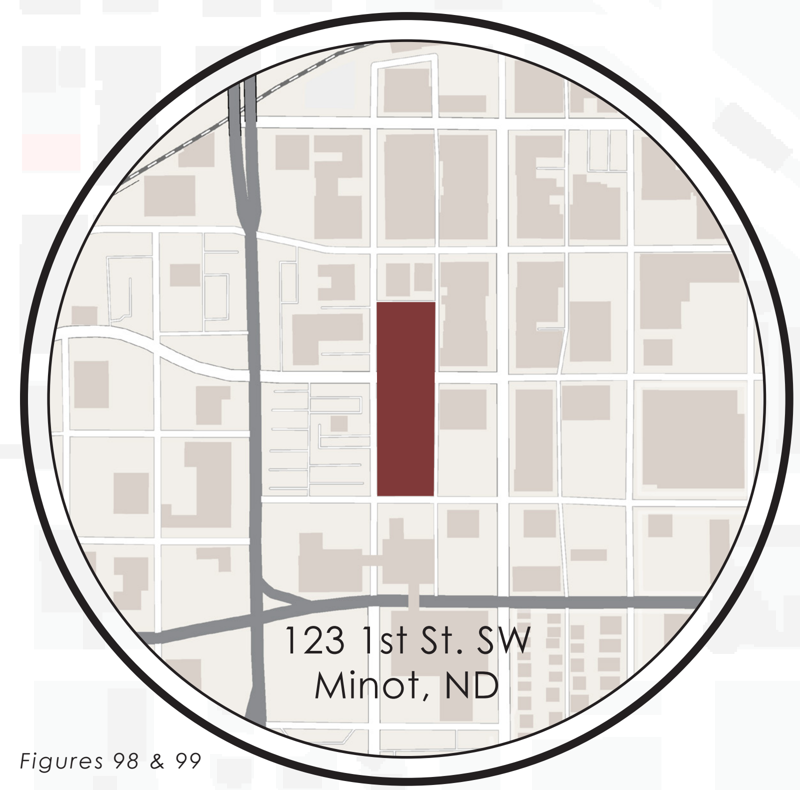
Figure 97

STATISTICS	CITY	STATE
• Population	47,338	736,162
• Population density/mi^2	1,743	10
• Median age	31.9	35.2
• Male/Female ratio	1.1:1	1.1:1
• Income per capita	$33,446	$33,107
• Median household income	$62,324	$59,114
• Median home value	$201,900	$164,000
• Poverty level	8.1%	11.2%
• Unemployment rate	1.6%	1.9%
• Most comon profession	Health & Education	Agriculture & Ag. Services

SITE INFORMATION

MUNICIPALITY CITY CENTER DOWNTOWN

SITE LOCATION



Figures 98 & 99

Zoning: C3 - Commercial / Mixed Use

The Site for this project is located within Minot's downtown district, which is zoned for commercial and mixed use. It located just one block northeast of the intersection of Minot's two busiest roadways: Broadway and Burdick Expressway.

ZONING

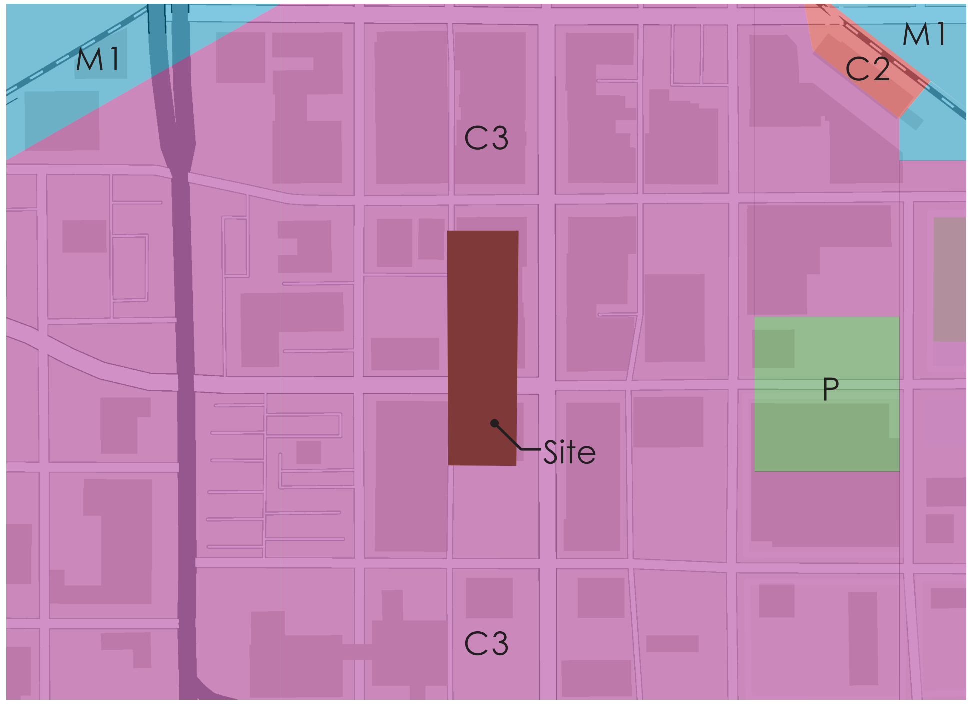


Figure 100

C3 - Central Business

The C3, or Central Business Zone in Minot is the central core business district in the downtown part of town. Multiple uses are permitted within this zone, including but not limited to retail, eating and drinking, business, assembly, public parking, and residential located above commercial use. The number of dwelling units permitted is based on the area of the lot. The C3 zone has seen increased development within recent years as more builings are being adaptively reused to suit new functions.

A new focus has been placed on pedestrian oriented design in the C3 zone, and an increase in public transit in this area has yielded higher vehicle and foot traffic. Many of the buildings downtown are historic to the city, and emphasis has been placed on preserving their architectural character while repurposing them for future use. Overall, the central business district affords a lot of flexibility for design. The constraints are as loose as they can be in terms of the city's regulations, and the opportunities for reuse are virtually endless.

CLIMATE INFORMATION

The upper midwest is known for its seasonal weather, and North Dakota is no exception. The weather in Minot (and the rest of North Dakota) is characterized by long, cold winters with heavy snowfall, and short, hot summers with high humidity and moderate amounts of precipitaiton. Fall and spring usually come and go relatively quickly due to the large fluctuation in temperatures between summer and winter. Normal summer day temperature highs between the months of June and August typically average around 79° F. Normal winter night temperature lows between the months of November and March average around 0° F.

Minot's weather is mostly characterized by is variablity in temperature, humidity, wind, and precipitation. Local residents are used to this and know that being prepared for any type of weather is vital. It is not uncommon that locals will leave for work in the morning with the heat on in their car and then return home with the air conditioning running.

Though tourism is not a huge industry in Minot, the city is the site of the state fair, which occurs at the end of July, and attracts over a quarter of a million people each year. The warm weather, long days, and break in farm work before harvest make this the perfect time for the event.

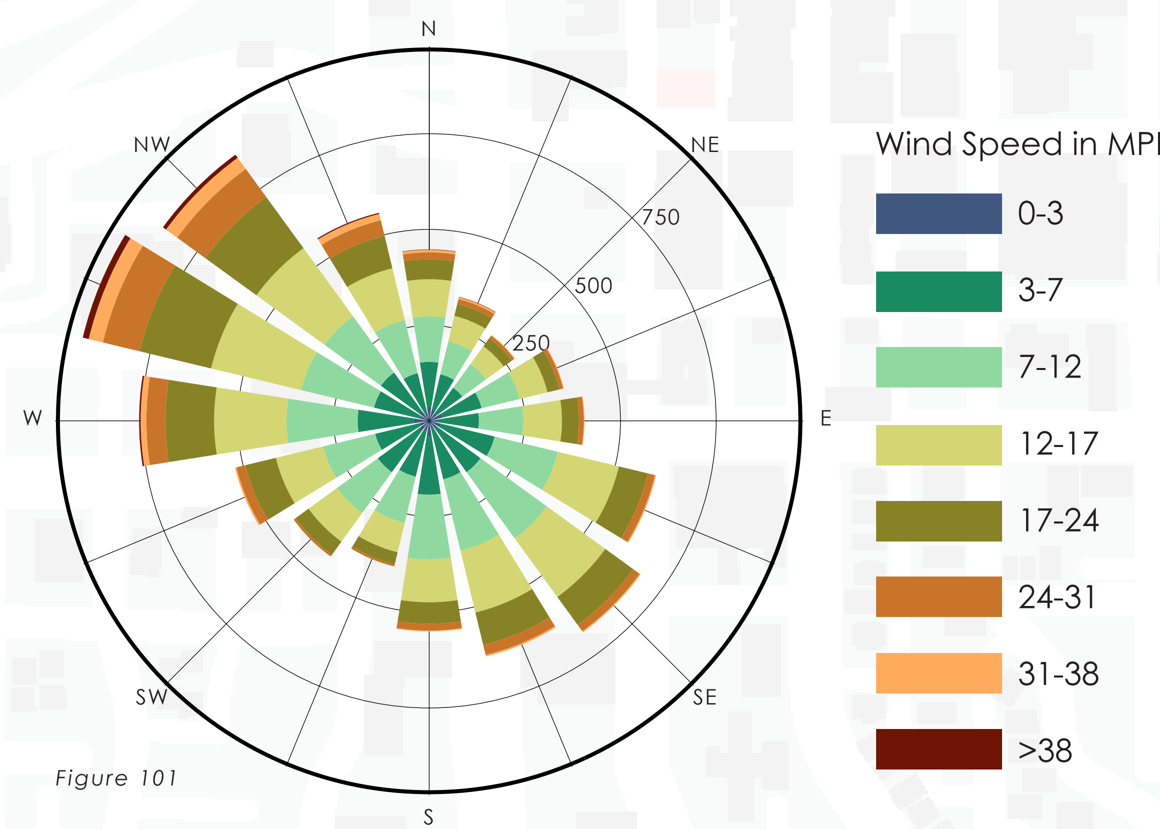


Figure 101

STATISTICS	CITY	STATE
• Population	47,338	736,162
• Population density/mi²	1,743	10
• Median age	31.9	35.2
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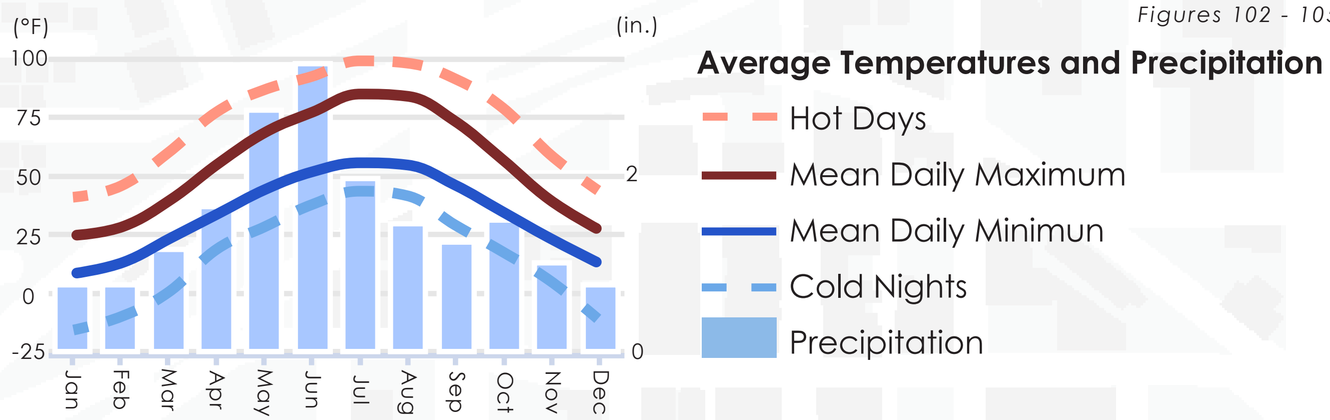
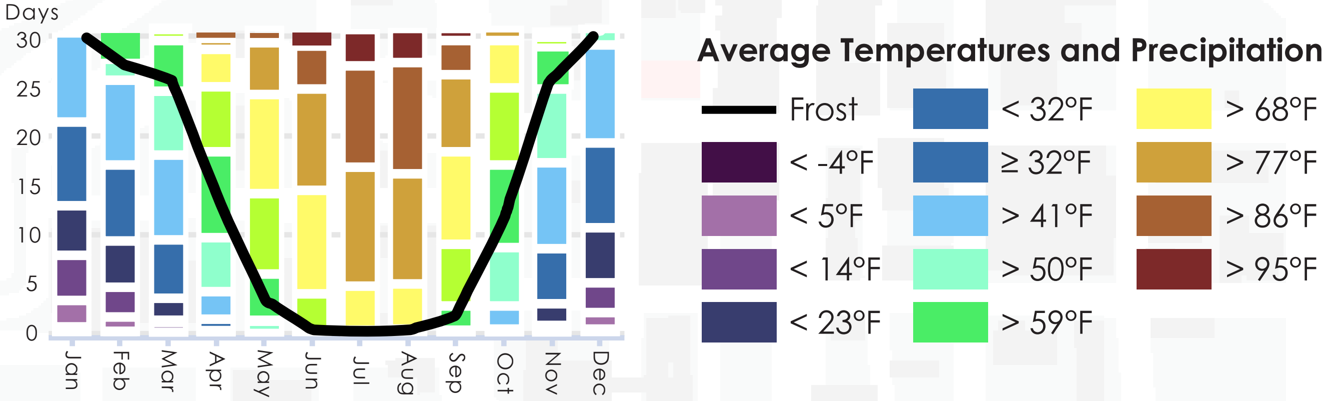
• Median home value	$201,900	$164,000
• Poverty level	8.1%	11.2%
• Unemployment rate	1.6%	1.9%
• Most comon profession	Health &	Agriculture &

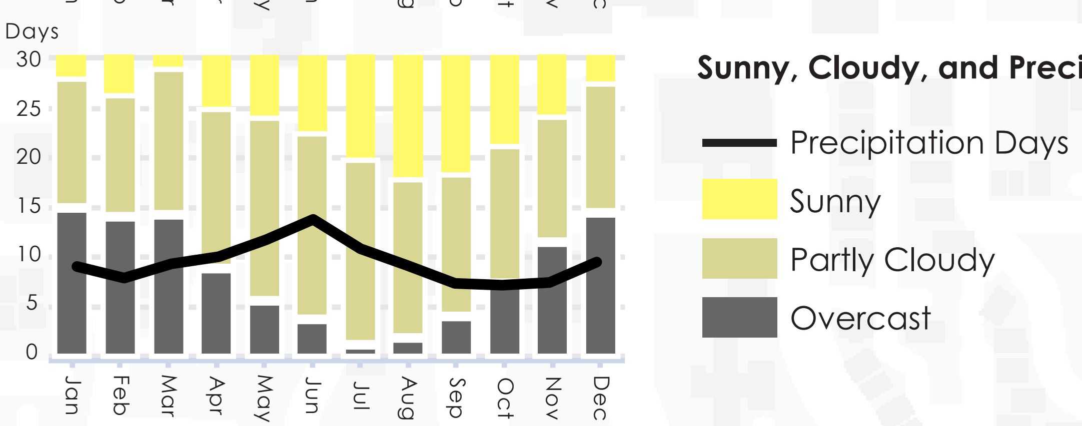
Figures 102 - 105



Average Temperatures and Precipitation



Average Temperatures and Precipitation



Sunny, Cloudy, and Precipitation Days

CLIMATE INFORMATION

Although the climate in Minot can be unpredictable and temperatures vary coonsiderably, residents enjoy the variety that all four seasons have to offer and pride themselves on adaptability. Summers in North Dakota are the highlight of the year for many. People tend to take long weekends, and go to the lake, camp, or spend time relaxing at home. A quick change in color of the leaves marks the beginning of fall, which seems much shorter than the calender would indicate. Temperatures drop rapidly through Sepetember and October, bringing the end of harvest for the many farmers in the surrounding area. Winter brings new activities and new tasks. The Souris River and nearby lakes freeze over, spurning masses of ice fisherman to create temporary cities on the ice. Many farmers also tend cattle, making the winter months an equally busy time. The spring is a welcome relief from the harsh cold, although sometimes, as Minot residents will tell you, it's a fake spring before the real one arrives. The snow melt leaves the town messy, but irrigates the soil. Ultimately, the four seasons are necessary for the area's economy to continue.

Figure 106

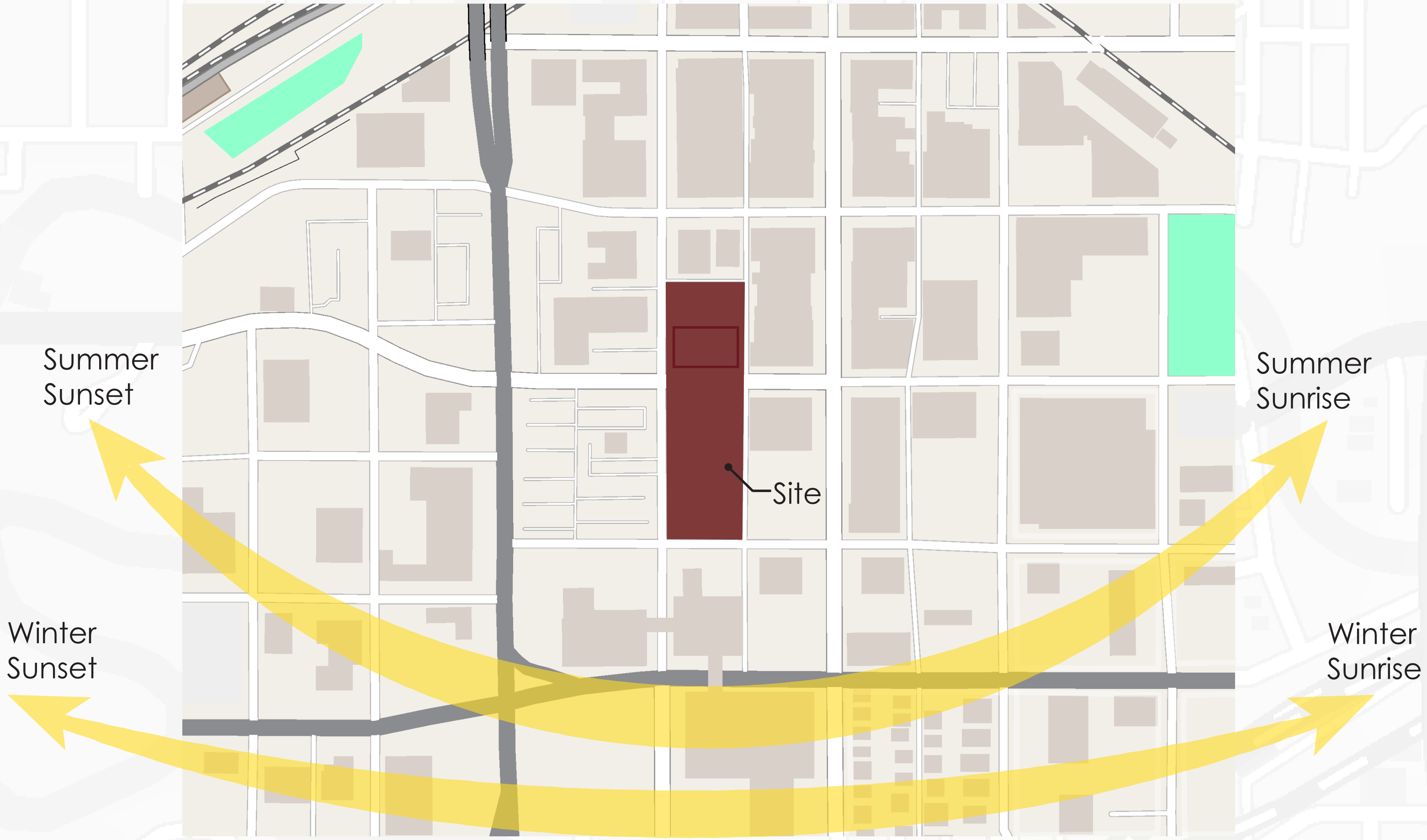
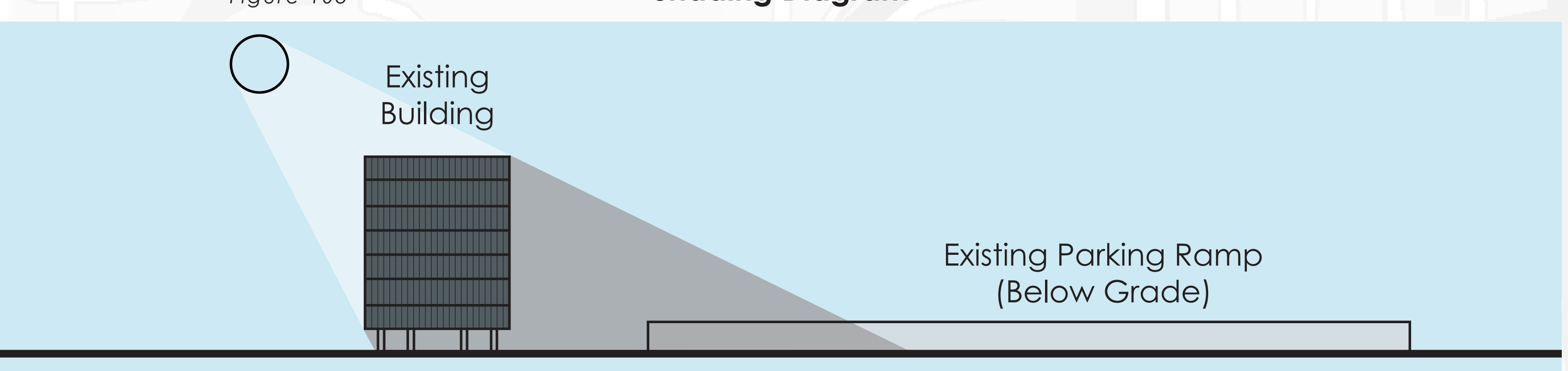


Figure 107

The site has ample acces to the sun. The existing hospital complex to the south may block some solar energy on the southernmost parts of the site, but only for a small part of the year since the buildings in town aren't relatively tall. The existing building on site is one of the tallest at 8 stories.

Figure 108

Shading Diagram



View of the exsting building on site

The existing building that has been selected for adaptive reuse is located at 123 1st St. SW in Minot. The building is definitely noticeable as it is one of the tallest in town, and the only to sport a completely glass facade. Tragically, the building has been mostly vacant since Midwest Federal Savings & Loan went bankrupt and liquidated the property.

Views of the surrounding sidewalks

In recent years, Minot has made renewed efforts towards revitalizing its historic downtown area. For years, downtown was a place that was unsafe to be at night. A clean up effort as well as new infrastructure and architecture have transformed this area into an up and coming arts and entertainment district. There is still much work to be done, as vacancy is still high.

View of the on site parking ramp

For the past few decades, the city has been been struggling with the issue of parking downtown. Several years ago, a group of investors proposed two below grade parking ramps with mixed use facilities located on top. Issues arose during construction, prompting the investors to pull out, leaving Minot with two hideous parking ramps that don't have enough drivers to fill them.

Figures 109 - 111

TOPOGRAPHY

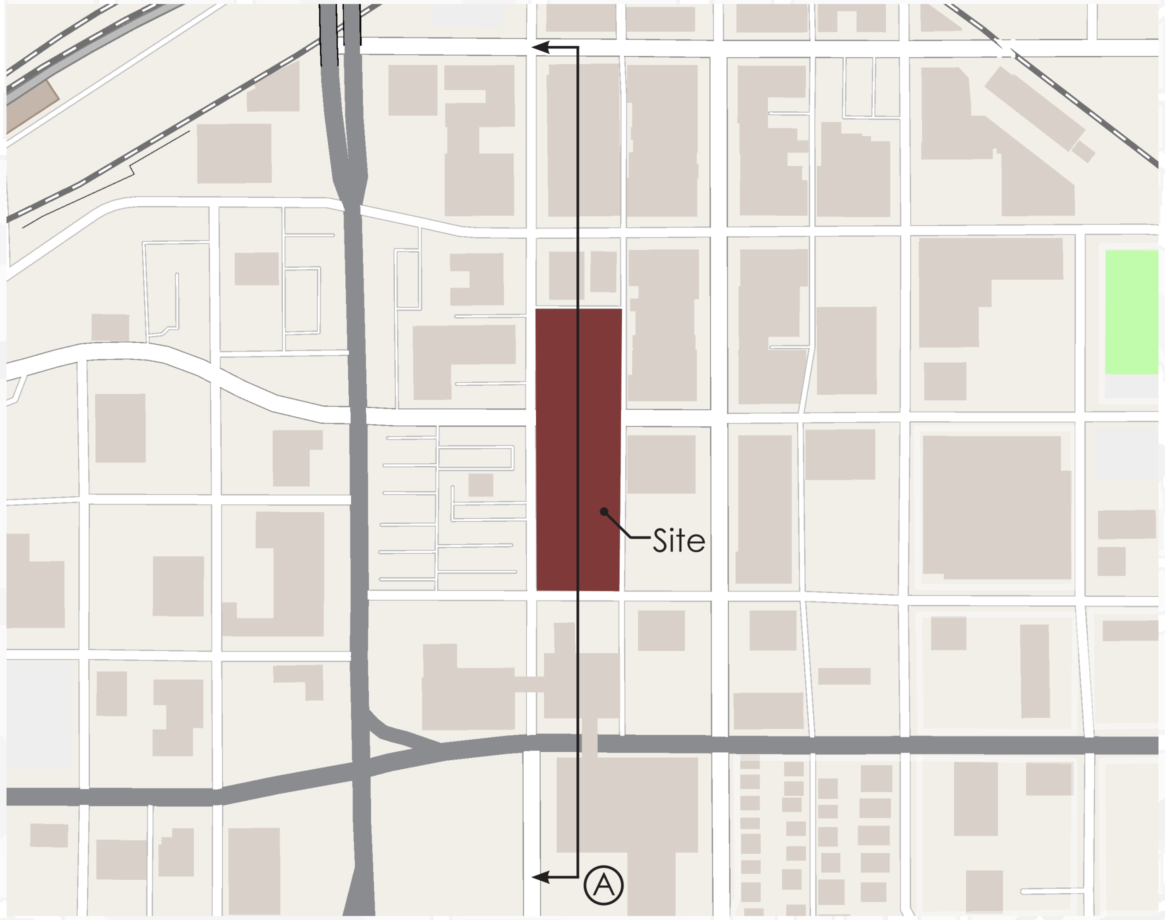
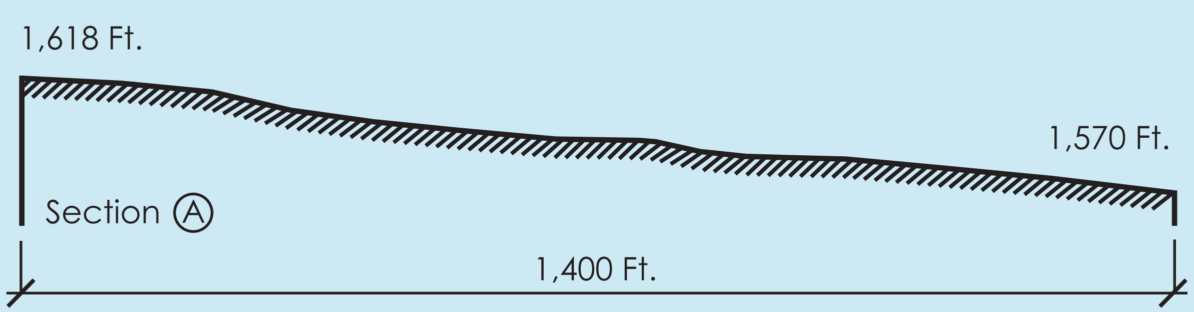


Figure 112

Minot is centered in the Souris Valley, the bottom of which is home to the Souris River. The land gently slopes towards the water, though some areas are much steeper than others. The site is far enough from the river that groundwater is of little concern and flooding is virtually impossible.

Figure 113

Site Section



SITE VIEWS

View of the existing curtain wall

The Midwest Federal Savings & Loan Building, Minot Building, or 'M' Building, was designed in the internation style by Brunner, Hoeffel, Bohrer, & Associates, with construction completion occuring in 1962. Like most other international style buildings of that era, this building had high amounts of glazing, little exterior insulation, and a steel structure.

Main street, one block east of site

Main street, which is located just one block to the east of the site, is the epicenter of the rebirth of the downtown area. Many new businesses are being created here, and the community has rallied in their support. Locals take pride in the goods and services that are created and provided by their neighbors, and will spend the extra dollar to lend their support.

North bank of the Souris River

The site is located within a half mile of the Souris River, which cuts through the entire town. In 2011, a record setting flood devastated the city, temporarily displacing thousands and causing millions in damages. Although the site is within close proximity, it is much higher than even record flood levels, leaving it safe from the threat of future flooding.

Figures 114 - 116

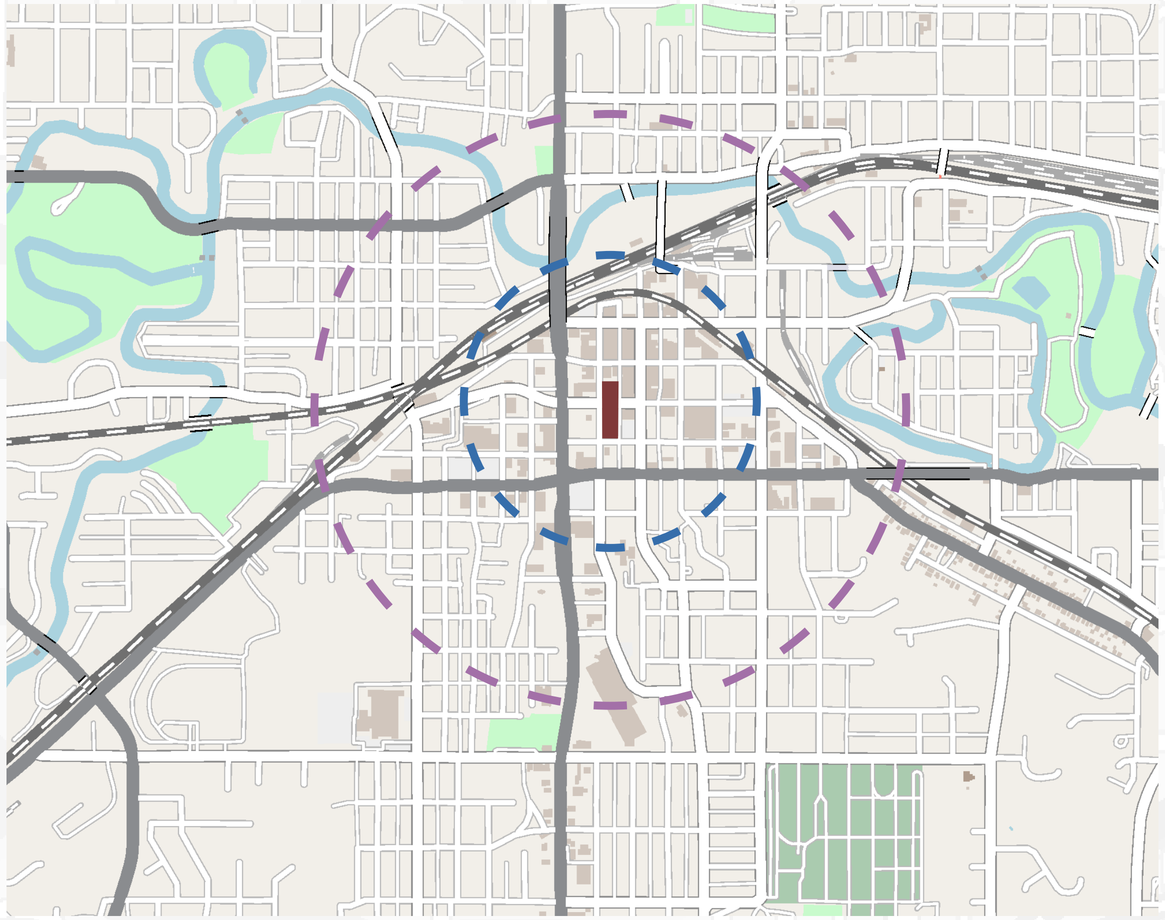


Figure 117

The site is very walkable, with a variety of goods and services withiin a 10 minute walking distance. Minot currently does not have many bike lanes, but the downtown sidewalks are much wider than most areas of the city, making pedestrian travel safe and efficient.

Figures 118 - 119

- Highway
- Residential road
- Train Tracks
- 1/4 Mile walking radius
- 1/2 Mile walking radius

Pedestrian bridge over rails near site

Minot is not a very pedestrian friendly town, though there are a handful of pedestrian bridges crossing both the river and the railroad tracks within the vicinity of the site. An increase in public transit as well as a new network of sidewalks and walking paths all give great promise for sustainable efforts. Linking together popular businesses is a great way to increase foot traffic.

Pedestrian crossing downtown street

Winters in North Dakota are difficult, and walking during these times is seldom an enjoyable endeavour. The downtown medical facilites have a few skybridges that help link together their campus. Their value is indispensable as they allow traffic to continue uninterrupted and protect pedestrians from the cold and vehicle traffic.

Intersection of Central Ave & Main St.

Figures120 - 122

Many of the historic buildings have been renovated and repurposed to suit modern needs. Although this is true, great care has been given to preserve the architectural character of these buildings as it is an important part of the city's history. Main St. and Central Ave. have the highest percentage of these buildings, such as the federal building and the Taube Art Museum.

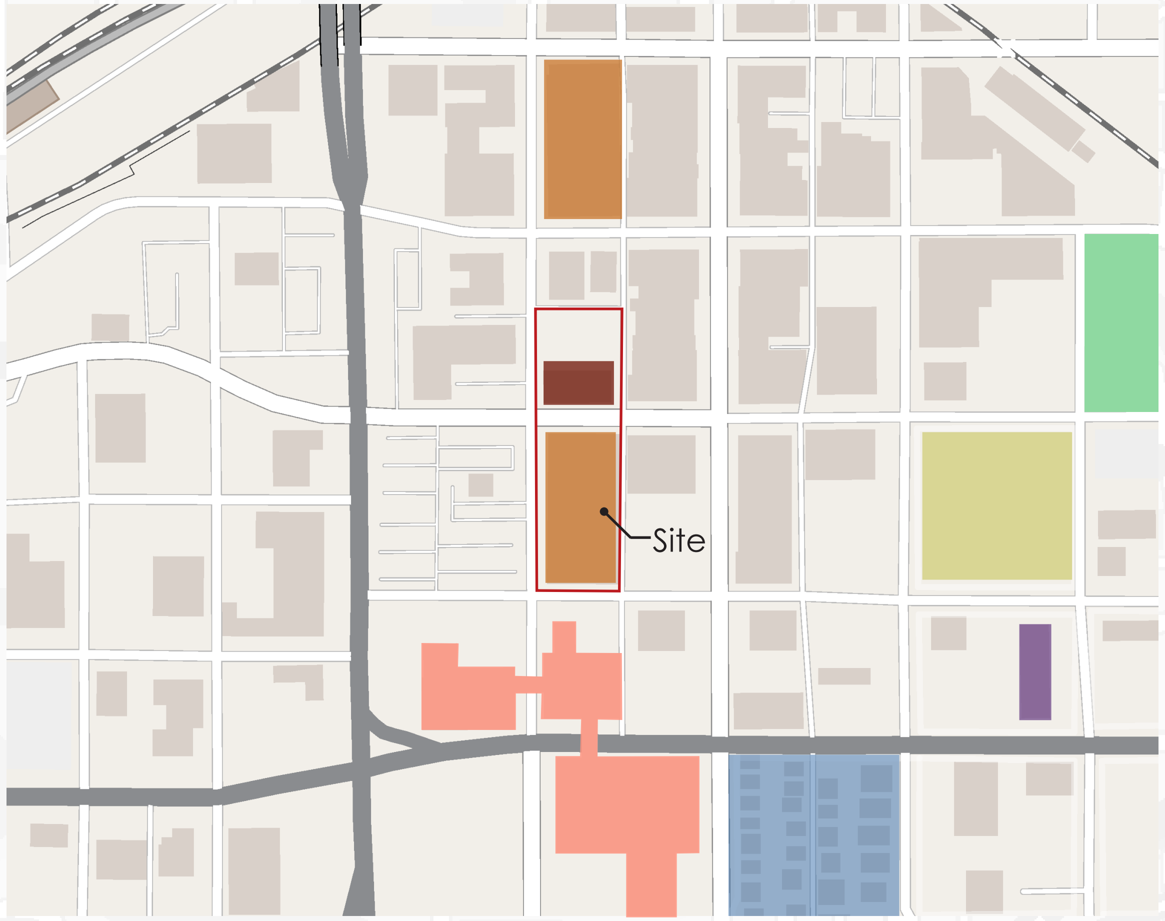


Figure 123

The site is surrounded by a variety of other building and business types. The current hospital is directly south of the site, and part of Minot's only public high school (Central Campus [yellow]grades 9 & 10) is located just two blocks to the East. There is little to no public green space downtown.

Figures 124 & 125

- Existing Building
- Parking Ramps
- Medical
- Single Family Residential
- High Density Residentia
- Education
- Green Space
- Commercial / Mixed Use

Broadway, with site in upper left

Broadway, a continuation of U.S. Highway 83, is the main arterial road in Minot. Broadway bisects the city running north to south. The site is located just one block east of broadway, giving it great access to the city's major transportation networks. The site is also just a block south of Burdick Expressway, a major aterial road bisecting the city running East to West.

View of Main St. during the holidays

Downtown hasn't quite become the billboard that Minot would like it to be, but it is on its way. City officials promote downtown events and events (especially during the holidays) to generate excitement in the area, which is a huge benefit for the area.

Vintage photo of ex. building on site

Figures 126 - 128

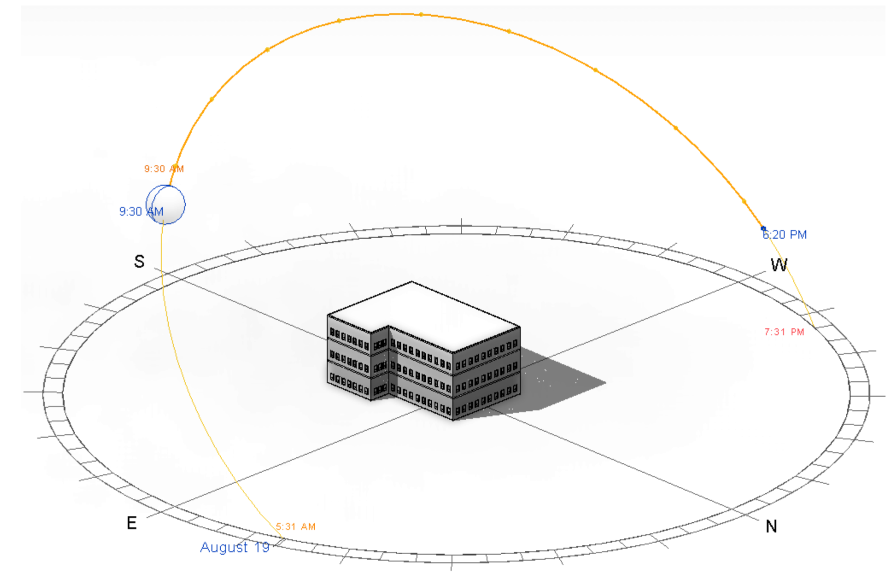
When the Midwest Federal Savings & Loan Company was still operating at the 'M' Building, it became the symbol of Minot. This was further reinforced with a large metal 'M' was placed on top of the building. The 'M' stayed lit up at night and rotate around in a 360° circle. Recently, the original 'M' was moved to the local high school football field, and was replaced by a smaller, much less noticeable one.

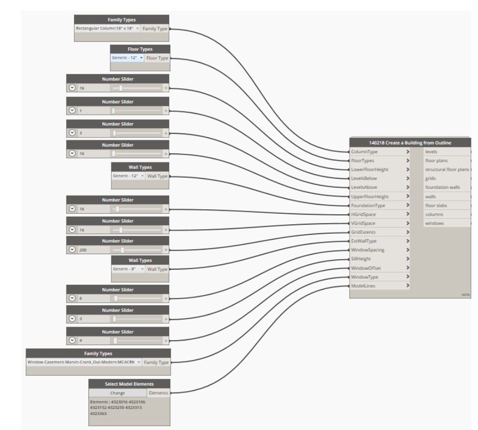
PERFORMANCE CRITERIA

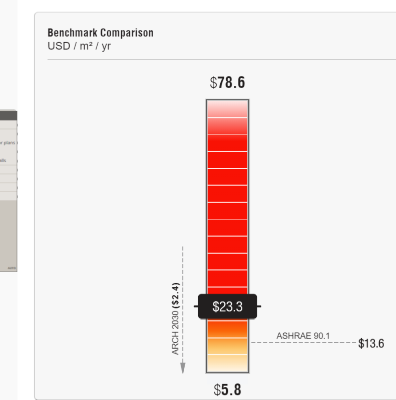
Optimizing performance standards for this site involved the use of the Revit-Dynamo-Insight Workflow developed earlier. In this workflow, Revit is the base program for operation. Model lines are drawn to represent the fooptrint of the building. From here, Dynamo is opened and the node “Building from Outline” can be used to rapidly generate a Revit model with variable inputs. This model can then be tested in the Autodesk cloud using Inisght, which provides a set of building diagnostics that can be used to measure performance. These values can be tested against any standard that is trying to be achtieved. In the case of this thesis, it is the WELL Building Standard, which focuses on the promotion of human wellness within the built environment.

The WELL Standards provide the framework for this project’s performance criteria. After a model is tested, and the diagnostics have been calculated in Insight, the values can be compared to each individual standard to check its performance. From here, the variable inputs and dynamo can be changed to make the most efficient building possible for the basis of design. Other designers are not limitted to the WELL Standard, they can use this workflow to test their project’s performance against standards like LEED as well.

In modern buildings, there are a number of similarities that make adaptive reuse a bit easier than buildings of other time periods. These buildings share similar mechanical systems, materials, organizations, structral systems, and so on. This means that similar adaptive reuse strategies can be used on each project, limitting the amount of time designers need to spend searching for the correct solution to optimize their project. There is no one correct solution, which is why the Revit-Dynamo-Insight is so important to determine which solution is the best.







Figures 129 - 131

Although other programs may be able to model forms and test energy quicker, the accuracy and level of detail that Revit, Dynamo, and Insight offer is unparalleled, and the speed is nothing to be ashamed of either. Most models can have a full diagnostic set completed in less than ten minutes. Also, the testing is done in the cloud, so it is completely hands free, meaning the only things the architect has to do is provide the Revit model lines, define the user inputs in Dynamo, and then send the Revit energy model to Insight.

Really, the focus of this project is researching the optimization of performance of twentieth-century buildings. The bulk of the research for this thesis specifically pertains to the topic of performance criteria.

SPACE ALLOCATION TABLE

Space	Square Feet	Percentage
Office	7,100	10%
Incubators	14,200	20%
Retail	3,550	05%
Food & Drink	7,100	10%
Lobby	7,100	10%
Bathrooms	3,550	05%
Mechanical	10,650	15%
Circulation	10,600	15%
Storage	3,550	05%
*Extra	3,550	05%
Total	**71,000**	**100%**

Figure 132

SPACE INTERACTION NET

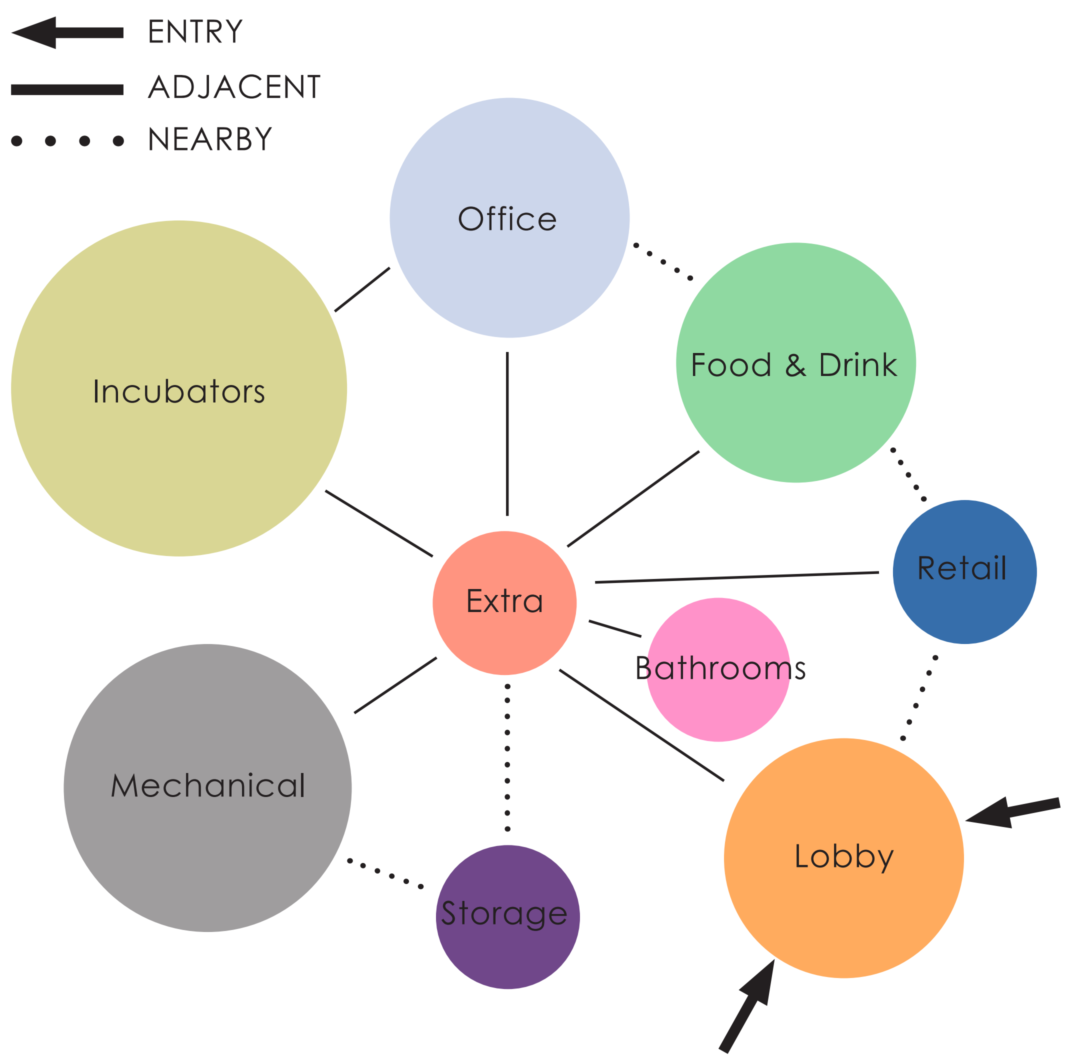


Figure 133

SPACE INTERACTION MATRIX

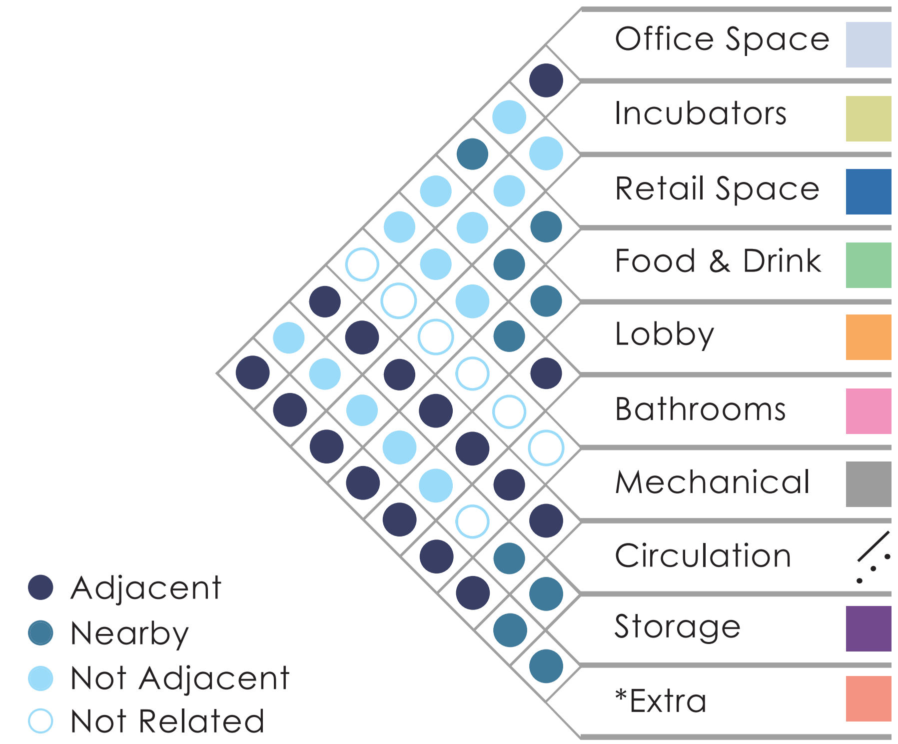


Figure 134

The spaces to be used in this mixed-use office building will have a high degree of interconnectivity. This is key for the success of each of the individual uses within the building. Efforts will be made to design the spaces to be adaptable, providing flexibility to the owner. It also allows for easier future re-design should it become necessary. The spaces listed in the tables on these pages do not take into consideration parking or any exterior improvements that may be designed since there is such a arge amount of space for this to happen around the site. The parking is already completed, and planning for the site may commence (if time allows) following the completion of the research & programming phases.

Building Breakdown

Food & Drink

Space	Sq. Ft.	%
Advertising	355	5
Kitchen	1420	20
Prep	1065	15
Storage	710	10
Cash Registers	710	10
Cleaning	355	5
Manger's Office	355	5
Dining	1420	20
Receiving	355	5
*Extra		5
	7,100	100

Retail

Space	Sq. Ft.	%
Advertising	355	10
Security	177.5	5
Dressing / Testing Rooms	355	10
Receiving	355	10
Open Shopping	1242.5	35
Cash Registers	355	10
Customer Service	177.5	5
Manger's Office	177.5	5
Break Room	177.5	5
*Extra	177.5	5
	3,550	100

Office

Space	Sq. Ft.	%
Storage	710	10
Private Office	1065	15
Open Office	1775	25
Work Rooms	1420	20
Break Rooms	355	5
Break Out Spaces	1065	15
*Extra	710	10
	7,100	100

Incubators

Space	Sq. Ft.	%
Sports & Exercise	1420	10
Food & Drink	2840	20
Retail	2840	20
Office	2840	20
Music	1420	10
Maker Labs	2840	20
*Extra		
	14,200	100

Lobby

Space	Sq. Ft.	%
Circulation	1065	15
Security	355	5
Reception	1065	15
Waiting	710	10
Information	355	5
Assembly	710	10
Exhibits	1065	15
News Stand	355	5
Vestibules	710	10
*Extra	710	10
	7,100	100

Bathrooms

Space	Sq. Ft.	%
Men's	1597.5	45
Women's	1597.5	45
Gender Neutral	355	10
	3,550	100

Storage

Space	Sq. Ft.	%
Permanent	1065	30
Temporary	1065	30
Dead Files	1065	30
Movable	355	10
	3,550	100

Mechanical

Space	Sq. Ft.	%
Electrical Chases	100	0.9
Duct Chases	500	4.7
Pipe Chases	150	1.4
Mechanical Room	5000	46.9
Boiler Room	2400	22.5
Control Room	1000	9.4
Penthouse	1500	14.1
	10,650	100

Figure 135

Circulation

Space	Sq. Ft.	%
Primary	3195	30
Secondary	3195	30
Tertiary	3195	30
Entourage	1065	10
	10,650	100

*Extra Considerations

Space	Sq. Ft.	%
Natural Space	355	10
Functional Mechanical	3195	90
	3,550	100

Incubator Breakdown

Sports & Exercise

Space	Sq. Ft.	%
Advertising		15
Security		10
Dressing / Testing Rooms		5
Receiving		10
Open Shopping		10
Cash Registers		10
Customer Service		10
Manger's Office		20
Break Room		5
*Extra		5
	1,420	100

Office

Space	Sq. Ft.	%
Storage		10
Private Office		15
Open Office		25
Work Rooms		20
Break Rooms		5
Break Out Spaces		15
*Extra		10
	2,840	100

Food & Drink

Space	Sq. Ft.	%
Advertising		5
Kitchen		20
Prep		15
Storage		10
Cash Registers		10
Cleaning		5
Manger's Office		5
Dining		20
Receiving		5
*Extra		5
	2,840	100

Music

Space	Sq. Ft.	%
Group Spaces		20
Instruction		10
Recording		10
Sound Engineering		15
Production		10
Music Selection		5
Instrument Display		15
Listening		5
Storage		5
*Extra		5
	1,420	100

Retail

Space	Sq. Ft.	%
Advertising		10
Security		5
Dressing / Testing Rooms		10
Receiving		10
Open Shopping		35
Cash Registers		10
Customer Service		5
Manger's Office		5
Break Room		5
*Extra		5
	2,840	100

Maker Labs

Space	Sq. Ft.	%
Schematic Design		10
Design Development		10
Assembly		20
Testing		20
Working		25
Receving		5
Customer Service		5
*Extra		5
	2,840	100

Figure 136

PROGRAM

Figure 137

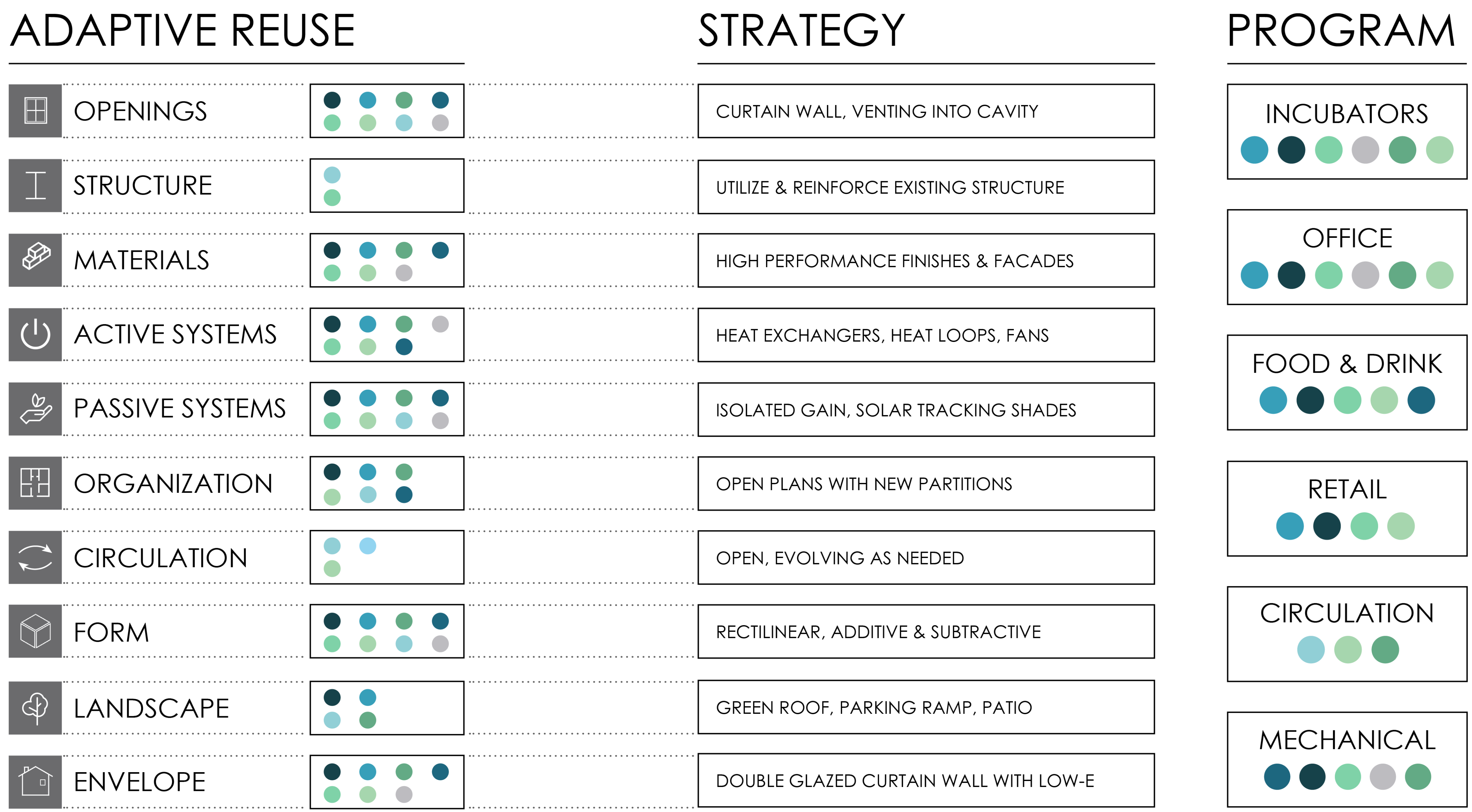


Figure 138

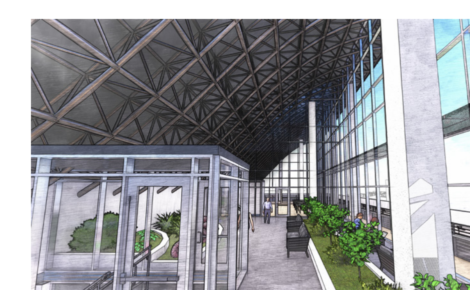
Figure 139

DESIGN PROPOSAL

Figure 140

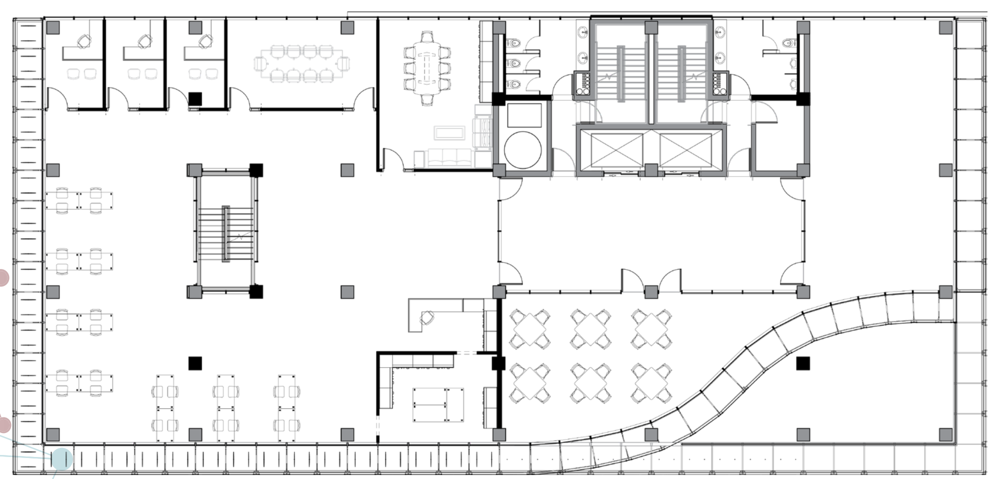
It was critical for this thesis to be able to apply the research in such a manner that was traceabe from the start. As a result, all of the strategies listed in the Linkage chart in Figure 138 have been implemented into the adaptive reuse of the M Building in Minot, North Dakota, in order to create a model work environment focused on occupant wellness for the community, specifically the young adults who are interested in business. Performance analysis via the tools provided in Revit Insight was conducted simultaneously throughout the design in order to measure the effects of each strategy. The resulting design proposal illustrates an old, beautiful jewel so loved by the community that has been polished new and given new life.

Figures 141 - 146

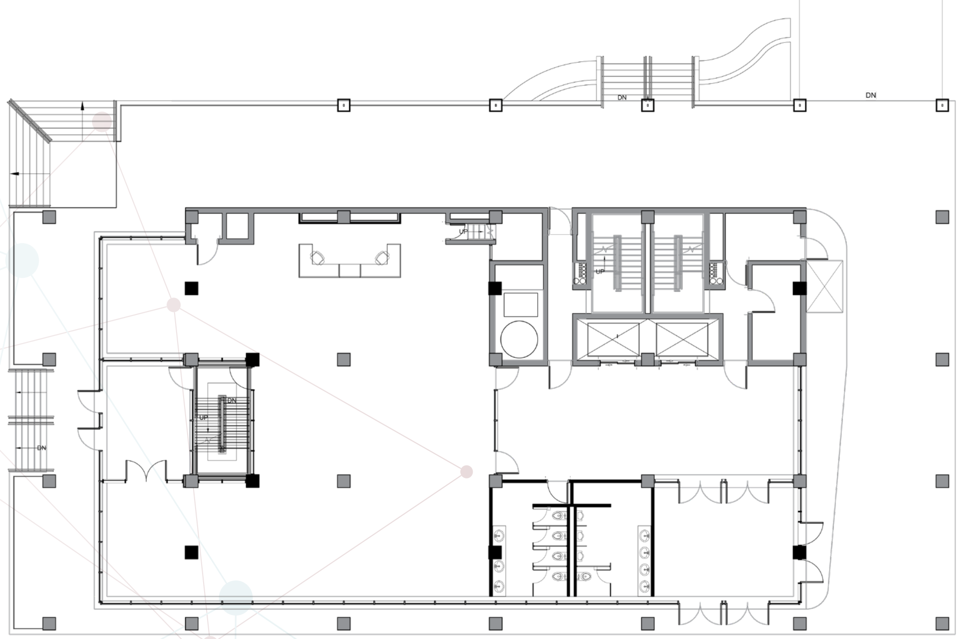


Figures 147 - 149

3rd & 4th Floors

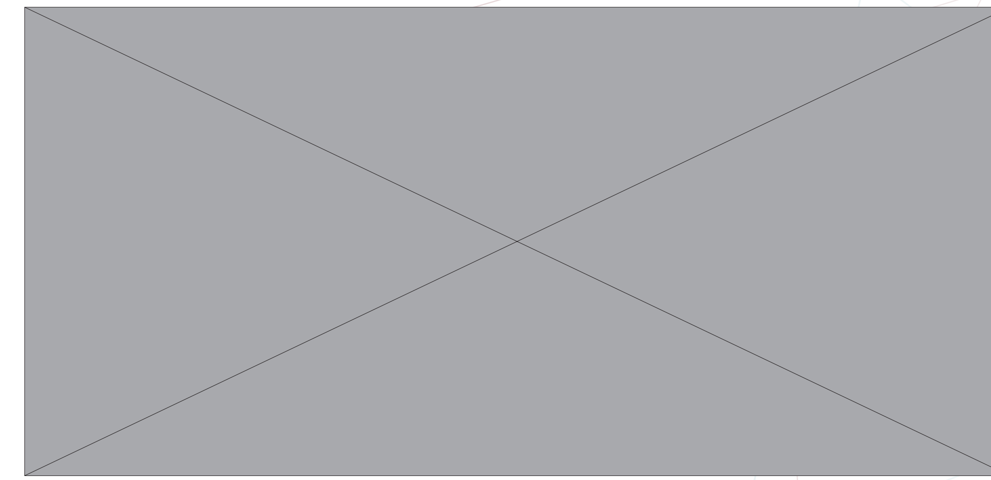


1st Floor

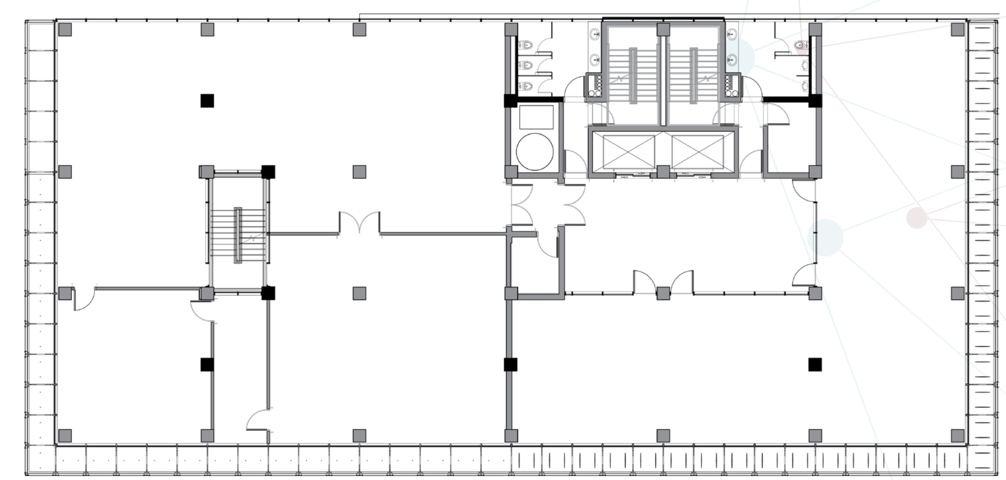


Figures 150 & 151

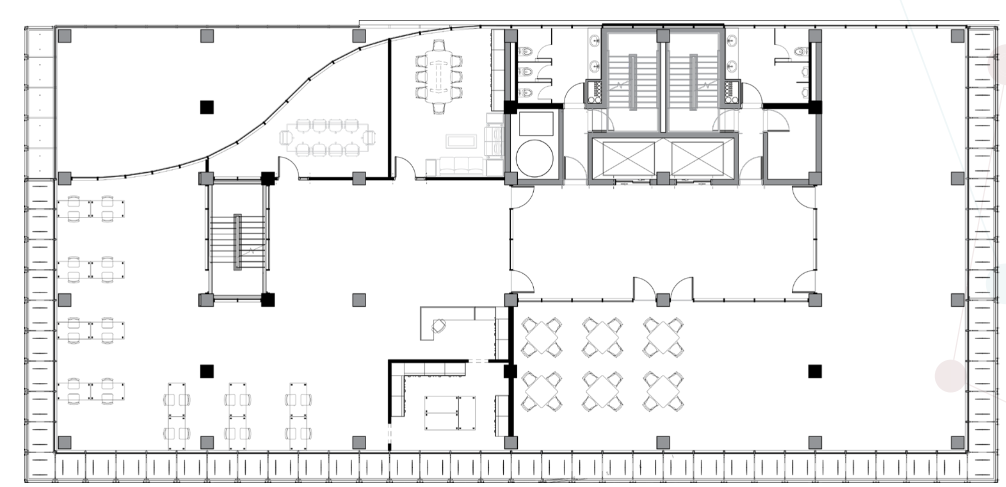
9th Floor



7th & 8th Floors



5th & 6th Floor



Figures 152 - 154

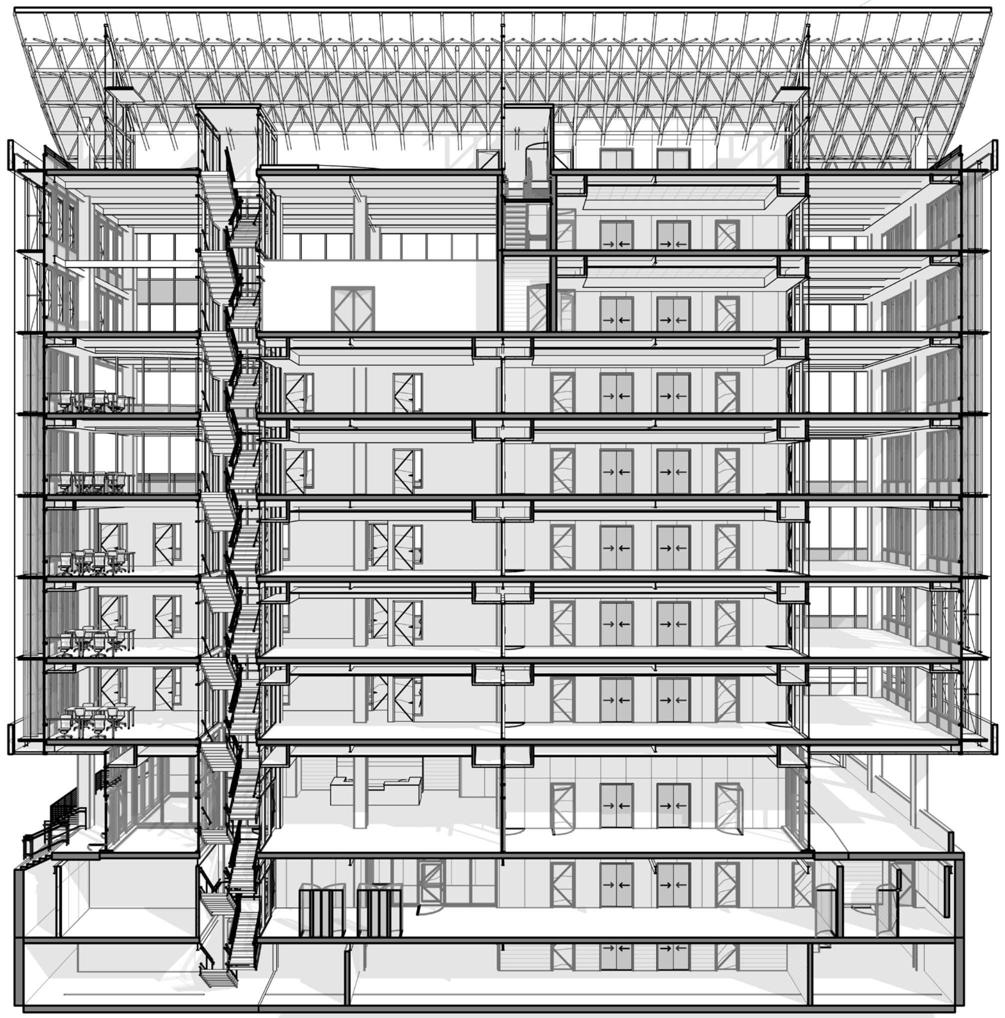


Figure 155

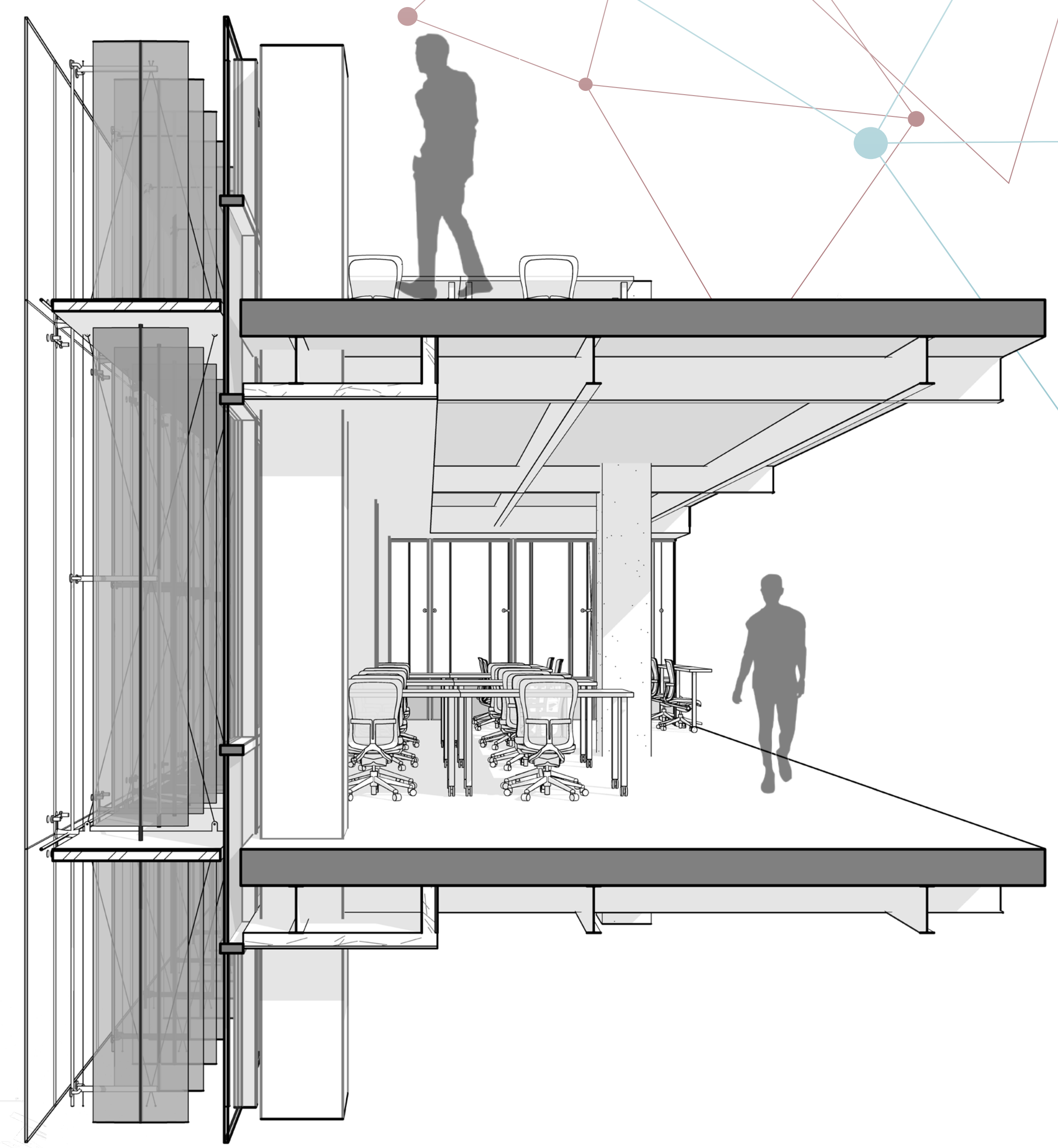
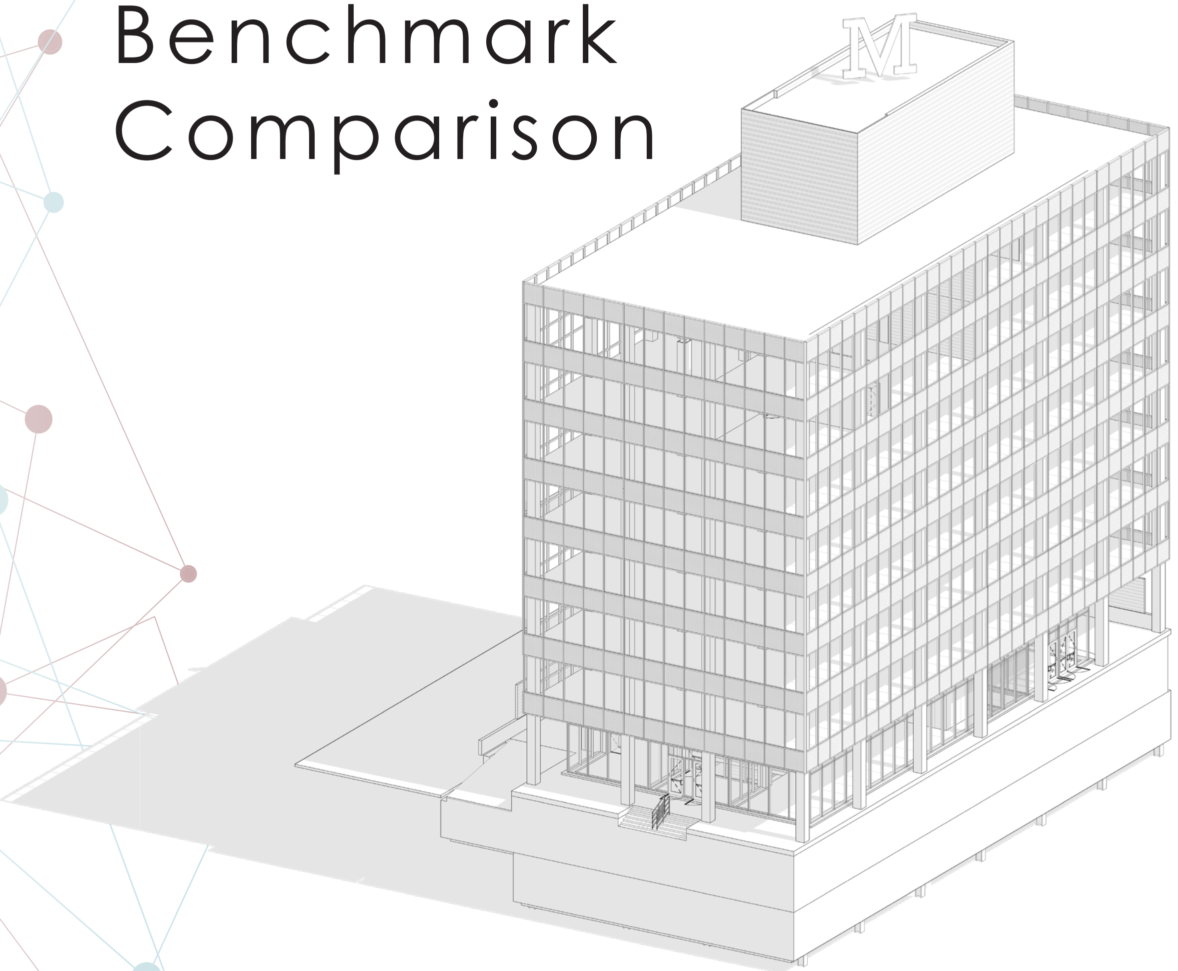


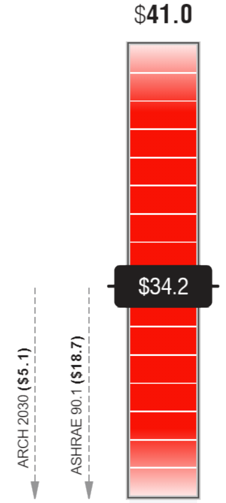
Figure 156

Benchmark Comparison



Benchmark Comparison
USD / m² / yr

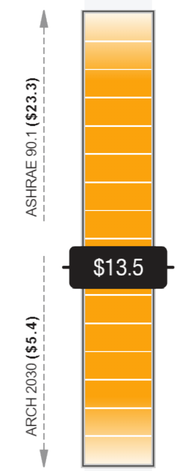
EXISTING



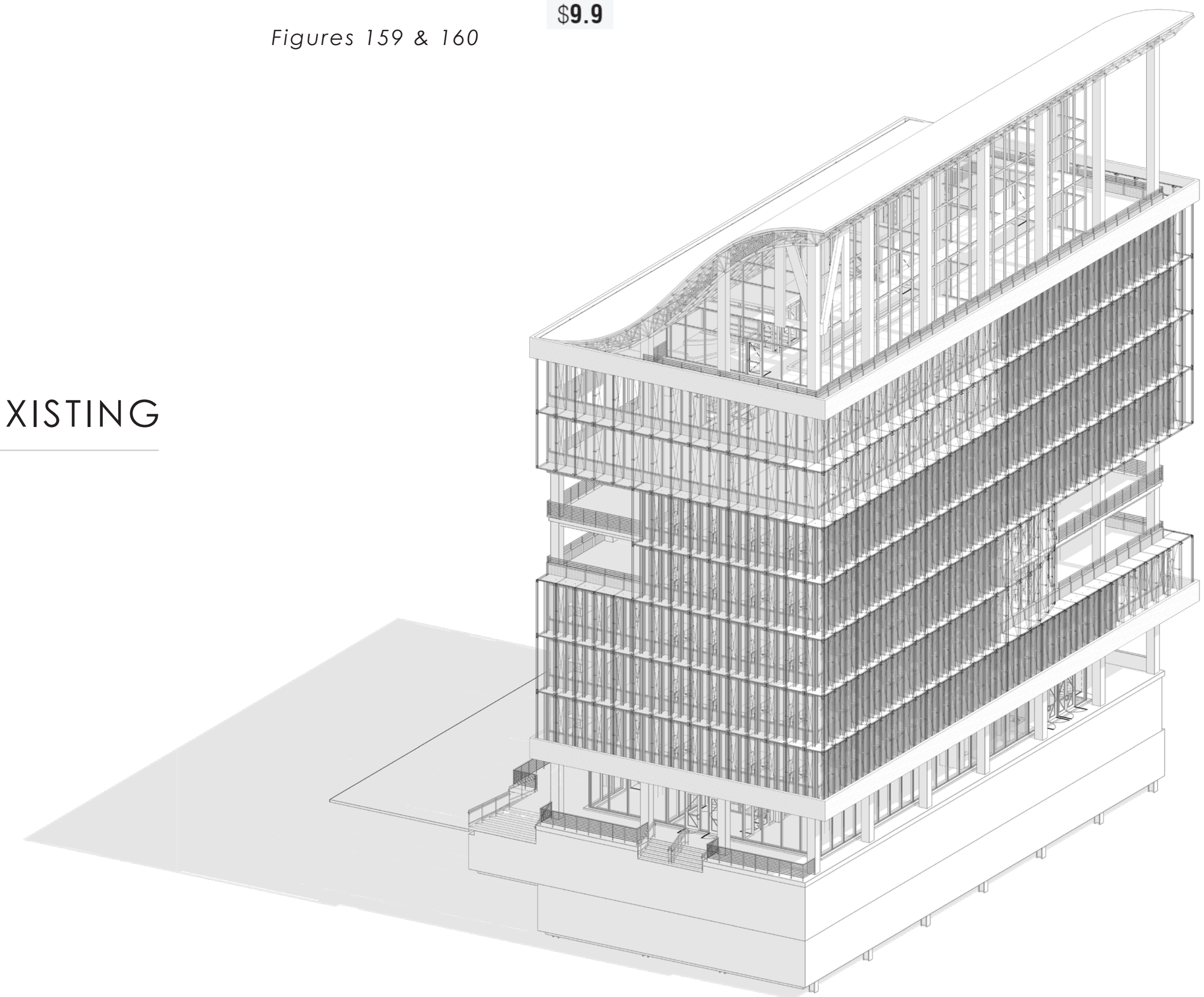
Figures 157 & 158

Benchmark Comparison
USD / m² / yr

ADAPTIVE REUSE



Figures 159 & 160



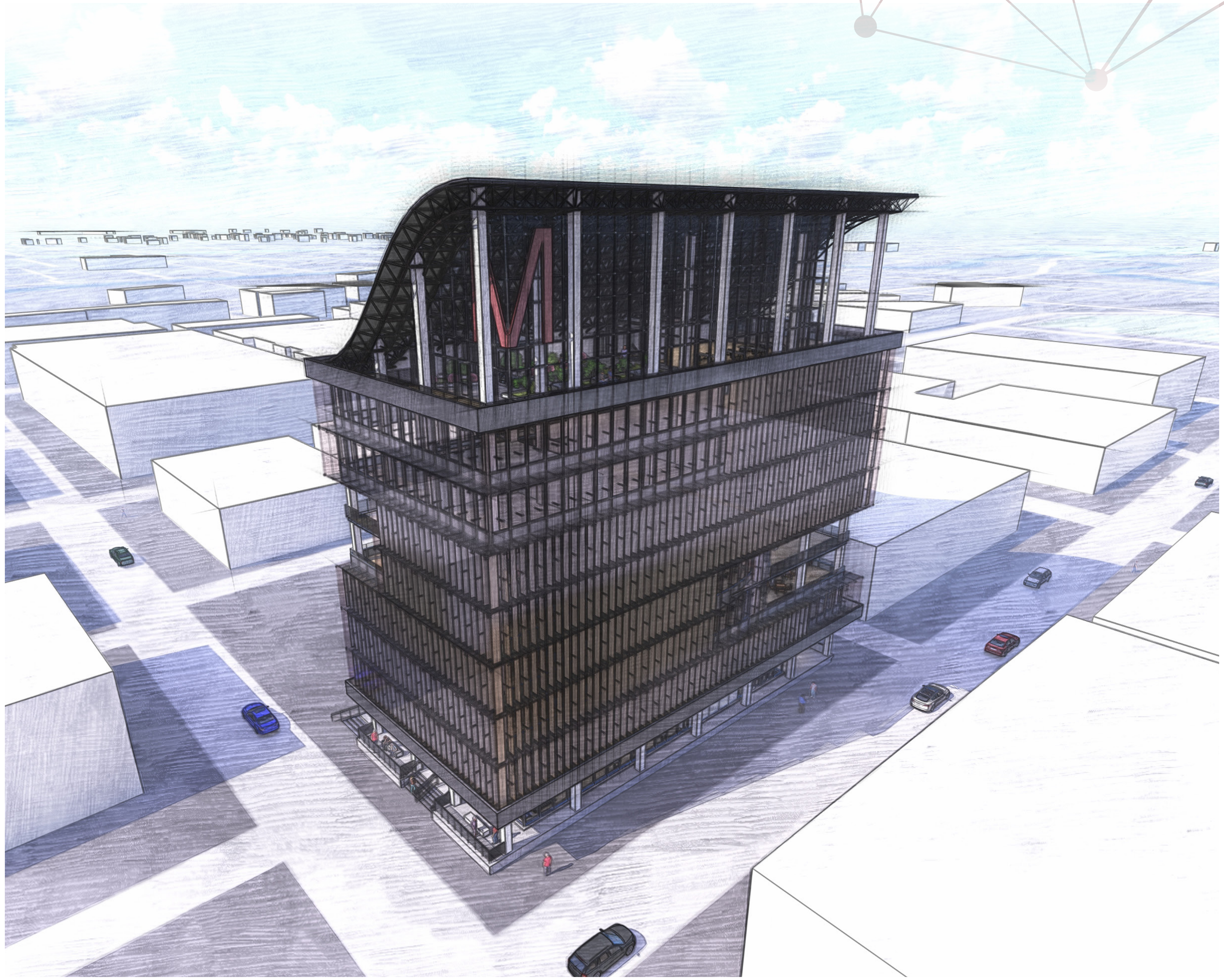


Figure 161

CONCLUSIONS

After completing the project, a final performance analysis was conducted in order to compare the benchmark price (per square meter per year) of both the existing building and its new adaptive reuse. The results were staggering, showing that the new design, implementing the adaptive reuse straetgies that were ellucidated by the WELL Building Standards, was much more efficient, inviting, and better for occupant wellness than the existing building. This ultiamtely verifies the hypothesis of this research; can the IEBC be supplemented by an additional set of design standards which have been created to promote human wellness?

Yes.

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APPENDIX

APPENDIX

DESIGN STUDIO EXPERIENCE

1ST YEAR
Fall: Heather Fischer
Environmental Design | Fargo, North Dakota

2ND YEAR
Fall: Daryl Booker
Tea House | Fargo, North Dakota

Spring: Milt Yergens
Small Dwelling | Marfa, Texas
Birdhouse | Fargo, North Dakota

3RD YEAR
Fall: Paul Gleye
Mixed-Use Student Center | Fargo, North Dakota
Fargo Visitor's Center | Fargo, North Dakota

Spring: Mike Christenson
IIT School of Architecture | Chicago, Illinois

4TH YEAR
Fall: David Crutchfield
Urban and Sustainable High Rise | Miami, Florida

Spring: Paul Gleye
International Design Studio | Brussels, Belgium

5TH YEAR
Fall: Ganapathy Mahalingam
Research Design Studio | Fargo, North Dakota

Spring: Ganapathy Mahalingam
Design Thesis Studio | Fargo, North Dakota

ACKNOWLEDGMENTS

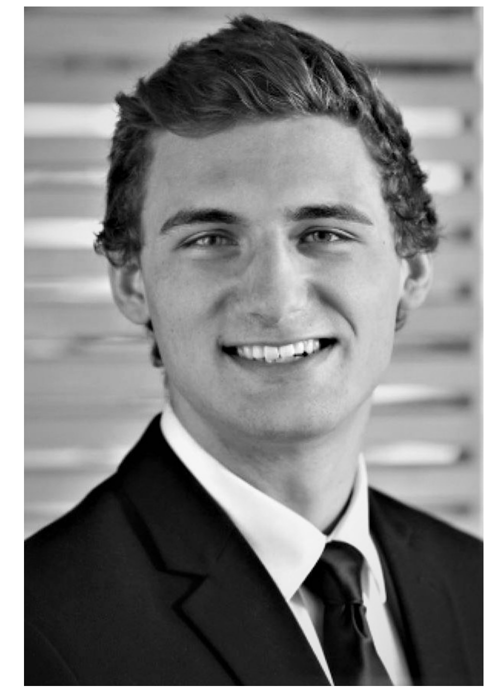
I'd like to give a special thanks to my thesis advisor, Dr. Ganapathy Mahalingam for his unwavering support and guidance throughout this process. In times of doubt, he reassured me and allowed for the successful conclusions of this research project. I'd also like to thank my family and friends for providing support, especially through times of adversity. Ultimately, this project would not have been possible without them.

APPENDIX

ABOUT THE AUTHOR

Architecture to me is more than just a profession, it is a form of art that combines the visual arts, sculpture, and sensory experiences all into one harmonious entity. The people that occupy and interact with our buildings are the most important aspect of our designs. I have learned a significant amount about architecture at North Dakota State University, and hope to never stop learning throughout my career.

-Jared Kramer



APPENDIX