DOWN TO EARTH

Abstract:

This thesis project dives into the question "Can subterranean architecture create a more sustainable design?" In a healthy relationship, there is an equal give-and-take, a symbiotic relationship. The built environment takes and rarely gives back to the natural environment. This has indirectly led to climate change. Subterranean architecture could be a solution to this problem, as it takes the earth's volume and wraps it around the built structure. It takes the consistent temperature from the earth to warm the design and gives the whole site access to grow plants, no longer limiting the footprint for natural elements. Subterranean design can be represented as the purest form of symbiotic relationship between the built environment and the natural environment. The attempt to design a residential typology was the main focus in order to understand the positive and negative impacts of these spaces, which must be designed to inhabit. Many past architects have advocated for this form of design be adopted, but the approach has often been overlooked.

Narrative:

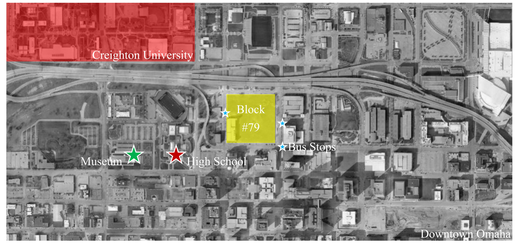
Humans have lived underground as one of their first shelters. It is in our instincts to find a shelter that can protect us from the outside elements. However, we now live in built structures that differ from our old housing. When we design buildings, we need to promote a sustainable relationship between the built environment and nature. We already see the impacts of taking and not giving back today. If we begin to design our buildings in a way that offers something back to the site, it will create a sustainable relationship that can benefit the residents and the future generation. As architects, it is our responsibility to design for the comfort levels of the users and to allow the users a comfortable future. The users, however, won't be comfortable in the future if their own buildings are harming the surrounding environment. This will just cause more problems until we can find a solution that doesn't create a different problem. Subterranean architecture could be an answer to this issue, as it takes some of the earth volume of the site and places it on top and around the building. This doesn't impact the site long term and the building will benefit long term from the protection and other benefits that these designs offer. Through my research I came across Malcolm Wells, who was an advocate for these types of buildings. He mentioned that this way is overlooked and quite promising. A large part of the research was figuring out how and why this way is overlooked. The research into this question showed the history, the positive, and the negative side effects of subterranean design as to why it is overlooked. The question isn't easy to answer as it depends upon how it is designed, how it is constructed, the location of the design, and composition of the soil.

Application:

This design addresses and applies the theoretical premise through the research that was gathered and formed. It utilizes systems in the design to reduce energy consumption, impact on the environment, and lower long-term maintenance and overhead cost. The building is three stories due to the efficacy of light and ventilation entering the lower areas. The applications used in this design are divided by the pros of subterranean design and how the cons of these spaces were addressed.

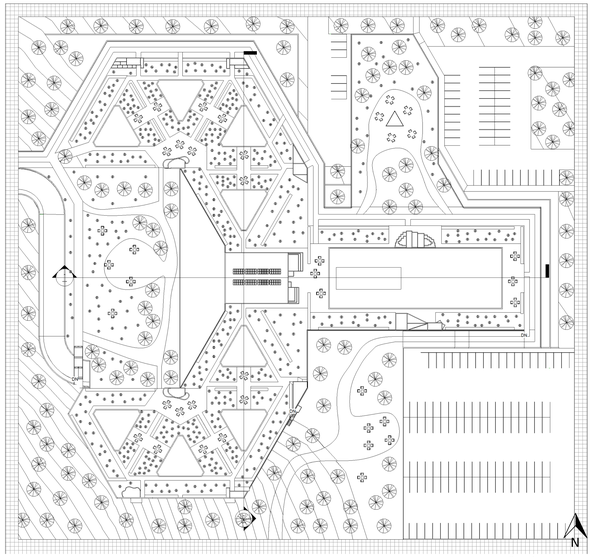
PROS: Since the building is using the earth as a layer of insulation, it was important to continue that utilization of the temperature of the earth. Geothermal heat pumps were utilized to lower maintenance cost and decrease fossil fuel usage to heat and cool the building. These pumps are located below the freezing line of the parking lots. Since the earth is at a constant temperature year round, it can be tapped into to heat and cool the rooms relative to the seasons. These systems are most efficient and common to use a radiant heating and cooling system. These designs bring back nature to urban areas, while having multiple purposes within one site. These designs allow for an unlimited amount and mixture of functions such as public spaces, parks, parking lots, and various typologies of buildings within one site. For this site, green roofs were incorporated to cover the building and parking lots, which lower the runoff and promote absorbing water into the aquifer to be naturally treated. Water pumps are incorporated to collect this filtered water and used for gray water uses, such as watering plants and outdoor water features. It allows a majority of the site to grow plants to heal the infill.

CONS: There are reasons why we might overlook this form of design. Ventilation and lighting are the most important factors to consider with this design, as these factors are naturally lacking in these spaces. To lower this lack of ventilation and lighting from occurring, the design was formed in a way that open courtyards acted as a way to allow natural ventilation and lighting to penetrate these spaces. Skylights were incorporated into the design to allow for more natural light to enter the hallways of the design. Another con was the depth of the water table. The deeper you go, the higher chance of leakage. No construction is perfect, so it was vital to keep in mind the water table and mitigate the water from entering. Concrete was the material chosen to retain the water from entering the building, because it can resist lateral loads of earth and water, is fire resistant, and is more resistant to water than other materials. Another issue that needed to be solved was radon. The ventilation solution ensures there is no radon build up within spaces. Layers around the building envelope are used and an active sub slab suction system to efficiently allow radon to pass through the building without interacting with people.



Site Information: The site location is in Omaha, Nebraska, Block #79. Having lived in Omaha over the summer, the place has a lower cost of rent compared to the nation's median. This block is within the downtown of Omaha, which is close to many job opportunities, bars, and shops, making this a very walkable area. I personally only used my car to get groceries and just walked to work. There is the Omaha Metro System that offers public transportation near the site as an option. Omaha has a growing economy and the population of the city is rising, thus more apartments could assist in alleviating future housing issues. A large flood occurred a year ago south of the city, however, the chosen site is well outside the flood zone.

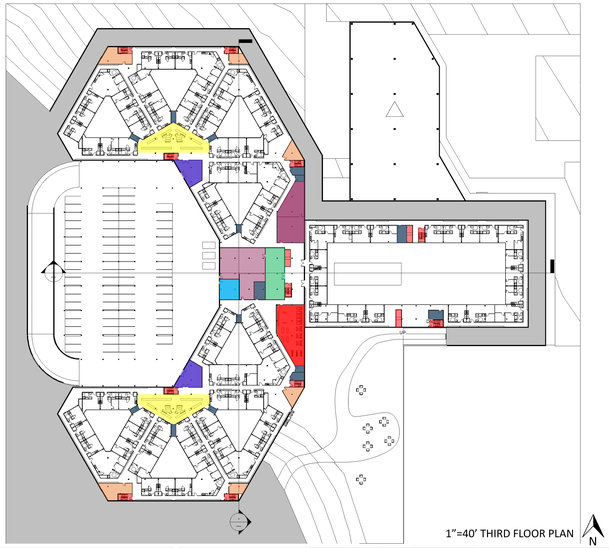
Site Analysis: The site is considered an infill, vacant space in an urban area waiting to be used, with the exception of a parking garage on the southwest side of the site. The slope of the grade changes from 1% to 4% with the southwest being the highest point. The surrounding area has apartments close by, a high school, a university, a college football stadium, soccer stadium, museums, restaurants, corporate offices, banks, churches, and hotels. It lacks access to groceries, which is why this building possesses a small grocery store on site, to further limit the need to drive. The make up of the soil consists of silty clay loam from 0-12 deep inches. At 12-80+ inches it primarily consists of silt loam. The water table is estimated to be 12 feet or more. On site there will be water pumps to collect the water from the aquifer to mitigate the water level and to water plants.



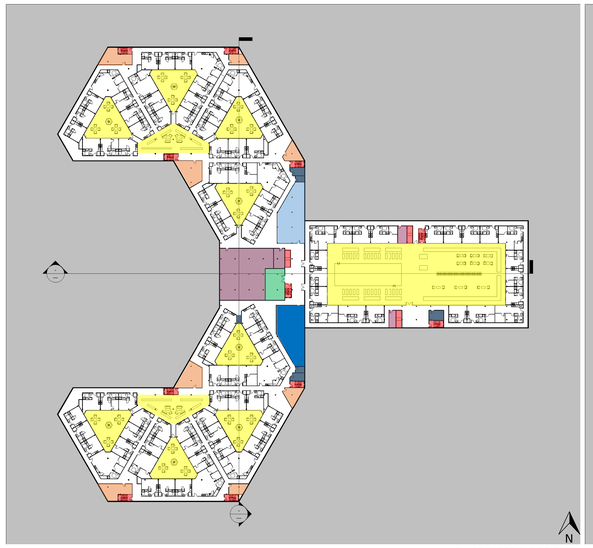
1"=40' SITE PLAN

KEY

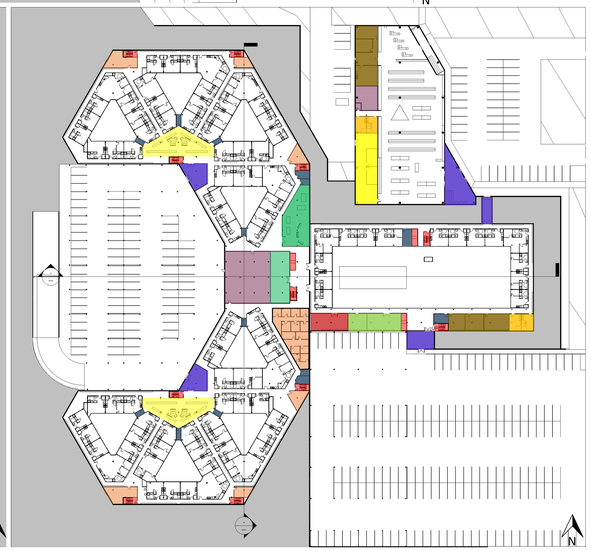
- Vertical Circulation
- Mechanical Room
- Storage Room
- Rentable Spaces
- Garbage Room
- Community Spaces
- Pool Maintenance Room
- Game Room
- Bike Room
- Unload/Prep Area
- Gym
- Handyman Workshop
- Electrical Room
- Entryways
- Mail Room
- Offices
- Public Restrooms
- Custodian Closets



1"=40' THIRD FLOOR PLAN



1"=40' FIRST FLOOR PLAN



1"=40' SECOND FLOOR PLAN

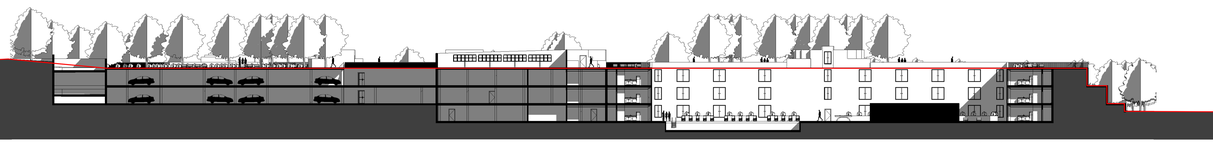
LARGE COURTYARD PERSPECTIVE

UNIT PERSPECTIVE

SMALL COURTYARD PERSPECTIVE

ROOF PERSPECTIVE

1"=20' LATITUDINAL SECTION



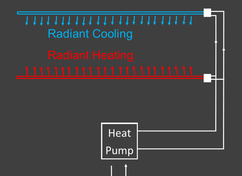
1"=20' LONGITUDINAL SECTION

1"=40' EAST ELEVATION

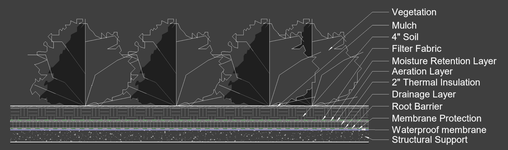
1"=40' NORTH ELEVATION

1"=40' WEST ELEVATION

1"=40' SOUTH ELEVATION

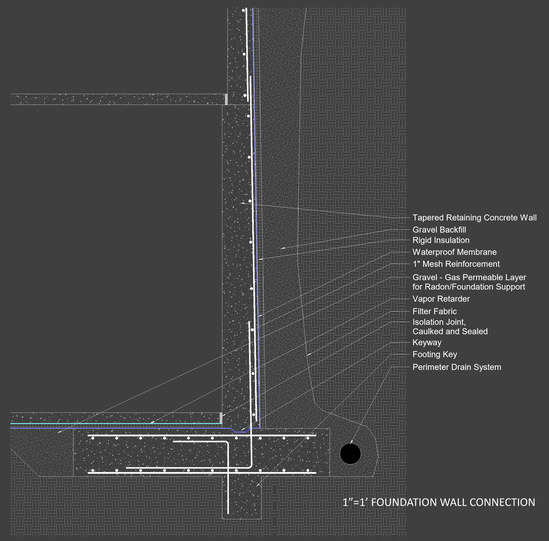


GEOTHERMAL HEATING/COOLING SYSTEM

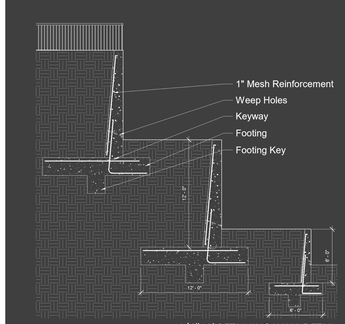


1"=1' GREEN ROOF ASSEMBLY

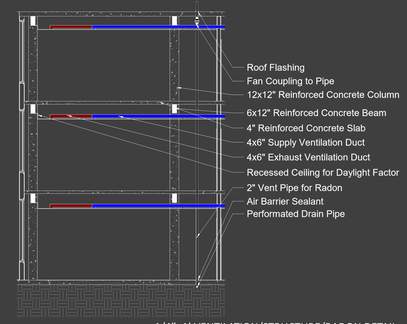
1"=1' GREEN WALL ASSEMBLY



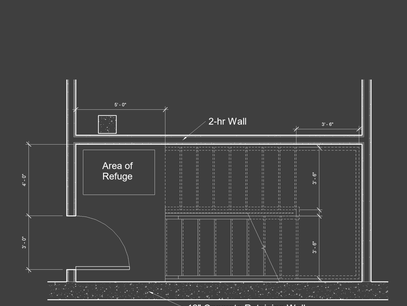
1"=1' FOUNDATION WALL CONNECTION



1/4"=1' RETAINING WALL DETAIL



1/4"=1' VENTILATION/STRUCTURE/RADON DETAIL



1/2"=1' FIRE ESCAPE DETAIL

Design Process:

The beginning of the design process started with the space interaction net and user circulation. This helped create parameters for the initial design. Once the spaces were finalized, I put a focus on imagery of subterranean design elements that would help inspire and influence the design and the program. Following the inspiration and imagery, I focused on the site plan and how the flow of the site was established. I started with many sketches on what might work and what wouldn't work. These sketches were preliminary for the spatial aspect of the site. I continued to create different forms and spaces to see how the site played with the iterations. The more iterations I tried the more designs I eliminated as it didn't work with the site nor subterranean design. At different views, such as section cuts, elevations, and plans, it was easier to organize the spaces and see how these spaces worked underground and the amount of light that would enter. These iterations helped focus on common trends that worked for subterranean design.

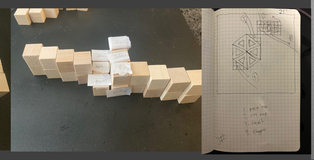
I finished the preliminary spatial iterations and needed to focus on the 3D aspect of the designs to better understand subterranean design as it is very different from above ground design. It was harder to design and visualize these spaces without the 3D version, so I made a few physical iterations using small wooden blocks that added a sense of scale to further the design process.

The final spatial iterations took more information into account, including the four different types of users. These four different paths were applied to new iterations. These newer iterations focused on the flow and circulation of the spaces. Very quickly in these iterations, a common trend emerged where all of the circulation and spaces began to revolve around the courtyard light tunnel areas that lets light into these spaces. These iterations also were created using various space grid patterns to form a scale and patterns that repeat themselves to create other shapes. Triangular spaces were introduced as a way to form repetition and represent the triple bottom line that correlates with the direction of this thesis. The triple bottom line representing each corner of the triangle: planet, profit, and people. The image below that is labeled as the Spatial and Circulation Concept is the iteration that became the base for the rest of the design. The biggest change from this iteration is the rotation of the grocery store to allow more space for a loading space for food.
The proportioning system I utilized was the direct relationship I found that the deeper the building, the wider the courtyards need to be to allow enough light and air to enter.

1. IMAGERY FOR INSPIRATION

2. SPATIAL ITERATION PHASE 1

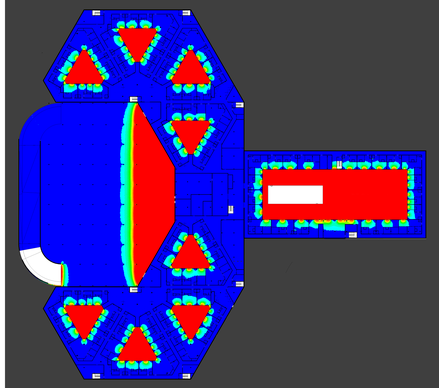
3. SPATIAL ITERATION PHASE 2



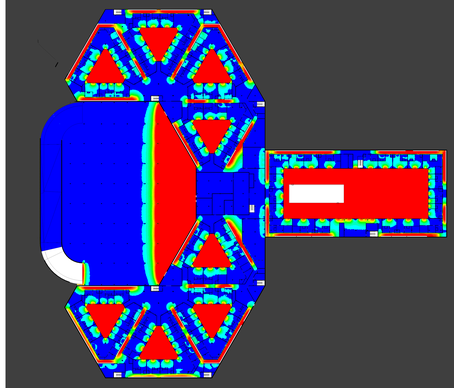
4. SPATIAL ITERATION PHASE 3

Performance Analysis:

To perform an analysis that represents how effective the design is for lighting, a daylight factor analysis was conducted. In the original analysis, not shown, resulted with the windows needing to be raised and part of the ceilings close to the windows to be raised as well. The Daylight Factor Attempt 2 resulted with the progression of the design by deciding to incorporate skylights into the hallways to allow light to enter on the floors. The finalized analysis, Attempt 3, shows how the addition of the 3-foot wide skylights impacted the final design on the third floor, which emulates similar trends on the lower floors. To note, the lower floors are similar as the hallways provide 1-foot wide skylights to penetrate to the first floor. This shows that even subterranean design can allow light into spaces should it be needed, dependent upon the depth of the design.



1"=50" 3RD FLOOR DAYLIGHT FACTOR ATTEMPT 2



1"=50" 3RD FLOOR DAYLIGHT FACTOR ATTEMPT 3