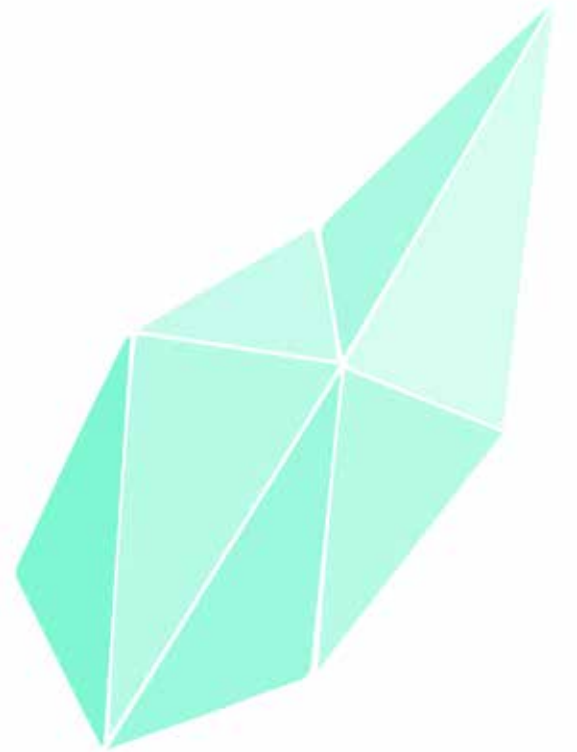


MASTERS THESIS | final



V

ARCHITECTURE'S INFLUENCE ON GROWTH

Master's Design Thesis to the Department of
Architecture and Landscape Architecture
of North Dakota State University

By

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PRIMARY THESIS ADVISOR



THESIS COMMITTEE CHAIR



FIGURE 1 | PORTLAND THEATRE, DOWNTOWN PORTLAND

FIGURES

1	PORTLAND THEATRE, DOWNTOWN PORTLAND	72	BEACON
2	CONCEPT OUTLINE	73	WILLAMETTE RIVER REDDIT
3-5	CASE STUDY AREAS OF FOCUS SKETCHES	74	CON-TEXT
6	BURJ AL ARAB, DUBAI, UAE G U I D O	75	IMMEUBLES-VILLAS
7	BURJ AL ARAB ATRIUM WALLART	76	MENARA-MESINIAGA
8-10	BURJ AL ARAB DIAGRAMS EDGECOMBE, DAVON [8,9]	77	PASSIVE SYSTEMS
11-13	THE PYRAMIDS, INDIANAPOLIS, IN EVERETT, VALERIE	78-80	PORTLAND MAPS REDDIT
14	THE PYRAMIDS DIAGRAMS	81	PIONEER PORTLAND VINTAGE PORTLAND
15	FARMING TECHNIQUES BGARISON // LUTERO	82-83	HISTORIC PORTLAND MAPS VINTAGE PORTLAND
16	SOILLESS GROWING	84	STEEL ROSE
17	PLANTAGON A1 RENDERING PLANTAGON	85	ROSE FESTIVAL ROUTE PORTLAND ROSE FESTIVAL
18	SOILLESS GROWING	86	TOPOGRAPHY REDDIT
19	PLANTAGON A1 RENDERING PLANTAGON	87	SITE LOCATION
20	AGRITECTURE PLATAGON	88-89	CLIMATE ACTION PLANS
21	PLANTAGON A1 DIAGRAMS PLANTAGON	90-91	PORTLAND CLIMATE
22-23	A2 VERSIONS PLANTAGON	92	SITE TRANSITION SPACES
24	HELIX PLANTAGON	93	SITE CONDITIONS MAPS OF PORTLAND
25	SELF-STANDING SECTION PLANTAGON	94	SITE ELEMENTS VARIOUS
26	PLANTWALL DIAGRAMS PLANTAGON	95-96	SITE CONDITIONS MAPS OF PORTLAND
27-28	STUDIO SPACE	97-101	SITE ELEMENTS VARIOUS
30	PIONEER SQUARE FARMERS MARKET, DOWNTOWN PORTLAND, OR	102	TPOLOGY REDDIT
31-33	MAPS OF PORTLAND, OR MAPBOX	103	PORTLAND DISTRICTS REDDIT
34	RE MET TRANSIT MAP TRI MET	104	UP-TOP RENDERING
35-36	PIONEER DISTRICT, PORTLAND, OR	105	FIRST PROCESS MODEL
37-40	PROJECT ELEMENT DIAGRAMS	106-115	NATURAL INSPIRATION
41	WORLD MAP	116-137	INCORPORATION PROCESS
42	PLAN FOR PROCEEDING DIAGRAM	138-161	FORMATION PROCESS
43	COFFEE SELFIE	162	ARIEL SUN STUDY
44	RETURN FROM PORTLAND	163	FRONT FACING SUN STUDY
45-50	EVOLU CONTENT	164	AIR CIRCULATION
51	EVOLU BOARD ONE	165	HVAC SECTION
52	EVOLU BOARD TWO	166	H2O SECTION
53	BURJ AL ARAB DIAGRAM	167-171	FLOOR PLANS
54	PYRAMID STRUCTURE DIAGRAM	172	V COMPARISON
55	PLANTAGON TRACT DIAGRAM	173	CAISSON
56	URBAN AGRICULTURE PLANTAGON	174	TRACT SECTION
57	SEEDING HUFFINGTON POST	175	FRAME CLOSEUP
58	SPROUTING HUFFINGTON POST	176	GLAZING SECTION KRUPNA, TROMETER
59	CLOSE UP	177-179	ELEVATION PERSPECTIVES
60-61	INSPECTION AND MARKET PLANTAGON	180	PIONEER COURTHOUSE SQUARE RENDER
62-65	FOUR ELEMENTS	181	BROADWAY VIEW
66	VORONOI TO DELUANAY DUFFELL, PAUL C, MACFADYEN, ANDREW	182	MARKET
67	SUNFLOWER FLICKR	183	HARVEST
68-69	MITCHELL CANTILEVER SOM	184	PLOT BOARDS
70	STREET VIEW	185	THESIS SHOW
71	TRI-WORLD	186	MODEL LEDGE

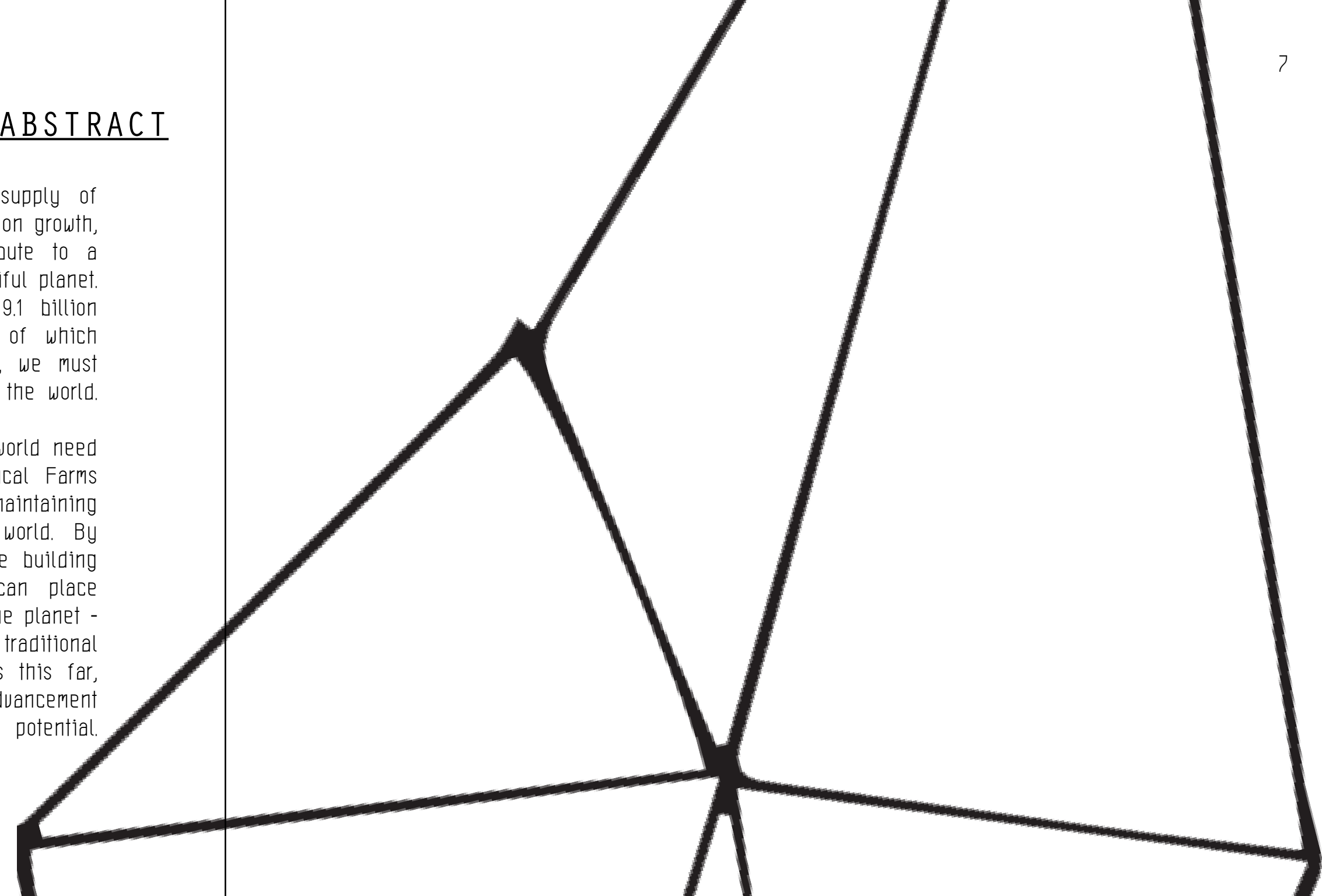
TABLE OF CONTENTS

1	C	O	U	E	R
2	T	I	T	L	E
4	F	I	G	U	R
8	N	A	R	R	A
10	T	Y	P	O	L
11	CASE				STUDIES
31	PROJECT	EMPHASIS	//	USER-CLIENT	
32	S	I	T	E	
36	PROJECT	ELEMENTS	/	GOALS	
38	P	R	O	C	E
39	H	A	I	K	U
40	EVOLU				BOARDS
46	UNIFYING				IDEA
56	C	O	N	T	E
62	SITE				ANALYSIS
72	DESIGN				SOLUTION
75	P	R	O	C	E
80	S	Y	S	T	E
82	FLOOR				PLANS
83	A	C	R	E	A
90	THESIS		SHOW		BOARDS
94	A	B	O	U	T
96	A	P	P	E	N

THESIS ABSTRACT

The Earth has only a limited supply of Resources. Climate change, population growth, and Urbanization together contribute to a major future problem for our beautiful planet. With a projected population of 9.1 billion people by the year 2020, 80% of which will be in an urban environment, we must find a way to feed the people of the world.

With limited land, farmers of the world need to think up instead of out. Vertical Farms could be our greatest solution to maintaining a healthy diet for the whole world. By creating an environment within the building suitable for plant growth, we can place these vertical farms anywhere in the planet - Maybe even galaxy. Our traditional agricultural ways have brought us this far, but it is time for yet another advancement in our methods to reach our full potential.



NARRATIVE

A Vertical Farm is a viable solution to not only improve our way of life, but also improve the efficiency of how humans eat and survive. By utilizing various technologies that are already implemented in today's modern society, we as a human population can change the way we view food.

Traditional farming techniques require vast amounts of land, time, and resources. Fuel usage for the massive machinery, chemical pesticides, and GMOs are among the major problems farming places upon our environment. Drought, poor soil quality, pests, and severe weather make up part of the long list of problems farmers of today face out in the fields. With these factors being uncontrollable, farmers often run the risk of not being able to provide a desirable product, which not only hurts them but also the people of the world.

Drought alone places a major stress upon the shoulders of farmers everywhere. Drought means farmers require irrigation to not only water plants, but to protect their crops from fire and soil erosion. Eradicating drought can be costly to farmers and to many others in need of freshwater. Also adding to the modern farmer's problems is the amount and price of land. With an expanding population, we humans require more food, and I'm not meaning just plants. The Beef, poultry, and pork industry also need land to raise these animals, which is made more difficult with less land to do so.

With an enclosed farm to grow crops in, we greatly reduce many of the previously mentioned problems farmers face, today. Water usage is reduced due to less evaporation, and more easily controlled watering techniques - i.e. Hydroponics. Plants do not require soil for any other purpose than to anchor to the ground.

By designing with the Sun as a major focus to provide as much natural light as possible. With natural light contributing to growing plants, as well as reducing the total energy load of the building. However, even though sunlight's role in agriculture is a vital role in plant growth, but a recent study shows that plants can grow more efficiently with artificial blue LED lighting. Utilizing this new found research, vertical farms can grow and produce crops around the clock nonstop. Not only will the plants grow more rapidly, but the building will require very little energy to power these lights. So little, in fact, that passive energy systems can provide the necessary energy supply.

In order for a building to be a success, it requires activity throughout the day. By implementing residential along with commercial use, the building is active all day every day. A market - much like a co-op - in the main level will bring a greatly needed food supply, and jobs to the urban center. The premise of the building is to provide for the people it serves; in the form of jobs, food, and an example of the advances in technology and agriculture. To be this kind of example places an opportunity for so many to learn and utilize the various methods into their everyday lives that so many of us take for granted all too consistently.

T TYPOLOGY

Vertical farming today, in regards to practicality, is about as realistic as your favorite sci-fi story. We view it as sci-fi because we are quite content with the way things are working out, now. However, the world is evolving and moving forward. The time has come to adjust our way of thinking of what can be done to better ourselves and the planet. A vertical farm not only provides food for many at a fraction of the energy required by modern farming, but it also provides housing, education, and jobs. By utilizing the advancements made in technology one could design a building that would be self sustaining and definitely Eco-friendly.

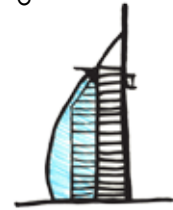
Now, with all that being said, the building is mainly to grow plants; therefore, it would make sense to draw inspiration from nature in shape, structure, and function. A plant reacts to the sun and climate, so why can't a building? Plants use the sun for photosynthesis, PV panels use the sun for electricity. It's relations like these that will make the building successful, and thus an example to be made of for the future.

With no real world examples of this project's scale to base my research on, I looked into features of existing buildings that would apply to vertical farming. Almost as if assembling a puzzle where the pieces match, but not the picture.

R RESEARCH

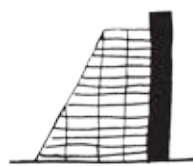
Examples used for consideration are as follows:

Burj Al Arab | Dubai, UAE | Tom Willis-Wright | 1999



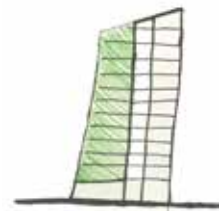
The Burj Al Arab is one of the greatest architectural features of the modern era and possibly of all time. The aspect in which I draw my focus to is it's massive atrium space. The immensity of the atrium allows sunlight to enter and spread all throughout the space. In other words, a perfect place to grow plants.

The Pyramids | Indianapolis, USA | Kevin Roche, John Dinkeloo | 1970



The Pyramids are not only a great design in form, but also in the relation between the heavy concrete and delicate glazing. The symbiosis between the two materials is a design and structural strategy I intend to use in the overall design of my building later on.

Plantagon | Linksping, Sweden | Sweco



Plantagon is the first building of its kind in its magnitude. In other words, the exact project typology I need to excel in regards to my thesis. The building is multi-use, and therefore continuously operational throughout the day and year.

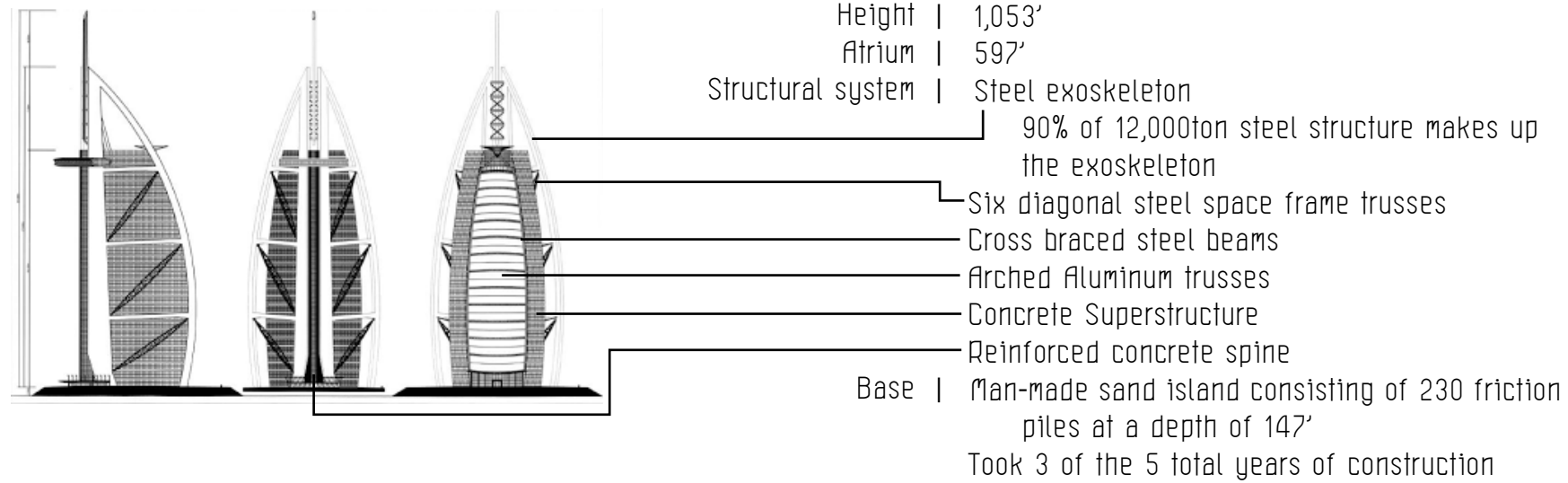


FIGURE 6 | BURJ AL ARAB, DUBAI, UAE | GUIDO



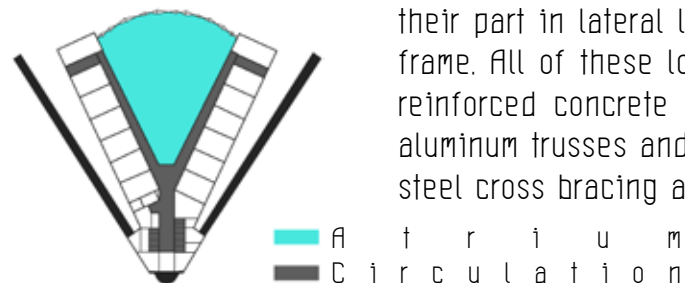
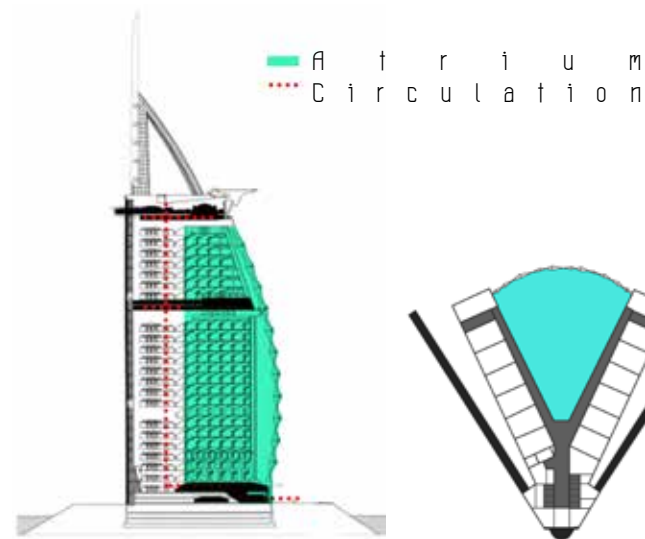
FIGURE 7 | BURJ AL ARAB ATRIUM | WALLART

BURJ AL ARAB



The Structure |

The Burj Al Arab was constructed using a variety of structural methods, each playing their own important role in support and design. Working from the ground up lets evaluate these methods. A concrete superstructure - bearing walls and core - makes up the majority of the form. Next an steel exoskeleton frames the exterior, spreading and redirecting the loads to the central spine. Part of the exoskeleton are the steel space frame trusses that control lateral loads from the harsh winds and sandstorms that frequent Dubai. Steel cross beams also do their part in lateral loads, but also uses tension to control the steel frame. All of these loads are redirected downward through a central reinforced concrete spine. The atrium membrane is made of arched aluminum trusses and a Teflon-fiberglass membrane, supported by the steel cross bracing and anchors at the top and bottom.



FIGURES 8-10 | BURJ AL ARAB DIAGRAMS | EDGEcombe, DAVON [8,9]

The Building |

In 1994 a project unlike any other unfolded in an explosively developing city called Dubai. Atkins Architects drew up what would become a symbol of wealth, Dubai, and the future. Boasting a height of 1,053 feet, the Burj Al Arab is one of the tallest hotels in the world. The real kicker, however, is that a considerable amount of space is being 'unused' because of its 597 foot atrium. The Burj Al Arab still has room 202 extravagant units (\$1,100 - \$15,00/night), 18 elevators, a tennis court/helipad, multiple restaurants and pools, all within 60 floors. It goes without saying this project is one of the best things to happen in the world of architecture. The original design inspiration came from the shape of a sail. Elegant and effervescent, the Burj Al Arab stands out from its surroundings in almost every way imaginable. Showing off its structure as an exoskeleton allows for a more open floor plan, and gave shape to the space in which I drew inspiration from. With 597 feet of pure nothingness, the Burj Al Arab holds the largest atrium in the world - although soon to be beaten out by Zaha Hadid. To design a project to this size and still find a way to make it look delicate and fill it with light in a unique way is the mark of true talent in architectural design, engineering, and craftsmanship.

The Site |

If memory serves me correctly, there is a story in the Bible that says to never build your house on sand. Instead rock is suggested as the ideal ground type to provide a solid foundation. Well beings that the Islamic community doesn't read the Bible they didn't quite get that memo. Not only did they build on sand, but they made an island-pad for the Burj Al Arab to stand out in the bay to taunt the city of Dubai. Engineers took three years to construct an island mad of rock, sand, and concrete in an absolute wonder to the world. The base is cloaked in numerous concrete structures that are used to break up waves and prevent erosion from happening. The sail inspiration is well interpreted throughout every aspect of the project.

The Lesson |

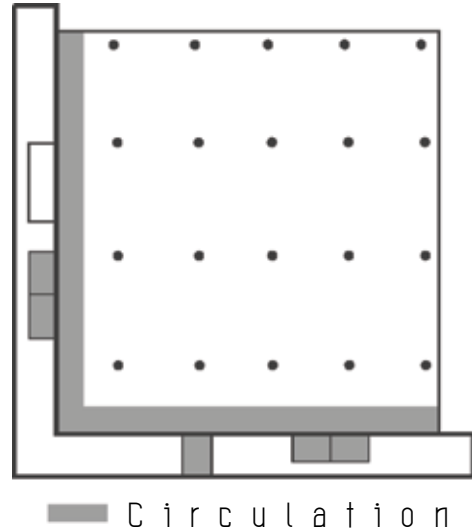
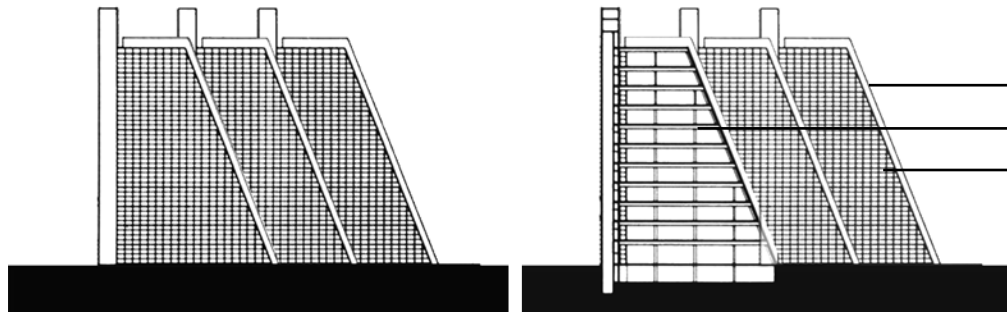
The Burj Al Arab took a source of inspiration and applied it to every aspect of the project. Atkins Architects were also not afraid to ask what if on multiple occasions, and it paid off extremely well. What I gathered out of examining the project is: If you're going to have a unique idea, your going to have to take risks and push the boundaries of what might be thought of as impossible. My idea does not exists on a scale of its size, therefore, I intend to approach the task with an open mind. Furthermore, vertical faming is the main goal and should therefore be integrated into every aspect of the project as well.



FIGURES 11-13 | THE PYRAMIDS, INDIANAPOLIS, IN | EVERETT, VALERIE

THE PYRAMIDS

Height | 110'
 Area | 420,000 sq. ft.
 Structural system | Concrete bearing wall
 | 14' wide
 | Cylindrical concrete columns
 | Steel glazing frame



The Structure |

The Pyramids are each identically constructed utilizing two 14 foot wide concrete bearing walls on two ends and a 30 foot grid of cylindrical columns attaching to each of the floor slabs. Lateral loads are reduced by adding double height concrete bridges between each building on the second and third floors. The immense glazing facades are supported between each floor by a grid of steel mullions. The Pyramids are a classic example of simple yet seductive in regards to structure. The columns' connections are hidden above the ceiling providing a minimalist and strong look to each space.

The Buildings |

Designed by Kevin Roche John Dinkeloo and Associates, The Pyramids were built in 1970 just outside of Indianapolis. The Pyramids were built for College Life Insurance Company as their new campus headquarters when they were experiencing a great run at expanding their company. In regards to the overall design of these buildings, it would appear to attract those of an acquired taste for brutalism. The heavy concrete elements dominate the eye from the entrances. Building users enter through these 14 foot walls into an entirely open floor plan, with only partition walls to divide up the spaces. The circulation, bathrooms, and building system spaces are all cut out from the walls to ensure this open plan. By carving into the walls the building does not require any additional structuring for these functions. When you walk around to the glazing side, the building shows its true beauty. By this I mean the heavy concrete walls go through a metamorphosis from a massive gesture to a light one. The glazing floats off the walls and conceals any idea of additional structure. The reasoning for the sloped glazing was a response to the programmatic requirements. Each floor varies in its size to accompany the sizes of the various departments within the College Life Insurance Company. The glazing, open floor plan, and a fissure between the core walls on the northern side allow light to fully encompass each floor with natural daylighting.

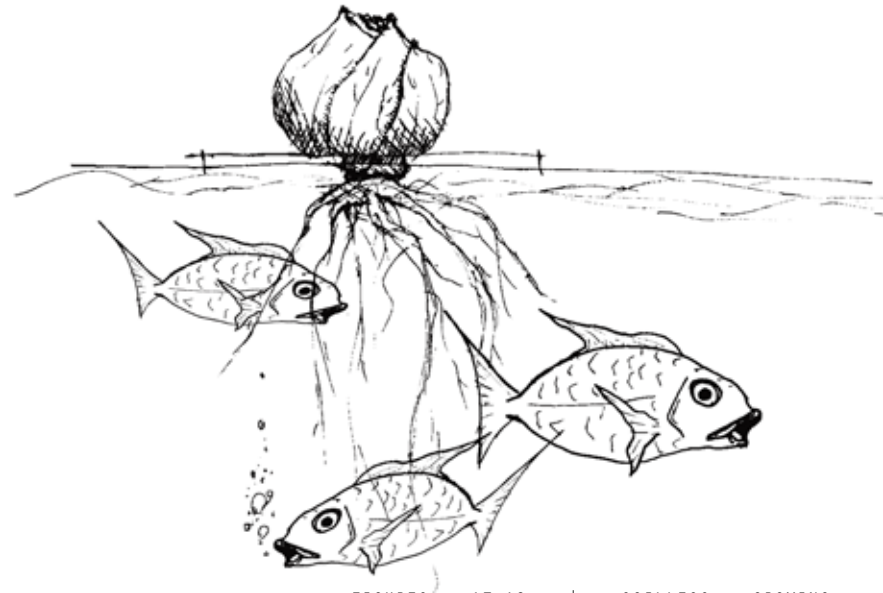
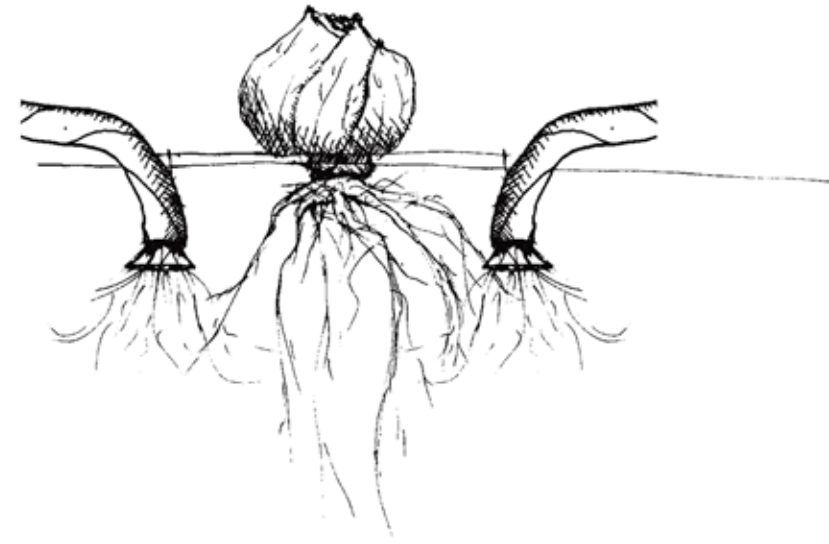
The Site |

The initial build called for only three building to be built, but the original design concept shows there were plans for even more expansion into nine total units. The buildings' modular design allowed for all nine to be interconnected. However, the College Life Insurance Company did not account for the advancement and integration of the computer, and ended up moving out of the buildings as they were no longer necessary for original purpose of storing the company's paper documents. Eventually running through multiple owners and functions throughout. Initially their context seems unfitting from seeing only the concrete walls, but from the other side they blend in perfect harmony.

The Lesson |

What I intend to take away from The Pyramids is to look beyond conventional styling and structuring to achieve a symbiotic relationship with the buildings environment and programming requirements. The buildings cater to the program and user of the person beautifully, all while being uniquely designed in a simple manor. An open floor plan surrounded by glazing will allow the residents of the other half of my vertical farm to feel as if they are also living within the growing space. It will also allow any light from the other side of the building to reach the plants. Clean and simple, just the way I like it.

FIGURES 14, 15 | THE PYRAMIDS DIAGRAMS



Since I first heard of the idea to choose a thesis topic for our fifth year, I knew I wanted to do vertical farming. I worked on a farm when I was younger and enjoyed seeing the crop come in. However, the conditions were sometimes unbearable, only escapable by going indoors. *Light bulb.* However, it has been brought to my attention that there has been some great advances in the realm of urban and vertical farming. Allow me to explain the difference.

URBAN FARMING

If you've never been on top of a roof - preferably black - in the summer, consider yourself lucky. However they are prime locations for anything what requires copious amounts of sunlight. Say, a greenhouse and lets throw in some PV panels as well. Urban farming is just that. By placing lightweight greenhouses on the roofs of existing warehouses along with PV panels to power the whole operation you can grow just about anything. Watering is not an issue because Hydroponics (fig. 17) - growing plants in nutrient rich water - uses ten times less water than conventional farming. What if you're in Phoenix Arizona where fresh fish are not available? Aquaponics (fig. 19) allows for this to happen by raising fish who feed off the algae or fish food. The fish's waste then provides the necessary nutrients a plant needs to grow - Farmed Here uses tilapia in the majority of their aquaponic systems.. The only real limitation to urban farming is it's site, in that you can only go as big as the building you plan to grow on. Also the greenhouse effect is still a real thing in today's society - muy caliente.

VERTICAL FARMING

Now, take all of that which we just discussed, and place it into a completely controlled environment. The greenhouse effect does not live here, as the majority of facilities are windowless and are the type of warehouses the greenhouses were more than likely built upon. With an absolute control of the interior environment, plants can grow year round. LED lighting can grow plants into maturity within 30 days as opposed to traditional farming's 60 days. Sunlight is not necessarily an essential aspect to plant growth with the new findings on LEDs. However, these systems can cost a lot of money and the start-up price is very intimidating. This is why it is imperative to make the building react with nature to provide nature. To emulate the outdoors, indoors, in other words. What a sight it would be to look up at 400 feet plants growing in a building right down the street from you.

FIGURES 16, 18 | FARMING TECHNIQUES | BGARISON // LUTERO

FIGURES 17, 19 | SOILLESS GROWING

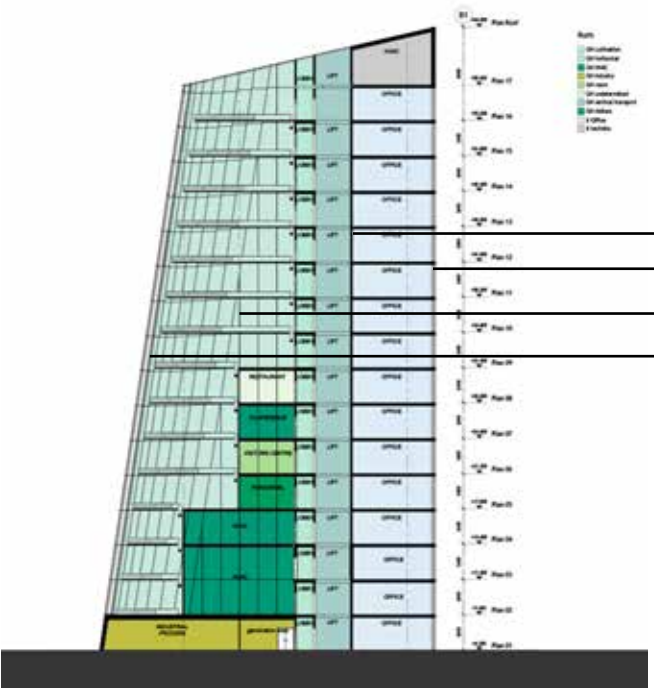


FIGURE 20 | PLANTAGON A1 RENDERING | PLANTAGON

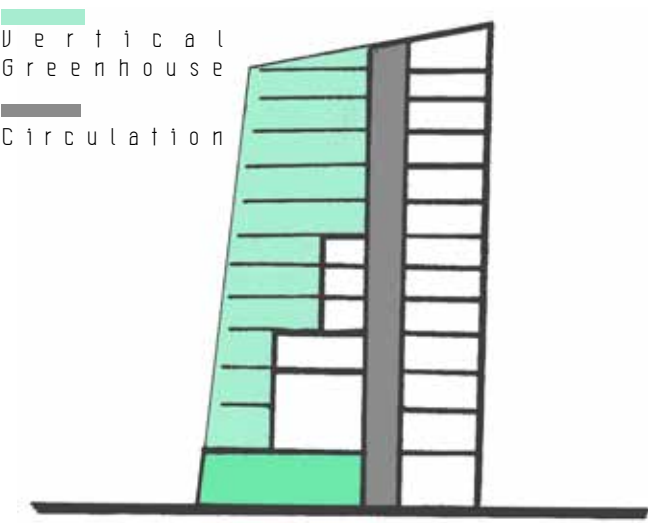
PLANTAGON



FIGURE 21 | AGRITECHTURE | PLANTAGON



- 197' | Height
- Reinforced Concrete Core | Structural System
- Concrete Bearing walls
- Cylindrical columns
- Modular Steel Framed | Facade curtain wall
- PlantaWall



The Concept | Plantagon is a innovation company working in conjunction with SWECO Architects in Sweden. They are main dedicated to research, product development, and a global objective to recreate the way we supply food to urban areas. Their first edition of the Plantagon, a comparatively simplistic approach was taken. After this idea took off, so did the imagination and resources of Plantagon. Each rendition is improved in both design and technology, but still remains similar depending on its placement in the world. Each concept is fit to their site like a key to a lock for optimal sunlight absorption. For instance, a Plantagon on the equator is spherical as apposed to the depressed cone design for anywhere north or south of it. Their research also took them into redesigning the floor space. The simplistic design was replace with a helical floor for easier transportation of products, and more area to grow plants since walls were now obsolete for structural purposes. What's more is that Plantagon wasn't satisfied with just making their buildings have vertical farms, so they developed the PlantaWall to be affixed to any building of your choice.

FIGURES 22-23 | PLANTAGON A1 DIAGRAMS | PLANTAGON

Different solutions for different zones and purposes

TEMPERATED



INTERTROPICAL



SELF-STANDING



MULTIFUNCTIONAL



FIGURE 24 | A2 VERSIONS | PLANTAGON

The Structure |

We've learned through Epcot, courtesy of Buckminster Fuller, that a geodesic dome is one of the best structures created due to its self supporting nature. Plantagon has taken it a step further for their inter-tropical version of a Vertical Farm. A central core is all that is required to support the helix. The geodesic frame supports the glazing effortlessly thanks to the sphere's ability to displace loads evenly throughout.

Now comes the familiar shape we saw earlier with The Pyramids and almost slightly the Burj Al Arab. However, this is not bearing wall and column structure. Even though they are not spherical, the temperated versions still have a helical floor suspended by a central core and the concrete wall. The two versions have separate glazing structures. The version to the left - and the section to the right - is a self supporting steel space frame. The version to the right requires anchoring to the concrete structure for stability.



FIGURE 25 | HELIX | PLANTAGON

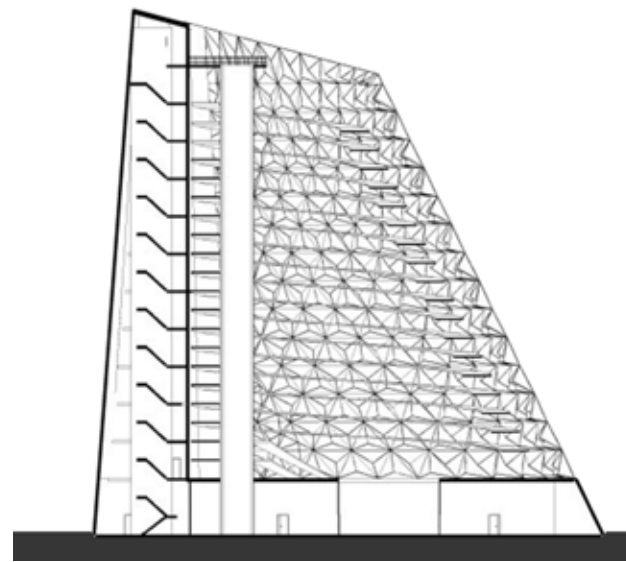


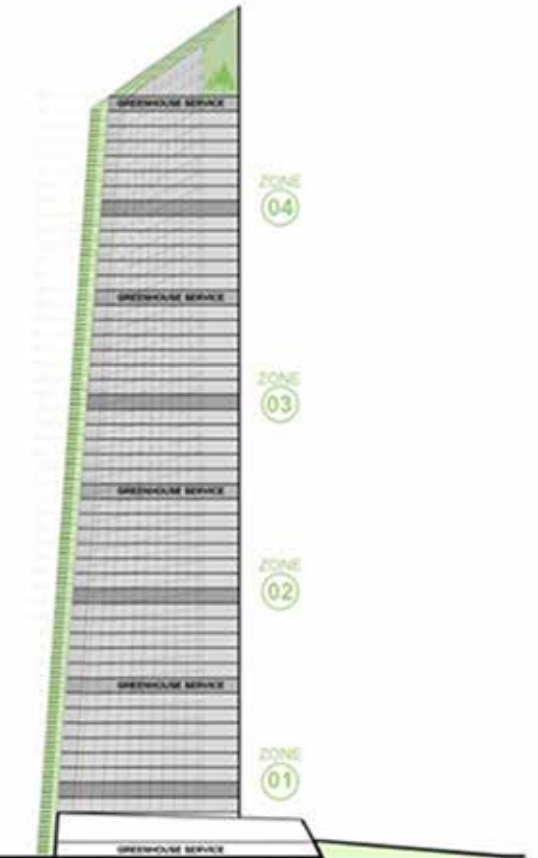
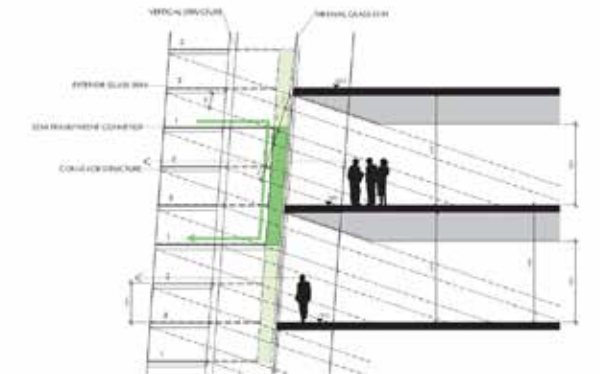
FIGURE 26 | SELF-STANDING SECTION | PLANTAGON

The Buildings |

Plantagon has me convinced that their innovation is the work of the future. Perhaps not these exact renditions, but the same concepts and outlook on a sustainable tomorrow. They are so sure of these ideas that they even patented their helical design. Plantagon also engineered pneumatic devices that slowly climb the helix and move each plant tray down a few inches. Each tray is loaded at the top as a freshly potted plant, and by the time they reach the basement they are fully matured and ready for harvest in a never ending cycle. The machinery to run these devices lies in the bottom two floors. The slope of a temperated version depends on the amount of sun hours and the average azimuth over the year. This ensures the building is going to produce as well as the sphere in the inter-tropical area, square footage allowing. A direct exchange of the O_2 from the plants to the people within the lower levels supplying the plants with their needed amount of CO_2 . Putting away the buildings for a minute, and discussing the PlantWall as shown to the right in section to show its modularity and process. Even if a full on building does not get built, the PlantWall could be the saving grace later on down the road. Imagine having one on your apartment building with a grocery store in the main level. The future is bright with creative problem solving.

The Lesson |

When I originally started my search for vertical farms I couldn't find any examples that fit my vision in one way or another. This accidental stumbling upon, in my opinion, has resurrected the project into a new level of innovation. As I am working on the eVolo competition, many of my past models resembled the forms Plantagon has put forth into the world. A reassuring sign that there are some great examples to learn from and to help my project grow and evolve into the potential I believe it deserves.



SECTION FIGURES 27-28 | PLANTWALL DIAGRAMS | PLANTAGON

SUMMARIZATION OF CASE STUDY RESEARCH

Looking back at the choices made for my thesis' case studies, they all share one thing in common. This shared commonality was what made me choose them as well, except for the accidental gold mine of the Plantagon. Their glazing features were the main reason I sought them out. Growing plants indoors does not require sunlight, but that is not the only premise to the case at hand. I want to design a vertical farm that doesn't come with a huge start-up cost, and can provide more than just the plants that grow inside of them. I also want to bring awareness to the conflict going on in the world in regards to the human race destroying it. We can do better, and I'm going to show you how.

The Burj Al Arab in all of its magnificent glory was a perfect case to study with respect to my thesis topic. I learned from the Burj Al Arab that from placing the structure outside of the building, one can design an immense atrium that could be used in the growing and harvesting of plants. I also learned that if there isn't an ideal site available for the building to reside, then go and make your own - budget and time permitting.

The Pyramids are brutal, lonely, and intimidating looking structures, but only from one side. The other side is a gorgeous combination between earth and water - concrete and glass. I found that by making your core, walls, transition space, and bathrooms all into the same feature, you are really left with nothing to put in the rest of the building. An open floor plan lets in the light and carries it throughout the building, which is what I want in my residential aspect as well to coincide with the overall passive strategy.

Vertical farming is progressively becoming more and more popular with each passing year. Along with each passing year we have a rapidly expanding global population and temperatures. The entire concept around vertical farming was just that, a concept; at least until Plantagon and Farmed Here took matters into their own hand and carved a path for a bright future for vertical farming. Plantagon especially has given me the inspiration to keep exploring for the next person to innovate another aspect, unless that person should be me - good one right?

I digress to come to this conclusion. 5 years ago vertical farming had me getting laughed out of my farmer friends' houses. Today, I'm proud to be able to say that this idea can be obtained, and bring their jobs into the city. Vertical farming is the future, and it is a viable solution to fighting malnourishment.





FIGURE 30 | PIONEER SQUARE FARMERS MARKET, DOWNTOWN PORTLAND, OR

PROJECT EMPHASIS

P A S S I U E
 S T R A T E G I E S

With the world's obsession with fossil fuels, an example of clean energy needs to come forth and show that there are alternative methods. By leading as an example we can educate the youth of today for a better tomorrow and a guaranteed future on this beautiful planet.

I N N O V A T I O N

With such a forward thinking idea it's important to utilize the newest technologies to include into the entire project. Being a leading example of what is to be expected of future architectural projects.

P E O P L E

With a lot of the urban areas today focusing on the vehicle more than the person, this project will focus on how people can interact with the site and building aside from vehicular methods.

USER//CLIENT

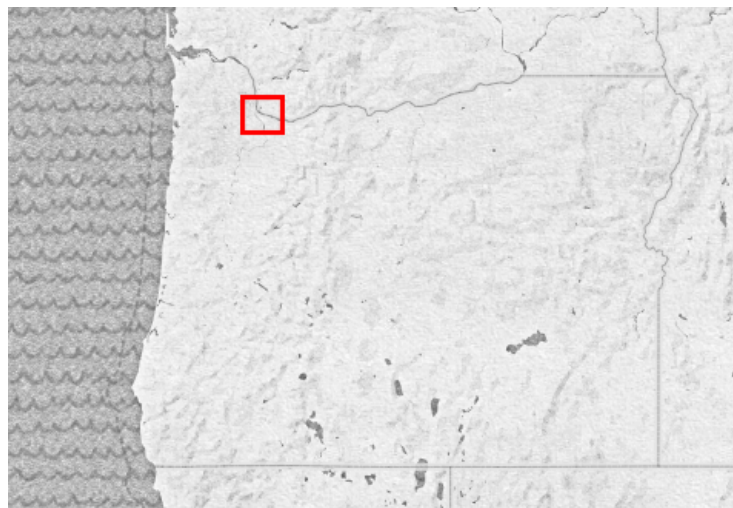
User|

Since the building will be growing 24/7, the staffing will also have to be hired for around the clock. A constant monitoring of the plants is necessary for maintaining product quality. Workers would receive waivers for living in the building to keep them on site in case of any problems that would arise. Aside from the Residential and Plant Growing facilities, the building will be operational from 6:00 AM - 9:00 P.M. Residents will have full access to the growing facilities and their own small section in which they can grow if they so choose.

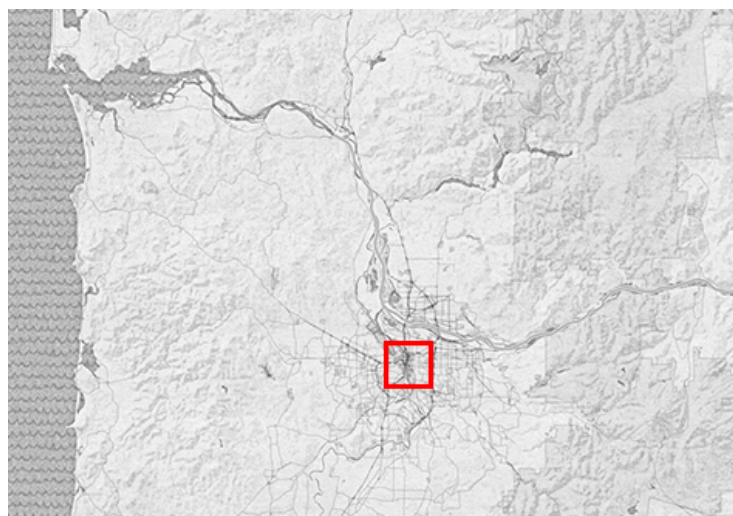
Client|

Clients can pickup their crops from the market located inside, or order for a delivery or a pickup from one of the separate growing facilities. With the client oriented smaller businesses being available before and after their working hours, it will allow more activity to be added to the building's overall economy.

THE SITE



P O R T L A N D ,
O R E G O N



D O W N T O W N ,
P I O N E E R
D I S T R I C T

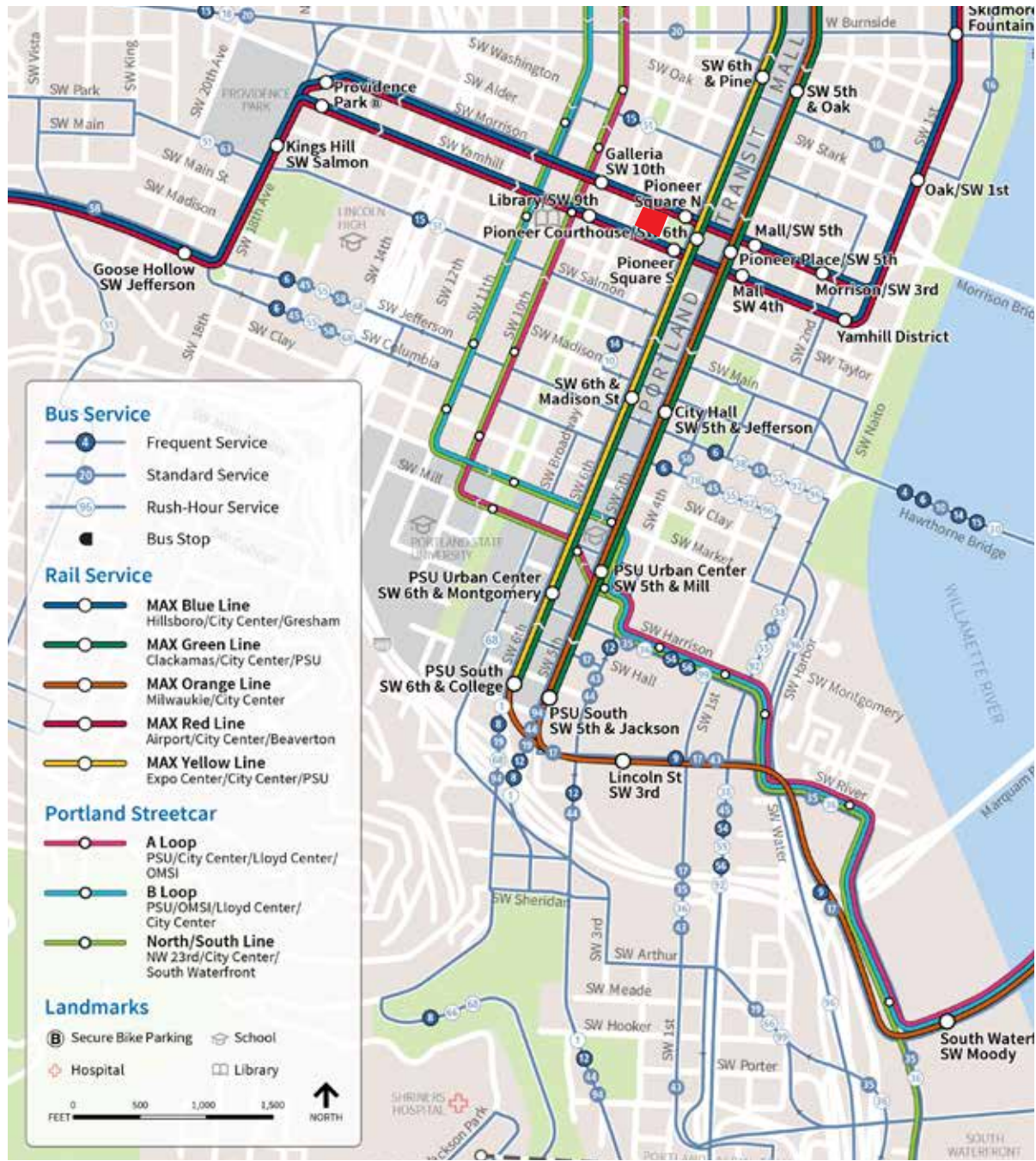
C E N T E R O F T H E C I T Y

THE SITE



FIGURES 31-33 | MAPS OF PORTLAND, OR | MAPBOX

The site for U has an incredible amount of urban amenities. Such as: Density, public transportation routes on 3 of its four sides, continuous sunlight hours throughout the year, proximity to main traffic arteries, freshwater source proximity, bicycle and pedestrian traffic routes, numerous and various surrounding businesses, and a handful of parks.



Located right across the street from the ever popular Pioneer Square, the site is quite literally surrounded by public transit of every kind. There is rarely a five minute gap between any form of transit to the site. During my site observation I noticed that people were using the public transit to either buy/bring a lunch to eat in the Pioneer Square itself. The opportunities to capitalize on a popular area of Portland are as endless as the transit systems them selves. There would be no need to drive to the market to grab groceries, thus reducing the carbon trail of the building. Also with the college nearby, students can work and/or live at the vertical farm.

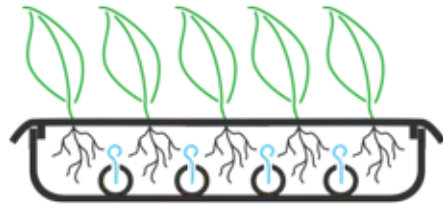
FIGURE 34 | TRE MET TRANSIT MAP | TRI MET



FIGURES 35 - 36 | PIONEER DISTRICT, PORTLAND, OR

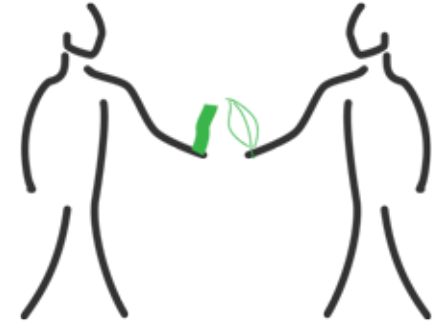
Site Amenities	Affect on project
Portland Travel Center	Mutually bringing more people into each other's businesses, increasing profit.
Farmers Market	The Pioneer Court hosts one of the many farmers markets that go on around the city from May to September. By placing the vertical farm right next to the market, an absorption of the market would remain open throughout the year and provide even more produce.
Restaurants/Food Trucks	Employees will be able to eat lunch within the area and possible absorption of trucks into program.
On and off street parking	For those who prefer to drive, its covered with plenty of street parking and garages.
Direct access to sunlight	The most crucial and primary reason for this site to utilize as much daylight for lighting, plant growth, and solar energy.
Portland Transit Mall	"Follow the trees." Also multiple public transit systems
Public Spaces	Gives building users and clients places to eat, meet-up, or hang out.
Shopping	Residents and faculty can walk to the store, essentially eliminating their carbon footprint.
Arts District	Provides a sense of culture and refinement to the area while providing entertainment.
Homeless Population	Could deter clients. Possible integration of workers.
Dense Population	High number of potential clients.

MAJOR PROJECT ELEMENTS



HYDROPONICS

Utilizing state of the art technologies, plants can grow around the clock and within a controlled environment. No pesticides, minimal water usage, and no transporting of produce make this method better than traditional methods.

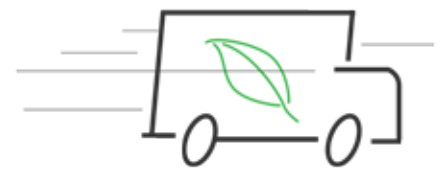


RESIDENTIAL

By incorporating passive strategies to provide energy, along with LED lighting systems, affordable housing can be accomplished. Affordable housing in an urban area cuts commute time and energy. Adding to a better quality of life.

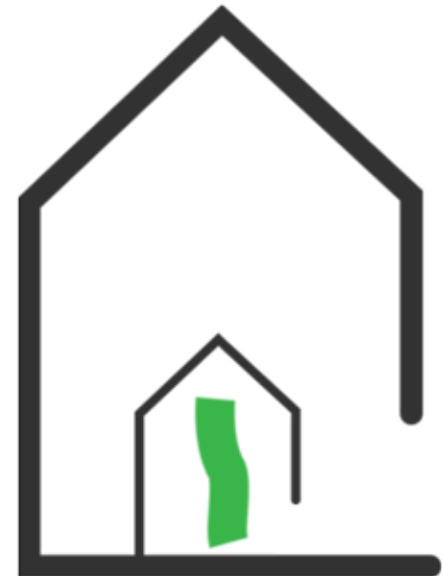
MARKET

The market is where produce can be purchased year round for residents and other businesses. By cutting out transport, fresh produce for restaurants and families can be easily picked up or delivered.



DELIVERY

By becoming local, delivery of products is possible and can be done so with efficient delivery methods outside of semi trucks and trailers. Smaller vehicles more suited for the urban environment can easily and inexpensively deliver produce to clients. More people more money.



MULTIPLE SITES

By using multiple sites, more produce can be grown to supply the market and demand for the crops grown. It will also aid to the delivery system in that it creates a broader range of clients.

PASSIVE SYSTEMS

When the focus is to be as plant-like as possible, passive systems are required to keep efficiency on par. LED lights use a fraction of the energy required to light a standard bulb, never go out, and are easily concealable. Biomass Disposal and geothermal technologies will heat the building, while wind and solar technologies will provide energy for the entire facilities.

ACCESSIBILITY

By placing the building directly between major public transit routes, more people are able to efficiently transport to the facility. Improving the overall impact on the city.

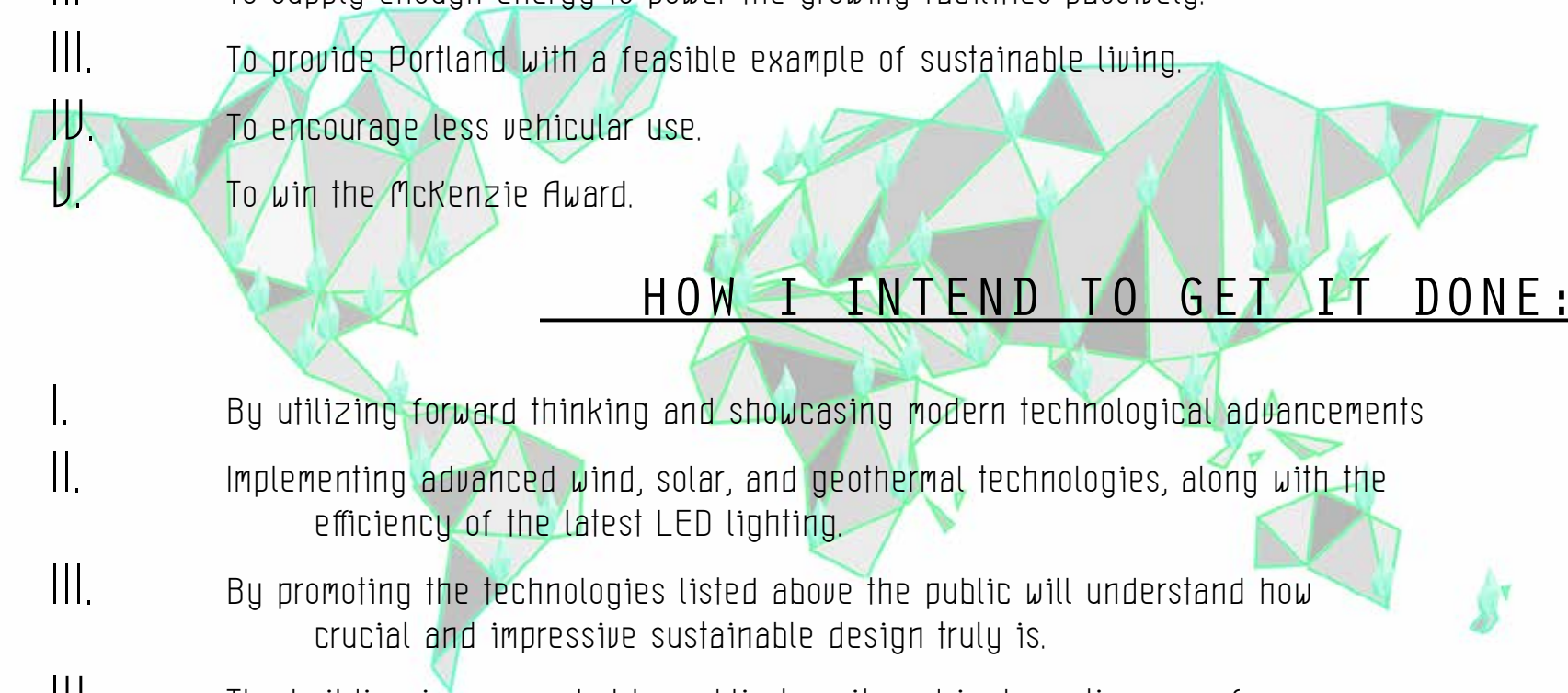
SMALL BUSINESSES

With the weekly farmer's market across the street in Pioneer Square, space gets to be tight for the farmers and food trucks. By allowing the farmers to come inside, and store their crops to preserve them, a business partnership forms instead of a competition.

FIGURES 37-40 | PROJECT ELEMENT DIAGRAMS

PROJECT GOALS

- I. To provide a new way of thinking for the agricultural world.
- II. To supply enough energy to power the growing facilities passively.
- III. To provide Portland with a feasible example of sustainable living.
- IV. To encourage less vehicular use.
- V. To win the McKenzie Award.



HOW I INTEND TO GET IT DONE:

- I. By utilizing forward thinking and showcasing modern technological advancements
- II. Implementing advanced wind, solar, and geothermal technologies, along with the efficiency of the latest LED lighting.
- III. By promoting the technologies listed above the public will understand how crucial and impressive sustainable design truly is.
- IV. The building is surrounded by public transit, and implementing more focus on bicycle transit integration.
- V. By displaying my skills in design, presentation, and unique thinking.

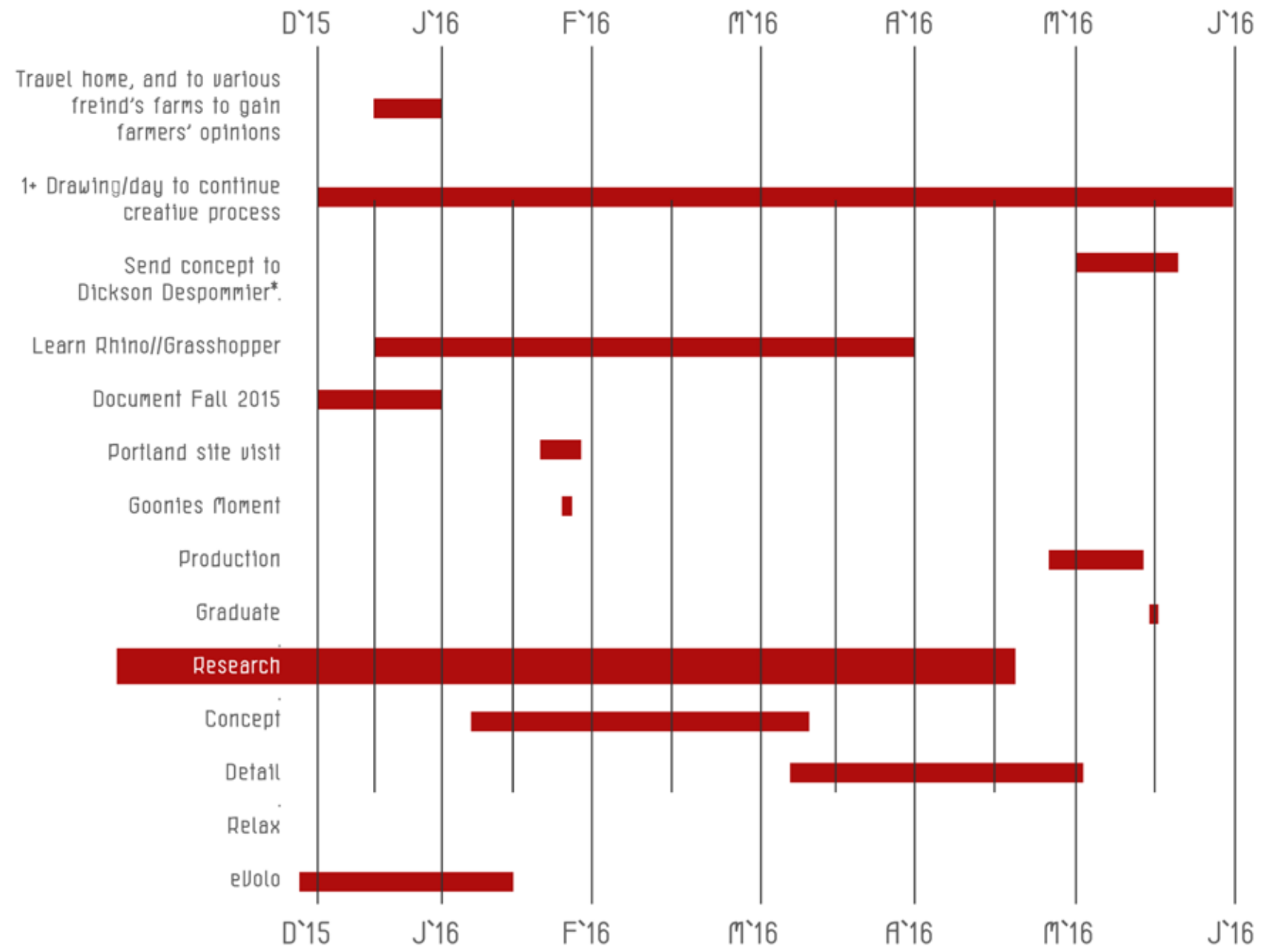
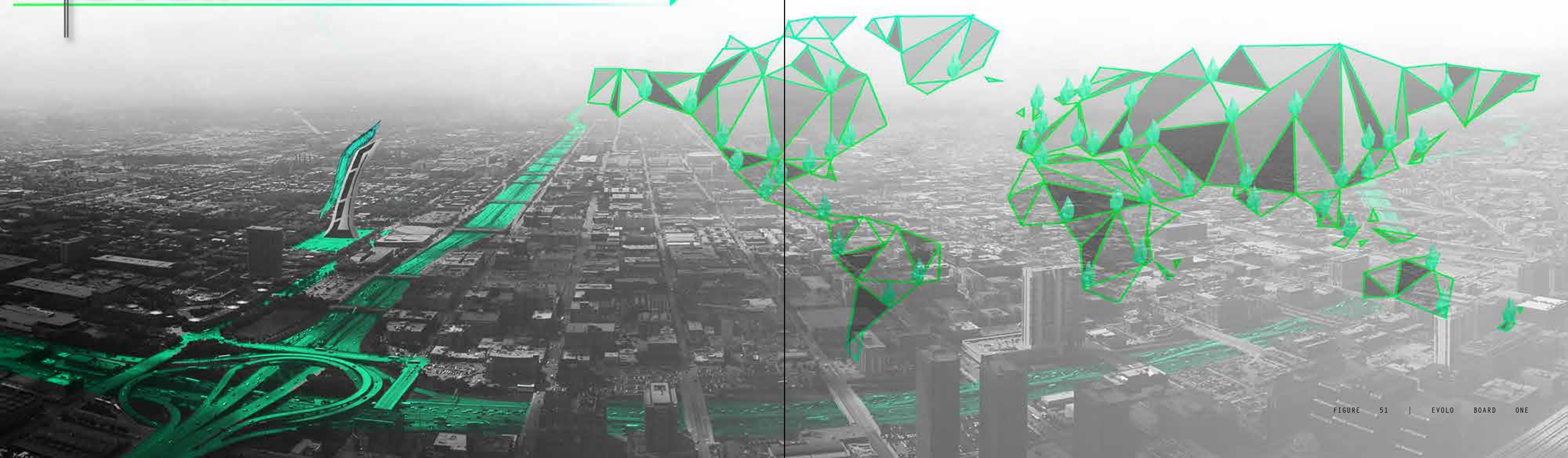


FIGURE 42 | PLAN FOR PROCEEDING DIAGRAM

HAIKU FOR YOU | NOSU

here at nd state,
 we o f t e n p r o c r a s t i n a t e.
 R E N L A S E R I S U P!!!

plan V



Year Five

Fall 2015 | Regin Schwaen

eVolo Skyscraper Competition

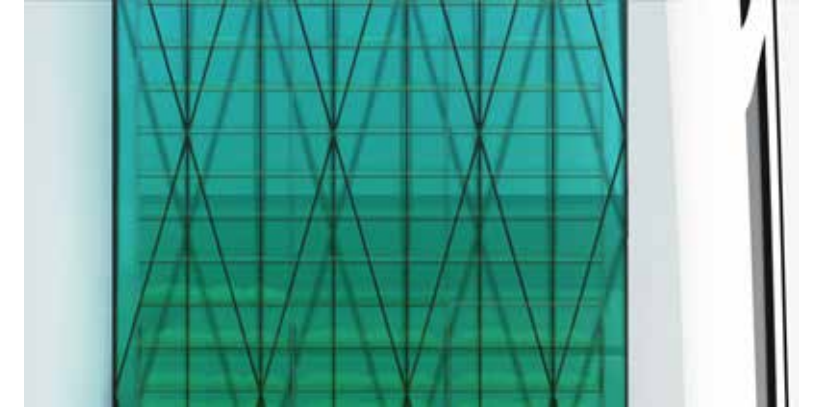
Multiple Sites, Earth

“Plan V”

We were to each enter a competition either as a team or individually. I used this time to expand and actively apply Thesis research to the concept. Each milestone or influential piece of information reshaped the building form. The ‘V’ in “Plan V” stands for the fifth iteration and vertical farming.

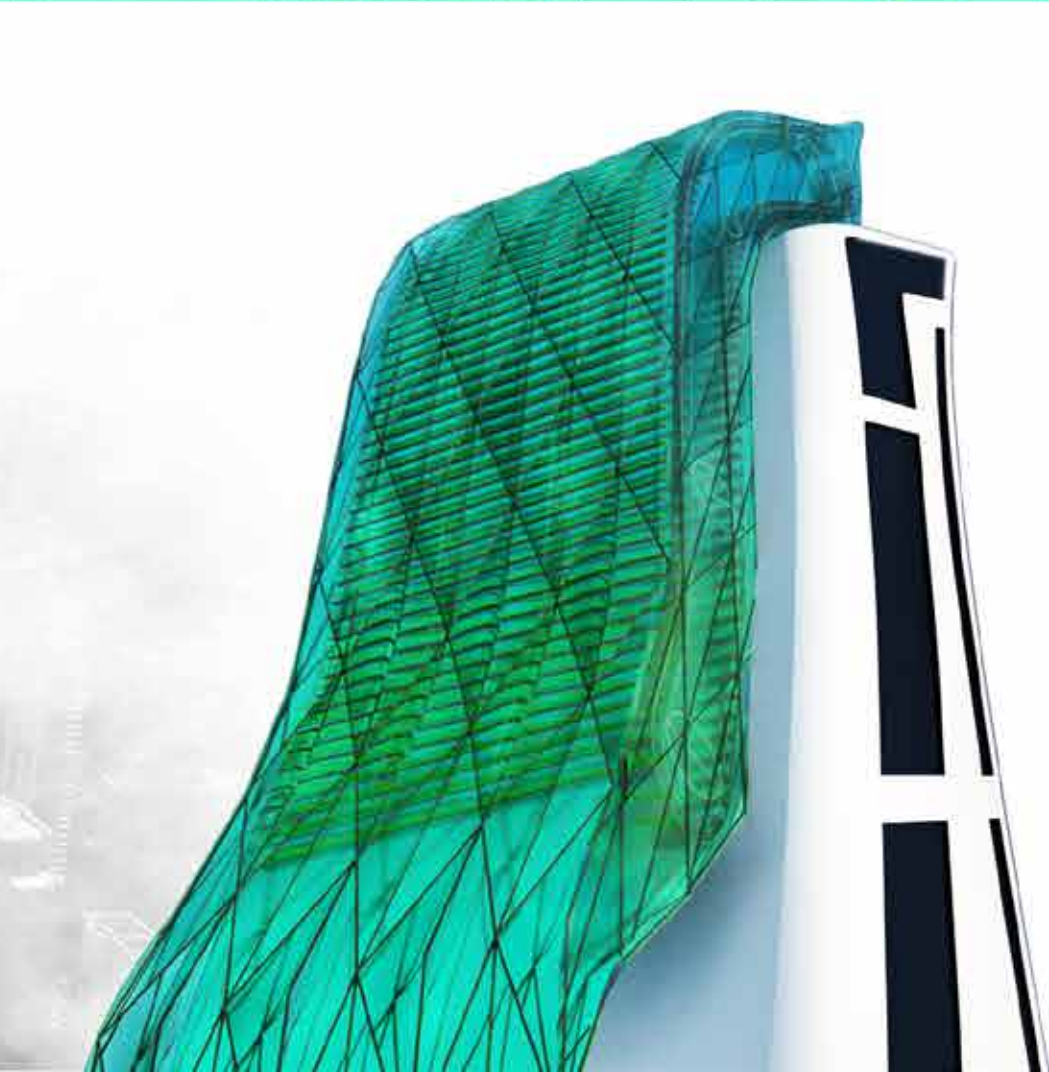
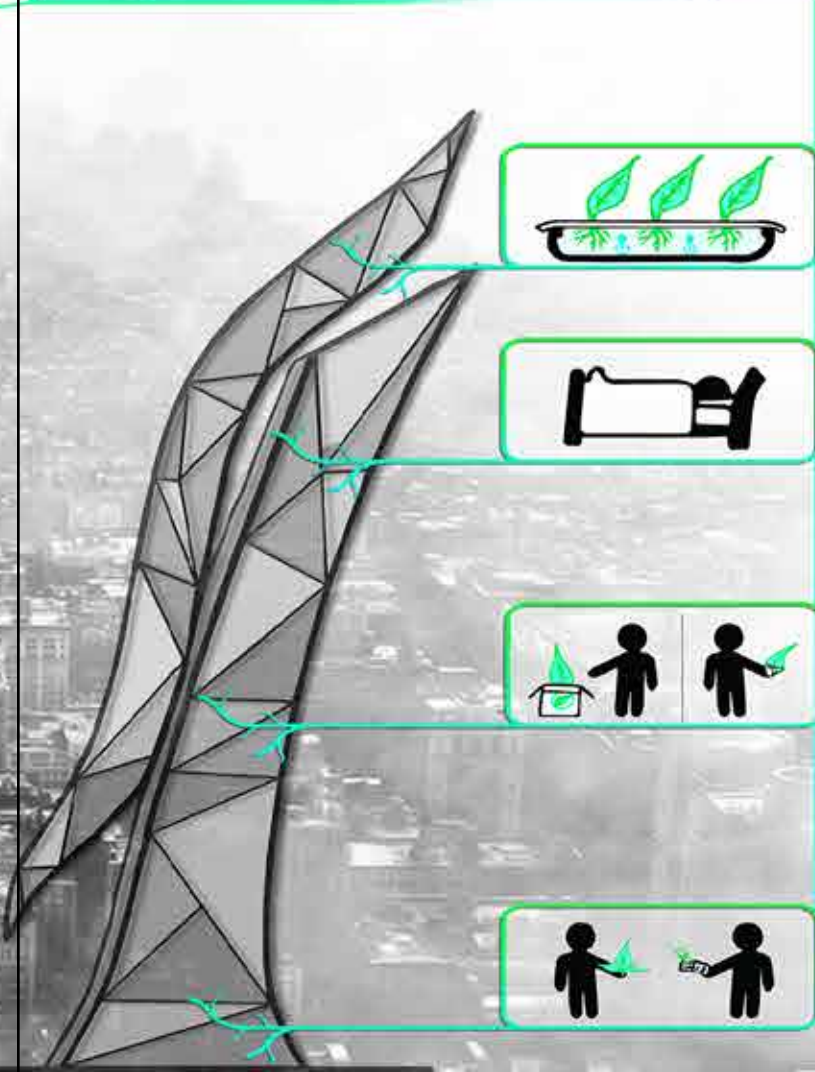
The competition was focused on simply designing and producing a beautiful looking building, and not focusing on the realistic structuring of the building. Thus, a conceptual model could take any form my imagination felt like. I used this as an opportunity to practice advanced designing techniques within the programs I utilized. The due date for the competition is the 26th of January, so I will continue to develop the project further after the semester.

My skills in Photoshop, Revit, and Rhino were greatly improved from previous projects. I show these images to provide an expectation for the final project.



plan

V



THE UNIFYING IDEA

As in the proposal, the case studies were evaluated base upon their similarities and features that could help understand the project typology. With the case study research providing a basis of understanding for the project, lets reflect on their impact in conjunction with furthered research. Each case study provided a frame of reference or at least a stepping stool for piecing together a possible buidling. Through graphical and rhetorical procedure, I aim to make my message clearer to provide a lineage between the information gathered and the translation into architecture.

The Burj Al Arab is currently the record holder for the largest atrium in the world, soon to be beaten by Zaha Hadid. This atrium is achieved through extensive structural systems, materiality, and great designing. The superstructural concrete core and spine provide anchor for the rest of the structural elements of the building. Steel Framing, Oversized space frame trusses, and aluminum framing techniques control the shear and lateral loads and deliver them to the concrete spine in an almost organic nature; concrete becoming bone, metal becoming muscle and tendon. The more reflection being placed upon this comparison brings out a flood of ideas in regards to replicating them into the vertical farm.

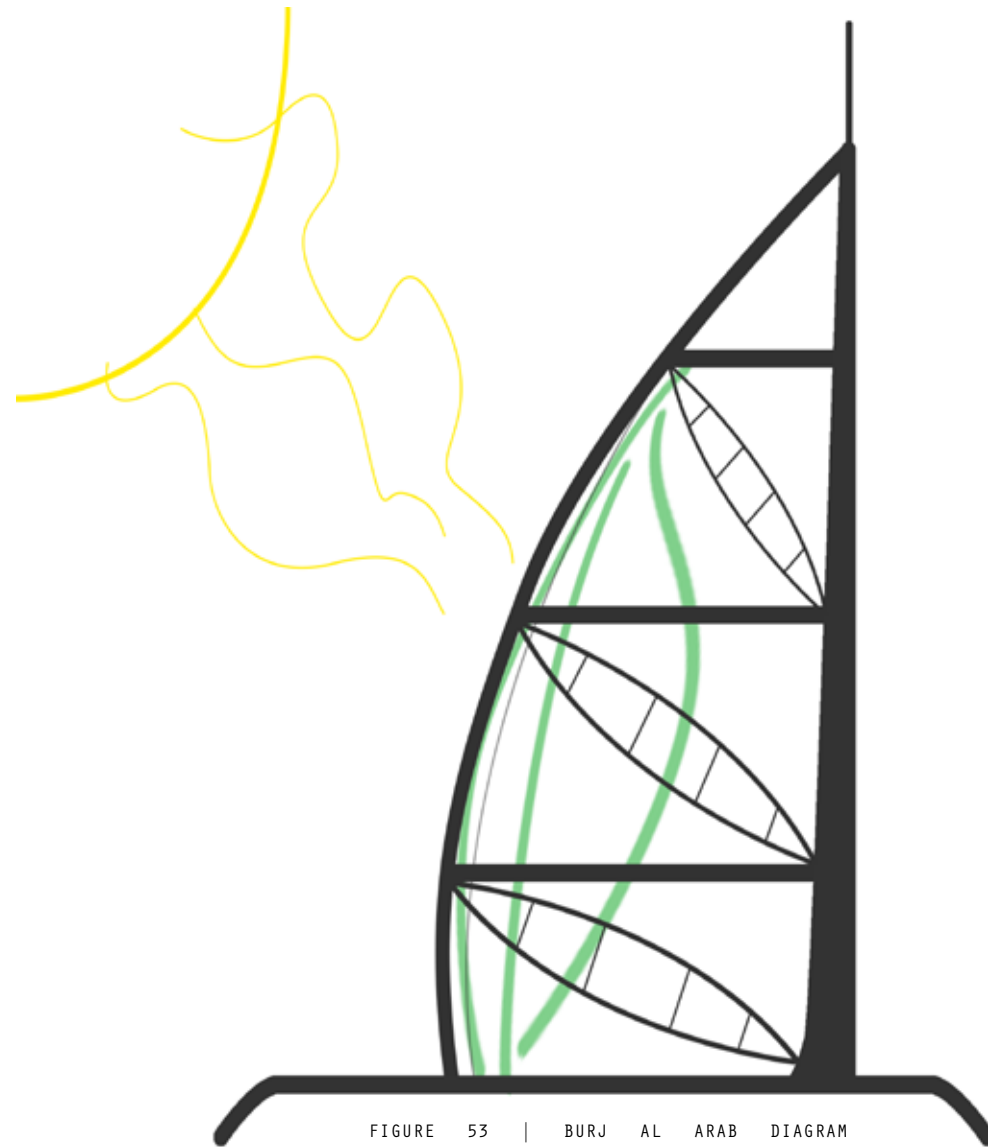


FIGURE 53 | BURJ AL ARAB DIAGRAM

It is of no surprise that there is nobody who really knows about The Pyramids in Indianapolis, as they were created with many peculiar factors. The brutalist stylization of the campus is rarely an appreciated method of designing. Brutalism seems to reject life than celebrate it. The campus is also located outside of the main city, making it a discoverable location rather than a beacon. These factors are surely to be avoided in the main facility, but could be used in the industrial setting of the secondary location. The hard juxtaposition of concrete to glass is a feature I intend to implement. With the massive and sterile core as a back drop, the sharp angles of the glass feature still embodies a sense of liquidity despite a lack of fluidity in form. The true inspiration lies within the buildings' incredible ability to minimally structure themselves. They in a way emulate a little bit of the Burj Al Arab, placing their weight on a backbone. They also reveal a concept often overlooked, integration of form and function into the core. In doing so with their 14' wide concrete walls, the floor plan could remain open and unobstructed from shear walls. Open floor plan means natural light, natural light means life. Maybe brutalism isn't lifeless, but perhaps tough love.

Plantagon is the key to all of this in regards to case studies. Their almost formulaic approach to designing with nature is inspirational. Techniques demonstrated by them open up the range of possibility. My approach would be to take the concepts of hydroponics, structure, and design set out by Plantagon and interpret them to my thesis project. If I were to try and replicate a plantagon to an exact, then what would be the point of all of this research? An interpretation has to happen in order to do what comes natural to life, evolve. Plantagon's concepts did not exist before they kept expanding, yet they kept going. Therefore, I too, must keep going; keep growing. A great beat producer out of Detroit by the name of J Dilla has one of my most repeated mantras in life, "...often imitated, but never duplicated."



FIGURE 54 | PYRAMID STRUCTURE DIAGRAM

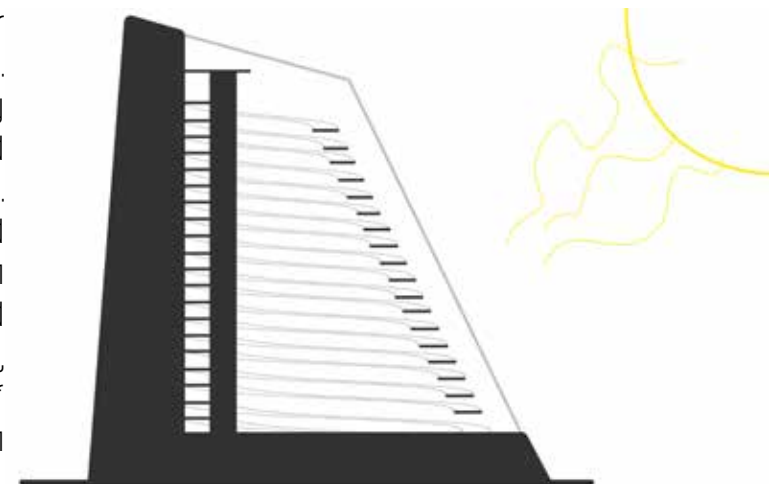


FIGURE 55 | PLANTAGON TRACT DIAGRAM



FIGURE 56 | URBAN AGRICULTURE | PLANTAGON

HUMAN IMPACT

If you're still asking yourself why vertical farming is important, consider the following. The human population is constantly growing and is expected to hit nine billion by 2050. With that size of population, people will migrate to the urban environments looking for work. An estimated 70% of the projected nine billion people on this planet will be living in an urban environment. Using urban density as a factor, the number of grocery stores needed to feed the population will take up valuable space for other businesses. These grocery stores will be filled with preserved, frozen, and pesticide grown food; This is all from having to transport from farms all across the nation/world. Outsourcing transportation jeopardizes the city's economy and the environment in regards to carbon emissions. By bringing the farmers into the city, we can use the land for livestock, larger crops, and preserve the land.

By building a farm within the city, it is an investment that pays off for everyone in various ways. Better food, quality of living increases, and even psychologically. It is proven that by having a plant on your desk at work can reduce stress and make you more efficient. Showcasing these plants will create a better environment from the inside out. The residents will have an entire garden right next to their living rooms, creating a sense of Zen with nature in an urban context.

HYDROPONIC SYSTEM

The concept of hydroponics isn't as new as some would perceive it to be. It's earlier methods are an almost different language in comparison to the more evolved modern methods. With modern technology, producers can grow more crops on an exponential scale.

Let's expand from start to finish; seed to sale. Since hydroponics allows the producer to grow without needing soil there is no need for traditional seeding methods; however, the seed needs to take root in order to begin growing. To do this, a nursery is needed to ready the trays of plants for cultivating. Seeds are placed in temporary beds of biodegradable compost for nine days and then placed into the hydroponic system.

Before a tray is secured into place, the roots are sprayed with a nutrient solvent that allows the roots to absorb the essential nutrients without using much water. By programing the watering system and reusing any excess solution, waste is cut off and allows the products to be properly nourished when nobody is around at night. Once a tray is loaded, the plants need only 90 days to complete the tract and become fully harvestable. Checkpoints are available to maintain and observe products, along with cameras and micro drones for hard to reach spots.

Since the plants are grown indoors there is no need for pesticides or herbicides. The plants are pumped CO₂ from the building users and outside environment, and the plants in return filter the air for the building users. Once a tray has made it's full trip around the tract, a producer preps the plants for storage, packaging, and sale. With such a short growing time it allows the producer to adjust to demand and future orders. The market will supply clients with freshly grown produce of its own in collaboration with various partners to complete the market. Any waste is composted into bedding for the nursery to restart the cycle.



FIGURE 57 | SEEDING | HUFFINGTON POST



FIGURE 58 | SPROUTING | HUFFINGTON POST



FIGURE 59 | CLOSE UP



FIGURES 60-61 | INSPECTION AND MARKET | PLANTAGON

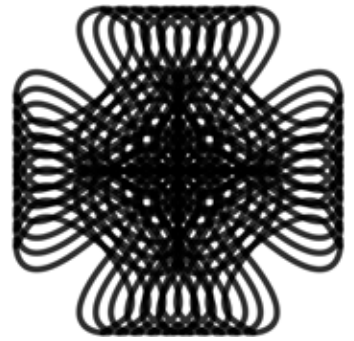


ART FROM SCIENCE

With almost every aspect of this building giving credit to the sciences, I can't help but notice the lack of an artistic and architectural presence. It may not be apparent, but it is an important aspect to the project, for science and art can coexist singularly. Maurice Merleau-Ponty states that any technology can be artistic, if given to someone whom will it to be. Plantagon and many other examples of vertical farming feel stagnant, or without meaning. Science can help us find the how, but art is needed to explain the why. Allow me to make the connection for you, from science to art.

Lets start with the basic needs of the human being, food shelter and water. These primal needs are what people need to survive, and we crave them. Humans can only go three days without water, eight days without food, and shelter dependent on the surroundings. Today, in a replaceable world, we often lose value or connection of where these needs are satisfied. Think of where it is your needs are met, or are able to be met. It is within my main facility that these needs are met in a singular form. The facility grows the food, provides the shelter, and has access to water, all within its own singularity.

If the facility is to embody these elemental needs, an elemental inspiration needs to come about. However, where is the primacy in the modern to be found? Earth 🌍, Wind 🌬️, Fire 🔥, and Water 💧 are as primal as elements can be, and open for interpretation. Earth is represented in the residential backbone, to support and provide a solid foundation for the facility. Wind is the flow between spaces within the building and between the two facilities; to withhold obstruction. Fire is metaphorically represented in the primal aspect of gathering. The facility is to be a beacon in the night sky using its LED systems, and to bring people together much like a bonfire. Water, is the most important source of inspiration. Water brings life, without it people and plants could not survive. Water is represented in the plants themselves, growing for all to see. The blue of the LED's will pour out from the building like water, bringing life into the environment around it.



FIGURES 62-65 | FOUR ELEMENTS

ARCHITECTURE

Keeping the artistic and scientific aspects in mind, lets evaluate the architectural translation. To embody earth and structure, we need to use the earth to structure it. Concrete is of the earth, it's highly structural, and is able to be poured into forms. With organic forming we can achieve minimal structure and maximum design. I attended Bill Baker of SOM's presentation at LOCI in Brussels, on organic structuring. In this presentation he states that structure is the language of architecture, and should be done simply. If we cannot explain the structure through simple means, then it should be considered nonsensical. Using the Fibonacci Sequence, a Voronoi Sequence (based upon Mitchell's Cantilever) creates the most optimal bracing using different polygons. However, my trypophobia will not allow me to design with that type of mesh. Therefore, the next most optimal is the Delaunay triangulation, which uses the same points, but uses triangles instead of other polygons.

To avoid hypocrisy, I'll explain simply. The Fibonacci Sequence is present everywhere in nature, you can find it in a sunflower's pattern. The placement of these seeds is how it naturally structures itself, and can be interpreted through genetic algorithms into structuring buildings. Far from the post and beam traditions of yesterday. The figure on the bottom right illustrates SOM's new skyscraper based upon these ideas. These methods are stable under lateral, gravitational, and seismic loads within a singularity and beauty.

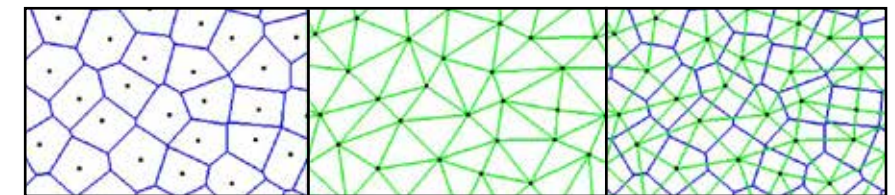
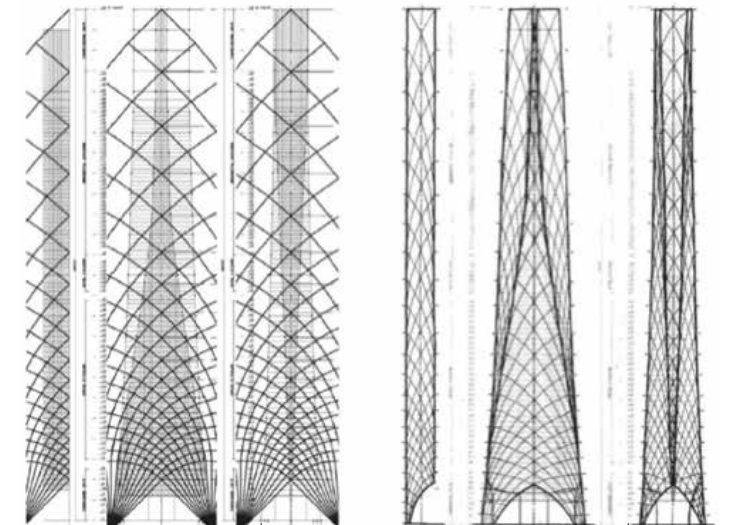
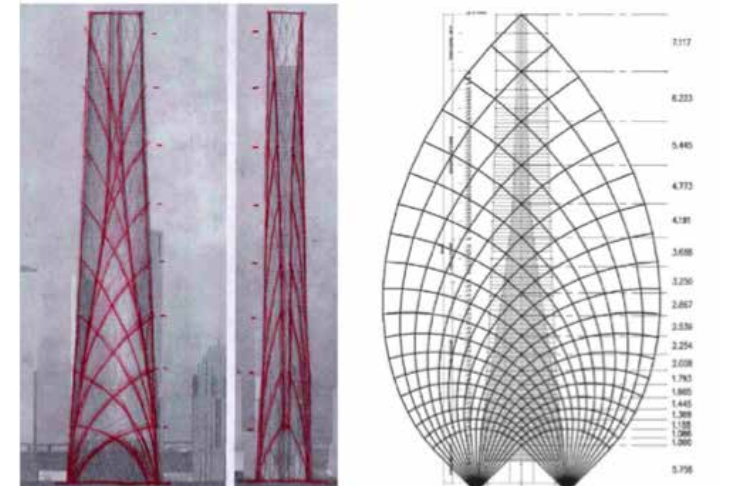
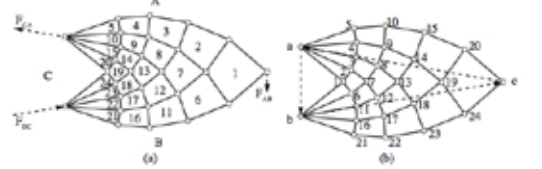


FIGURE 66 | VORONOI TO DELUANAY | Duffell, Paul C, MacFadyen, Andrew



FIGURE 67 | SUNFLOWER | FLICKR
Fig. 5 The solution to the discrete Mitchell cantilever (Chan 1990; Mazurek et al. 2011) is self-organized in form (diagram, b force diagram). The geometries of the form and force diagrams are the same.



FIGURES 68-69 | MITCHELL CANTILEVER | SOM

Architecture continued...

To incorporate wind and flow into the building, open space and limited circulation variations are to be implemented. A Singular core used by facility workers and residents together will create a controlled funnel and reduce wasted space. The circulation spaces will flow and include as few right angles and pathways to destinations, the elimination of spacial turbulence in other terms. By reducing this turbulence, facility users can easily navigate the building, and predict where to go if an emergency were to occur. Desire paths have always been an infatuation of mine, because they physically show the more efficient and preferred path by the users.

In this case open spaces mean the atrium and the open planned market. The atrium will be my focus feature of the project, therefore it should display itself as such. The plants that are growing inside will be placed on a rotisserie-like device, and to have such a device requires no obstruction at all. The plants also will need optimal lighting and air quality, therefore the atrium must be on a grand scale, yet without massive structuring techniques. If the plants are to get their required CO_2 and to release our required O_2 , then air must flow unobstructed. Placing massive structural elements within the atrium causes turbulence and thus eddies can form. As with the concrete forming, Delaunay triangulation will be used to not only structure the glazing, but also accurately refract and reflect natural light. In using triangular glazing one can flex the surface to meet the optimal sunlight hours for the site. If light is reflecting off the building beside the site, I want to capture it. Because, once again, natural lighting and design methods is the focus and key to making this project realistic.



FIGURE 70 | STREET VIEW

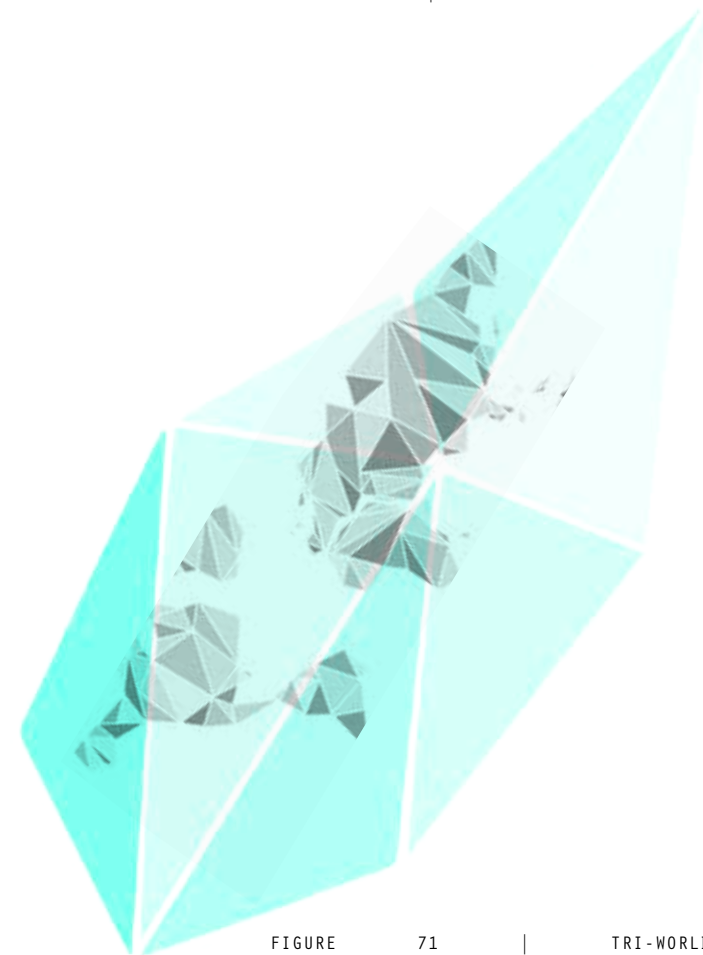


FIGURE 71 | TRI-WORLD

Architecture continued...

Fire is a primal gathering tool, humans are naturally drawn to it. The same can be said around any source of light given context. Looking at the stars and moon at night, the lights at a concert, the spotlights at a Hollywood premier. By adding a dominant night presence in addition to its presence in the daylight, the flame never dies out. The facility grabs the attention of the population and establishes itself as an icon of the city. The lights aren't only for show. The blue LEDs inside the facility will be growing plants around the clock. Blue LED lighting is proven to grow plants more efficiently than natural sunlight, in recent studies.

Water is life. It's the most important of the elements in that it is necessary for all life. Water's molecular structure is H_2O , our atmosphere is blue from the O_2 and O_3 in the air. Just as the sounds of water are soothing to humans, so too is the color blue. The blue LEDs will emulate a calming aura to its surroundings, spreading out into the warm incandescents like a river delta. These last aspects are crucial in establishing a presence and benefit to its surroundings, a dance of fire and ice.

FIGURE 72 | BEACON



Summarization of Research

Bill Baker also used in his presentation at LOCI a quote from Mark Twain, "I did not have time to write a short story, so I wrote a long one instead." What Bill meant by this is if we cannot describe what we know in a short and simple way, then you do not understand it enough. Thus, as with any piece of art, lets take a step back to see what all of this research looks like.

First off, we know there are no built examples of a facility like the one I am envisioning, but that's okay. Just because one does not exist does not make it impossible. We are either facilitators of dreams or enablers of excess. How can we progress if we are not willing to make that dream a reality? We've now found all of the pieces to the puzzle that is being assembled. Thesis Pieces, food for thought.

Constructing the frame of the puzzle first, we'll use our frame of references in the case studies. The case study research shows that there are many real world aspects that we can learn from. The Burj Al Arab's atrium more than exceeds the necessary height for the vertical farm. Precise structuring from The Pyramids show that an open plan is achievable if given a proper thought to core placement. Plantagon shows the promise of progress in the conceptualization of the future of agriculture.

Next, the human was brought into the equation. We discovered that humanity in its current state is heading toward a complicated future. If we are to prepare for the imminent task to feeding the world with a population of nine billion people that are more densely grouped together, then now is the time to start. Implement these methods to conserve land and environmental impact. The goal is to create jobs, not eliminate them. Quality of life, quality of food, quality of humanity, will all be improved.

Hydroponics are what make this restoration of humanity all possible. They can produce a larger amount of plants than ever before thanks to newfound technologies. Minimal water usage allows for less energy and more efficient methods of providing nutrients to the plants. Shorter cultivation times allow producers to keep up with demand, along with a symbiosis of passive and active technologies.

All work and no play, makes thesis a dull joy. If this was only a question of how, then there would be no relation to architecture. This project needs to embody an artistic will to deliver its message effectively. The embodiment of the earthly elements is driven upon our primal nature and the connections within it. They form the basis for our needs and cater to the desires of our world. A connection with nature is a connection with beauty, because we base our beauty upon the world interpreting it as we progress.

Finally, with the embodiment of the previous information in mind, a transition could be made into architecture. In using earth to represent the base of which to build upon, we learned of the presence of the Golden Section in nature. Organic formations found in nature allowing an exoskeleton to structure the building efficiently and minimally. The necessity for openness within the circulation spaces and atrium space is apparent in the connection to the humans and plants within the facility. The humans and plants both relying on air circulation to maintain a healthy environment. While humans interact with the building, a flow is needed to increase the efficiency of the building in reducing wasted space. Fire and Water create an attractive display of the facility and its surroundings. Fire burning bright in the use of its style and display of lighting, capturing the gaze of the city of Portland. Water calming the blaze with the soothing aura of blue flooding into its surroundings.

I'm not sure whether fate is real and we each have our own destiny, but I do know that everything I do know, has led to this project. I know what the puzzle looks like, now its time to find the final piece.

"in every life, one's birth and one's past define categories or basic dimensions which do not impose any particular act but which can be found in all... We never get away from our life. We never see our ideas or our freedom face to face."

-Maurice Merleau-Ponty



CONTEXT

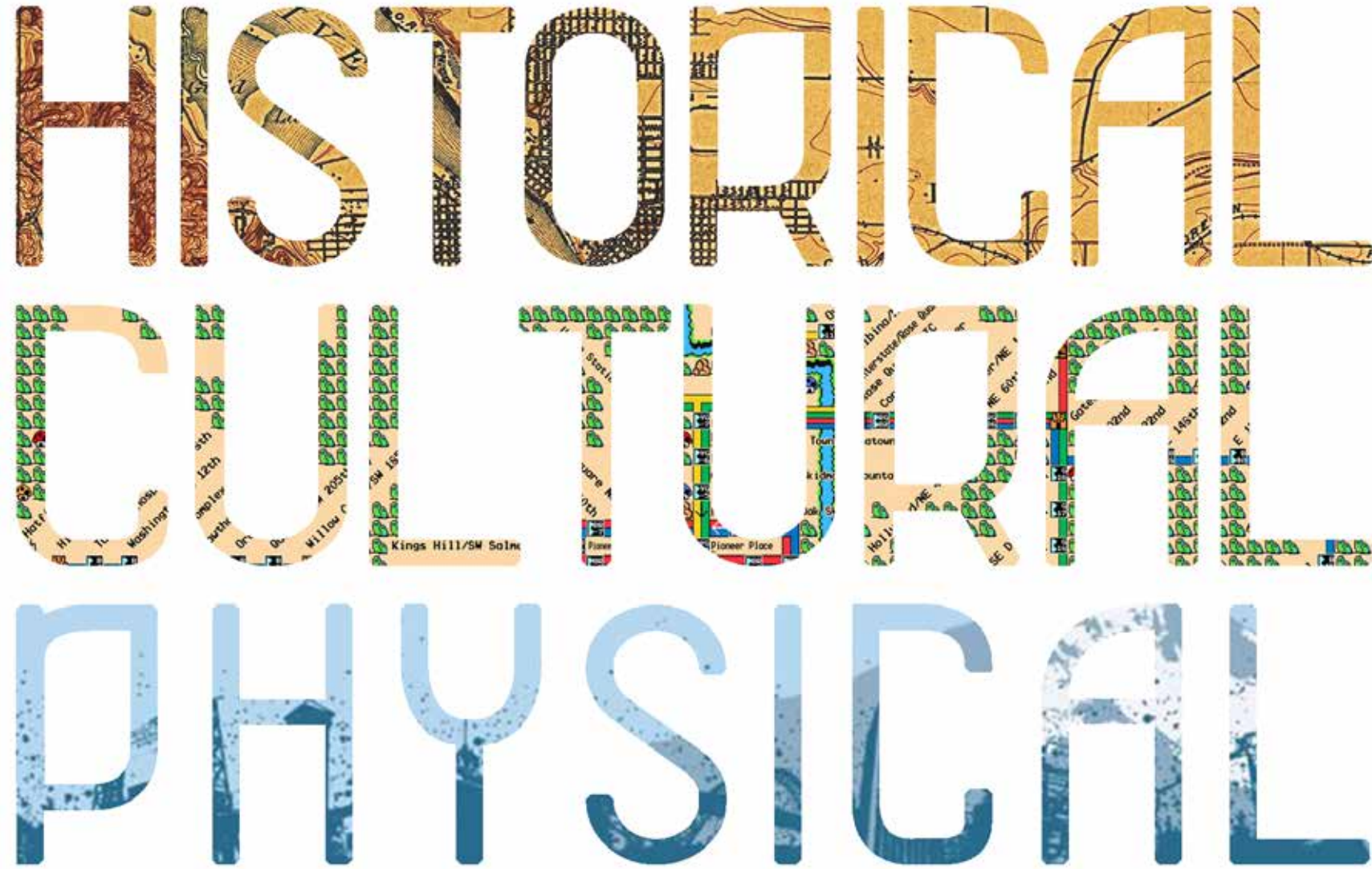


FIGURE 74 | CON-TEXT

HISTORICAL INFLUENCES |

With no other existing examples of a vertical farm to draw from, the historical influences are fairly limited. However, we can draw from the various concepts that are out there in the digital world and previous technologies used for farming within structures.

Farming, in an agricultural sense, changed the way we as a species lived more than 10,000 years ago. Humans grew out of the hunter/gatherer stage and started to dominate the planet. We learned about plants from cultivating them, and thus started to innovate our technologies. The tower of Babylon gave birth to the early stages of vertical farming. The original 'Vertical Farm' that began to grow plants in soil-less controlled conditions was known as a hydroponicum - the precursor to the greenhouse. Le Corbusier's Immeubles-Villas (1922) was the first integration of growing plants within a structure. In 1964, Vienna, Austria created the Glass Tower for the Vienna International Horticulture Exhibition. This signified the unification of the greenhouse and the hydroponicum in concept.

Ken Yeang was the first to propose a mixed use vertical farm in 1992 with Menara-Mesiniaga. The project featured an open air space to allow ample sunlight in to grow the plants, while also featuring livable spaces and stores. Vertical farming's entire idea was then conceptualized in 1999 by Dickson Despommier of Columbia University. This is where the merging of sustainability and mass production of plants became the standard. He describes the modern vertical farm as being a single-use facility that has a market integrated into the program, all while being self-sufficient. Innovations in solar and wind energy, hydro/aquaponics, and passive design have made this concept more and more of a realistic project.



« Immeuble-villas »; fragment de façade. Chaque jardin rigoureusement indépendant du voisin.
 FIGURE 75 | IMMEUBLES-VILLAS



FIGURE 76 | MENARA-MESINIAGA

CULTURAL INFLUENCES

Sustainability is sexy. By that I mean that sustainability is a rising trend and sometimes a necessity for certain practices. With the project focusing on utilizing passive strategies, we can observe a vast amount of examples to draw inspiration from and/or incorporate into the project. Another major component is the mitigation of the urban crisis. The world population is projected to rise to nine billion by the year 2050, with 80% living within an urban environment. With a vast majority of the population living in the city, we will have fewer farmers and farmland to provide for the people of the world. With such little land to work with, a vertical farm is the solution to helping out the farmers, instead of replacing them.

Portland's focus on sustainability makes it an ideal location for the project. The city is one of the most walkable cities in the world and also features the most extensive bicycle path system in the United States. It also has a huge group of followers in the organic farming techniques, hosting farmers markets all over the metropolis. Portlandian's bleed green. Speaking of bleeding green, I wouldn't put it past them. Portland's unique culture has earned them a perspective that sets them apart from the normal. Owing to keep Portland weird, I bring a weird idea to the city.

PHYSICAL INFLUENCES

Portland has a near perfect landscape to work with and draw inspiration from. The Columbia and Willamette rivers bring life into the valley, grounded by the surrounding Sierra Nevada Mountains. Mt. Hood stands out and provides a great backdrop to the city skyline. The Columbia river separates Portland, OR from Vancouver, WA in a beautiful gesture tied together by seven bridges, each telling a story of the area's history through design. The city's urban context is full of various styles and materials, thus allowing for this idea to have an open context as well.

Inspiration from the rivers and mountains will not only be integrated into the design, but also the programming as well. The farming facility bringing the building to life will be an interpretation of the rivers, the separate growing facilities will also be located along the waterfront for even further integration into the project along with transporting crops to the market more efficiently. The mixed use facilities will be solid and earthly like the mountains in the back, providing structure with elegance. Taking in inspiration in the form of the elements will not only solidify the project's connection with its surroundings, but also in the connection with nature.

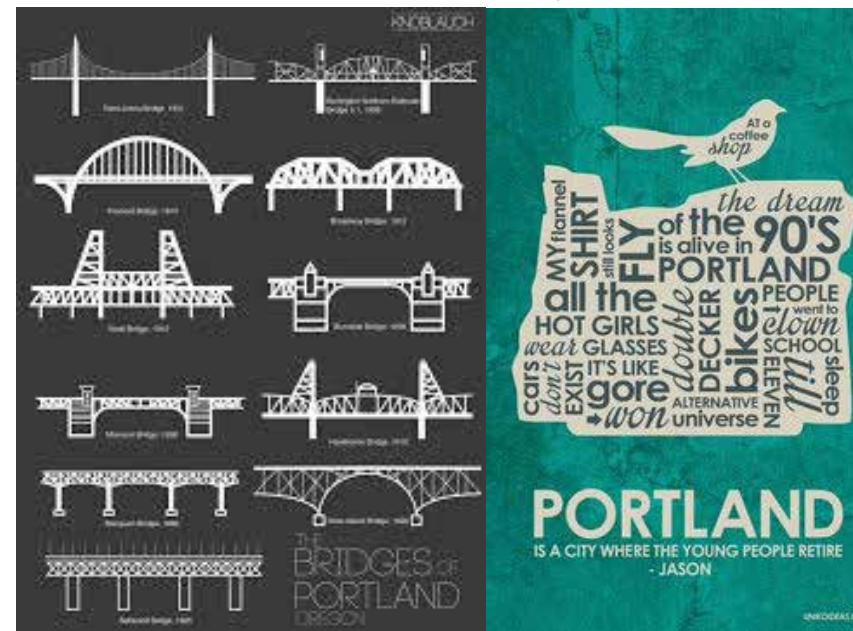
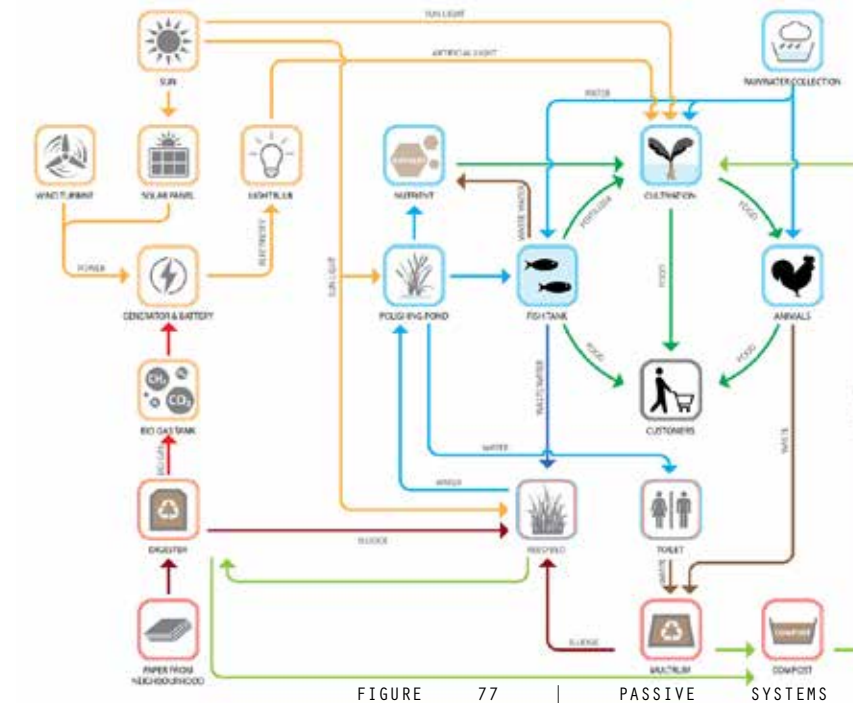




FIGURE 81 | PIONEER PORTLAND | VINTAGE PORTLAND

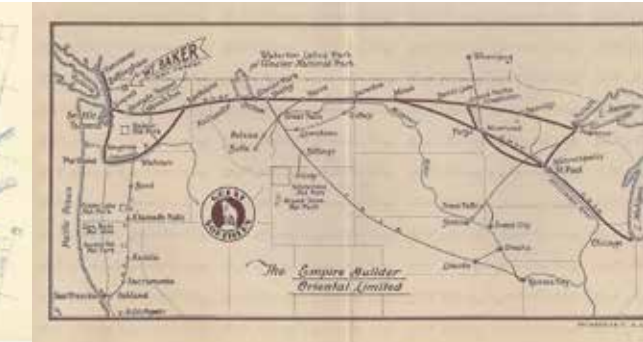


FIGURE 82.83 | HISTORIC PORTLAND MAPS | VINTAGE PORTLAND
 FIGURE 84 | STEEL ROSE
 FIGURE 85 | ROSE FESTIVAL ROUTE | PORTLAND ROSE FESTIVAL

ORIGINS |

Portland, Oregon may not have been the first settlement in Oregon (Oregon City), but since it's founding in 1845 it has been the front runner for the state. The city actually got it's name from a best two out of three coin toss between Francis Pettygrove and Asa Lovejoy. I admit, I use the exact same technique for all my life decisions as well. The city was named after Pettygrove's hometown of Portland, Maine, even though it would eventually become a major port in the Pacific Northwest until the rail reached Seattle in the early 20th century. As the city expanded - and continues to do so - into the Tualatin Valley it's agricultural presence took a hit in addition to lack of irrigation. One thing that did grow with great success were roses. So much so Portland gained the nickname, "City of Roses," and now it is impossible to see a building without a rose on it. The city even created the Portland Rose Festival, and has been going for over 100 years. The Festival's parade even passes in front of the site. The greater Portland area that we know today has gone from an early Pioneer settlement to the leading example of sustainable thinking in the United States. Portlandia's reputation has always been of a different flavor and thus adopted the motto, "Keep Portland Weird."

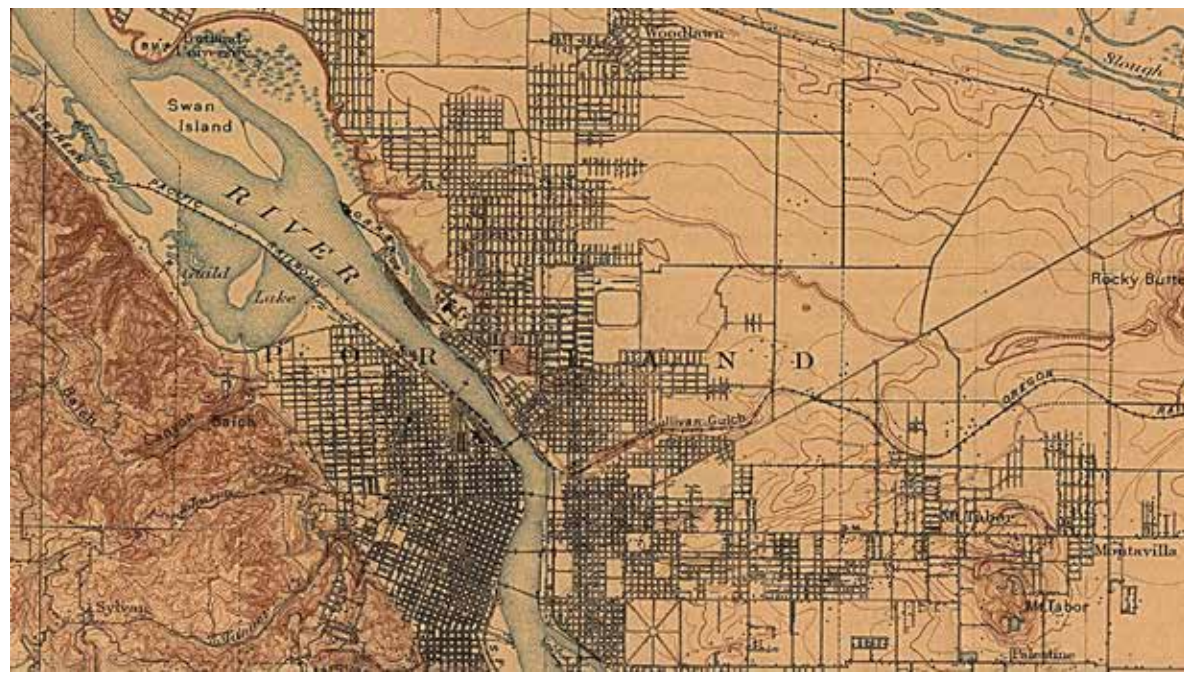


FIGURE 86 | TOPOGRAPHY | REDDIT
 FIGURE 87 | SITE | LOCATION

SITE

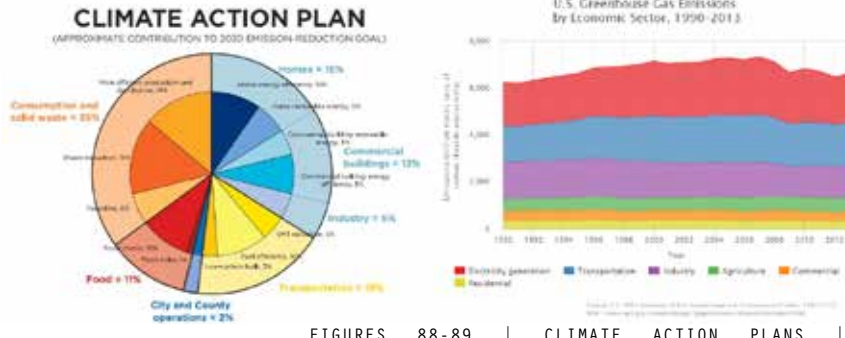
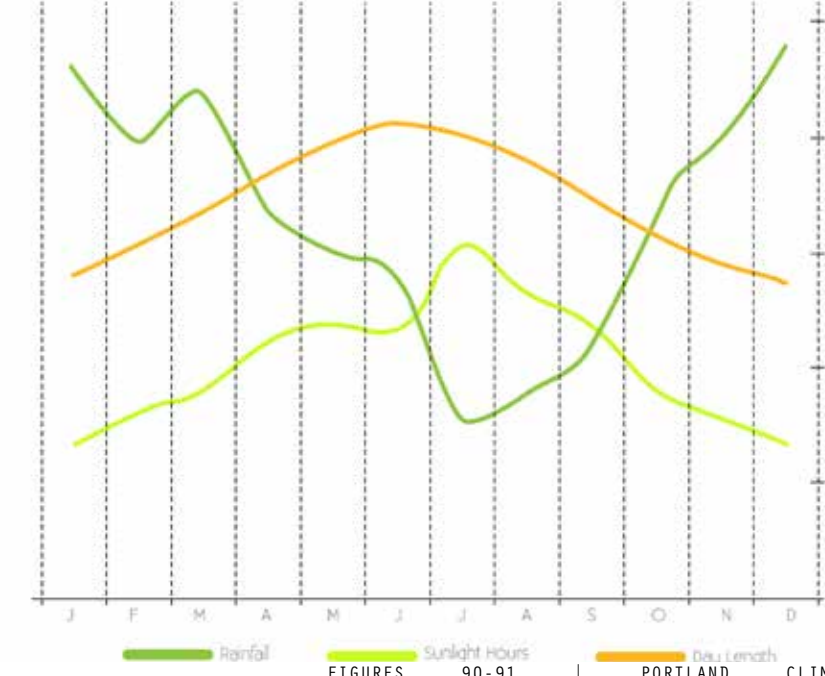
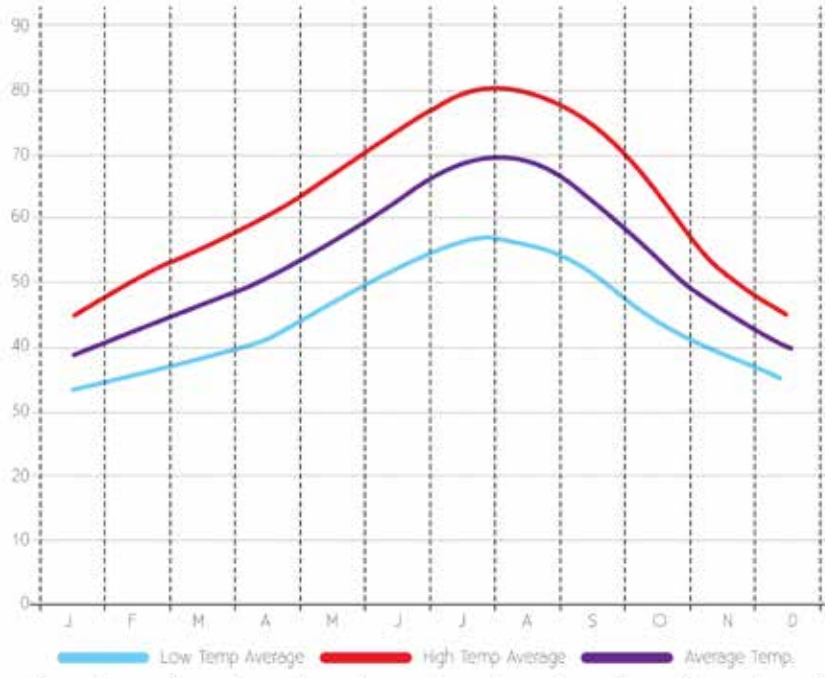
INVENTORY

Analysis

CLIMATIC ASPECTS

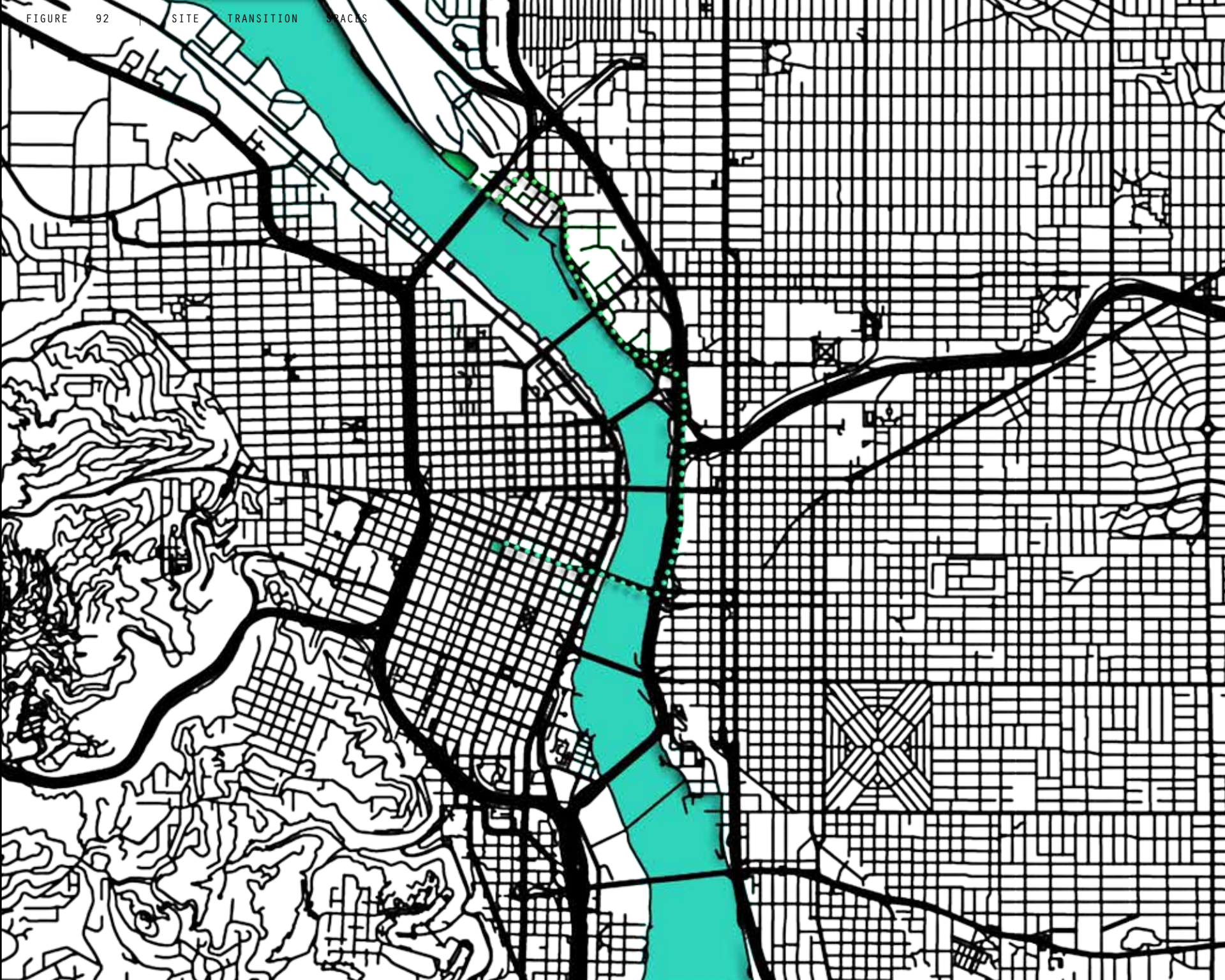
Portland is located close in the Pacific Northwest region of the US, therefore making it no stranger to rainfall. Water retention for the hydroponic system will be a definite feature with all of the water falling from the sky for free. Drainage raises some concerns, however. Temperatures remain fairly moderate and hardly reaches freezing, allowing crops to flourish.

Portland has been studying its carbon footprint and how it affects the world. By looking at the major carbon emitters, we can see where more effort needs to be placed. The project aims at being self supplying for the most part in regards to energy, and Public and smaller transportation methods are implemented already. Agriculture, Commercial, and Residential are all combined within a singular aspect as they are all reduced with passive and alternative active strategies.



FIGURES 88-89 | CLIMATE ACTION PLANS

FIGURE 92 | SITE TRANSITION SPACES



FIGURES 90-91 | PORTLAND CLIMATE

OBSERVATIONAL |

- LAND | The site has a 3-15% slope with a 57' elevation and its soil type is labeled as Urban Land, which is most commonly defined as N/A in various maps. Therefore I am assuming no limitations in regards to soils.
- BUILT FEATURES | A true downtown metropolis in the sense of density and building typology - high rise mixed use is the majority. The historic Pioneer Courthouse district is directly to the North, consisting of the Pioneer Courthouse and Pioneer square. The Portland Visitors Center is underneath the square, with a water feature forming the entrance. To the NW lies Director's Park designed by ZGF, which is also an entire block of open space and a large water feature. Parking units are two blocks to the north. Tri-Met stops surround the 4 block radius. A Starbucks is across the street.
- DISTRESS | No physical distress, as it is a very maintained district. High crime rate and homeless population.
- LIGHTING | The site is surrounded by high rises except for it's southern face, which allows it to receive massive amounts of sunlight (2,341 hours). The street lamps are meant to resemble classic styles, thus emulating a warmer light.
- CLIMATE | Warm and dry summers, Chilly and rainy winters. Average of 39" annual rain.
- VEGETATION | Deciduous trees line the east and west sides along the transit lines. Portland also has a serious dedication to the forestation of the city and green spaces.
- WATER | Direct drainage to the Willamette River, and has 3 major water lines to the North/ South/ East.
- PROPERTY | 40,000 sq. ft (.92 acres)
701 SW Broadway
South Park Blocks
Central Commercial zoning



ANALYTICAL |

- PEDESTRIAN | Extremely walkable city (82/100). There are two public spaces immediate to the site with another three within a two blocks radius
- BICYCLE | Portland's cyclist culture is no secret, as it is the most extensive in the united states. Cyclists have bike-ways to ride in, but even when they are not available traffic coexists effortlessly. Broadway is just one major path of the 319 total miles of bike-ways in the greater Portland area. Pioneer Square/Director's Park act as a great meeting point for cyclists. There are a proposed 50 additional miles planned by the year 2030.
- TRANSIT | Portland's TriMet transit system fully encompasses the city. TriMet system consists of Bus, MAX Light Rail, WES Commuter Rail, Streetcar, and an Ariel Tram. The Bus and MAX lines encircle the site with a streetcar line to the north two blocks. The MAX runs every 15 minutes, making it a very efficient and present feature to the site. The TriMet system extends past the city into the sub-regional cities and connects to Vancouver's C-TRAN system.
- VEHICULAR | The site still has moderate to heavy traffic throughout the day, but recedes after business hours. Traffic lights are timed to keep flow moving, thus never waiting for too long at any light. Drivers are very self aware for pedestrian/ cyclists/ transit.
- AMENITIES | Public spaces are all over the surrounding area, each as busy as the last. The Pioneer square hosts a farmers market along with food trucks, there's an entire block dedicated to food trucks to the NW, an arts and cultural district to the E, and various businesses all around. There is also a large vegetation presence within the surrounding areas as well.
- CHARACTER | The site has a two-sided characteristic in that it has a historical district to the front, with a modern sustainable district to the back. This juxtaposition of old and new encapsulate Portland as it truly is. A futuristic city stuck in the past.

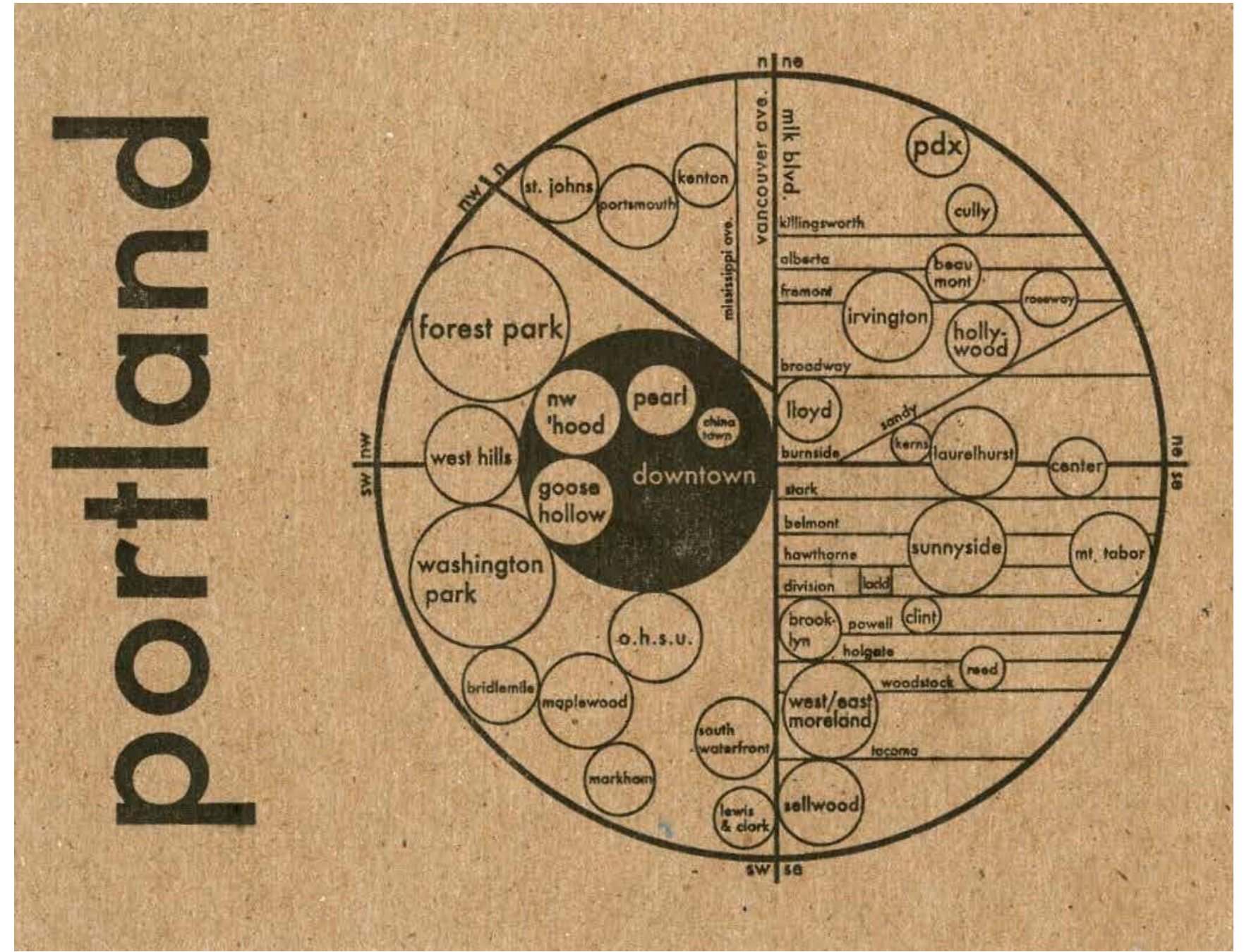
FIGURES 93,95,96 | SITE CONDITIONS | MAPS OF PORTLAND
FIGURES 94,97-101 | SITE ELEMENTS | VARIOUS

CONTEXTUAL RELATIONS |

Throughout the city Portland has many distinct districts, each with their own character. Each resembling a time in which Portland was expanding, preserving history.



FIGURES 102 | TYPOLOGY | REDDIT

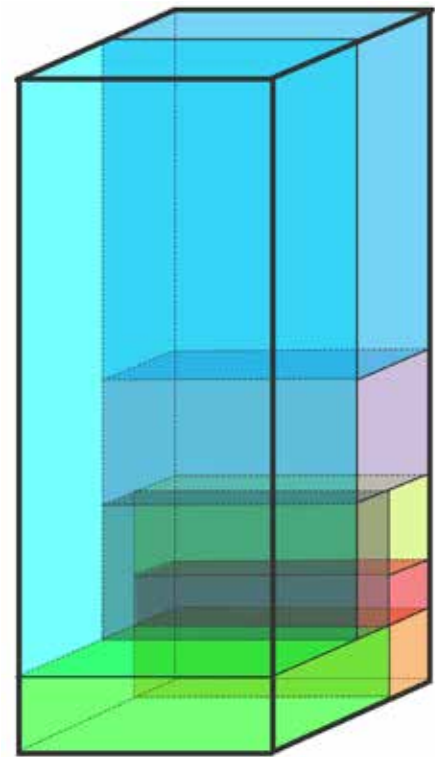


FIGURES 103 | PORTLAND DISTRICTS | REDDIT

BUILDING PROGRAM

MAIN FACILITY | 701 SW BROADWAY

The purpose of the program for the main site is to embody the idea of the separate forms/spaces/ inspirations into a singular cohesive plan. To find the dissimilarities and blur the boundaries.



45% Mixed Use



- Residences - mid-range to high end apartments
- Market - for own and local grown products
- Viewing Spaces - to educate and experience process
- Systematics - HVAC, Passive, & Informational
- Business - Meeting space, offices, lab, and processing
- Public Space - Public engagement through presence
- Circulation - elevator, stairs, transitional
- Misc. - Bathrooms/ etc.

35% U. Farm

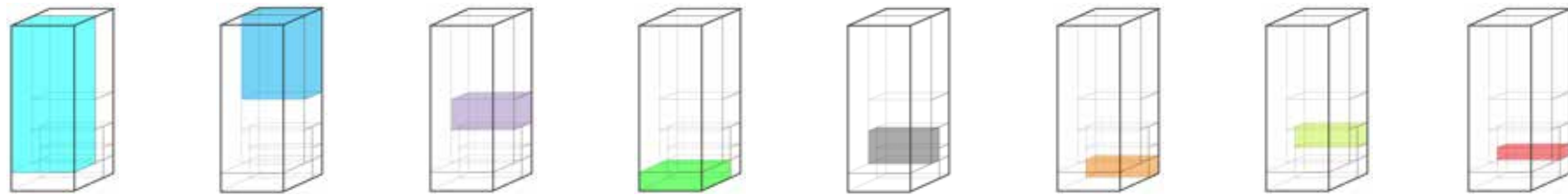


- Farming - Plantagon inspired layout and technologies
- Collection - to collect matured plants
- Observation - plant and technology management

10% Connection



- Supply vans/trucks - efficiently connecting to surplus facility and clients
- Loading/Unloading - integration within building to prevent traffic buildup



JUSTIFICATION

People need to eat. To eat, we need people to provide. To provide, people must grow. To grow, people need space.

We are running out of time and space to supply humanity with healthy food. Vertical farming is a very realistic approach to preventing this from happening. Growing time is cut in half while the controlled local environment negates the need for pesticides and preservatives, making food healthier for humans.

I have a lot of friends and family members that are farmers and I used to work on one as well. It is a hard job that can take a turn for the worse due to outlying factors. Drought, bugs, hail, fire, nature in general can take a product and way of making a living for the farmers, and completely diminish that. I want the approval and integration of farmers into my idea, and I am already changing some of my peers' perspectives.

My extensive research shows how the building can function as a vertical farm both artificially and naturally. Close attention to sun studies will form the building into an ideal space for plants specifically to the site.



FIGURE 104 | UP-TOP RENDERING

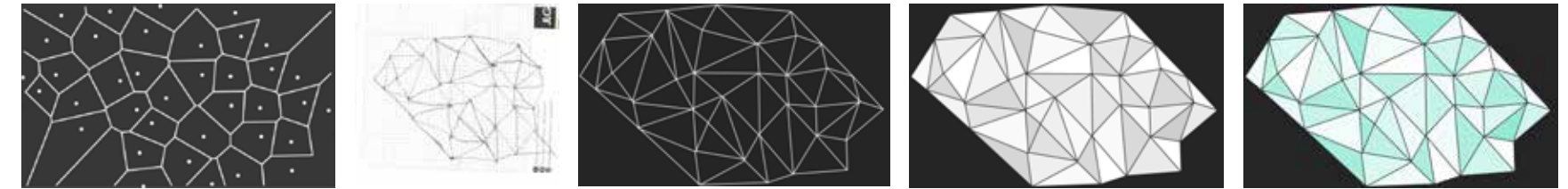
PROCESS MAKES PERFECT

When I began my final semester, I asked myself, 'What is most important to this project?' What I found to be the most important aspects would later each hold a key variable in the conceptualization of the project. Numerous sketches and iterations of building concepts came and went, the provided images show the evolution of the project from paper to mock 3D models.

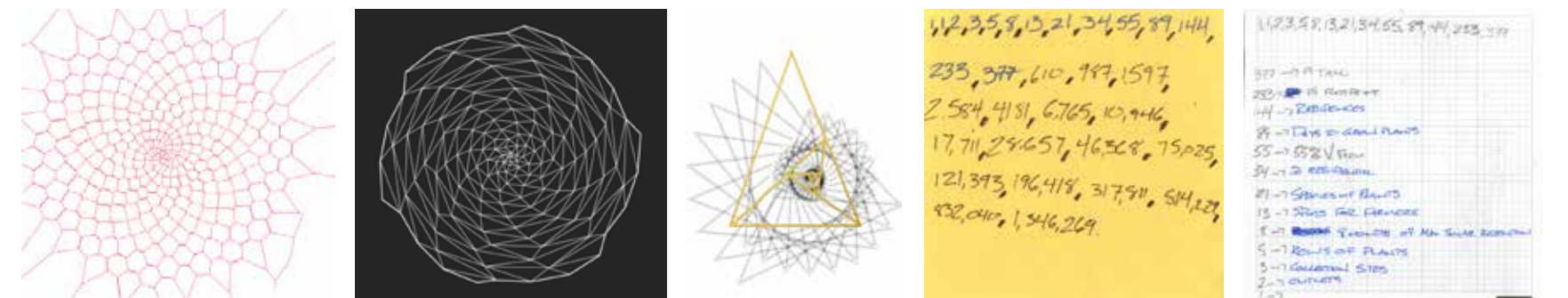
FIGURE 105 | FIRST PROCESS MODEL



The original concept of the building was to design for nature with nature. By that I mean to design with patterns found in nature. My research brought me to experimentation with Voronoi and Phi patterns to define design and structure. A breakthrough came in the discovery of the Delaunay Triangulation synchronizing with the points of a Voronoi pattern. To embody nature and the future singularly.



From the start, I knew the integration of these unfamiliar methods would take some time to understand. For the beginning stages, an abstract level of experimentation took place in the form of drawings and depth shading. These drawings would later aid in model making and figuring out how to triangulate curved areas.



Nature's golden section proved to be a much more difficult task than anticipated, and therefore was dropped from design aesthetics and implemented into the design pragmatics. The ratio of Phi proved to be useful in every step. From the height of the building to Adobe opacity levels

FIGURES 106-115 | NATURAL INSPIRATION

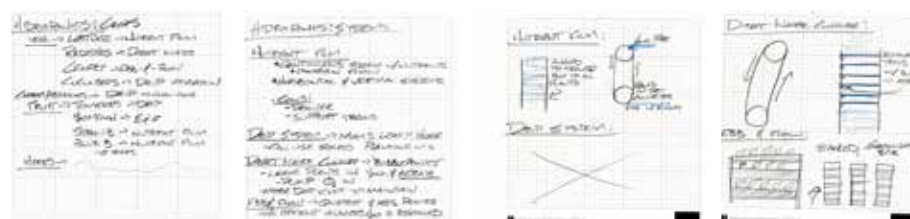
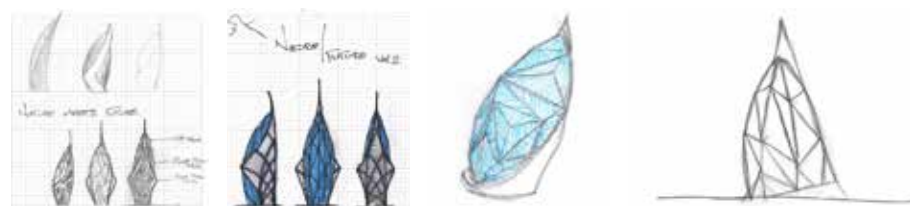
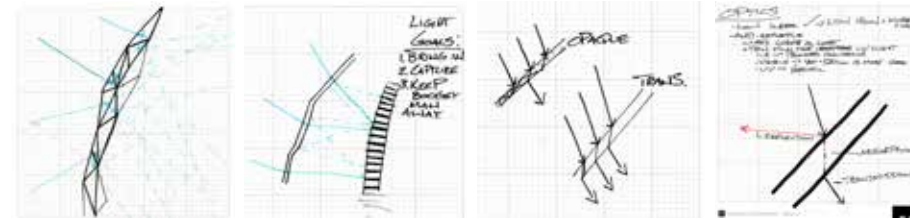
My process of refraining from architecture at the beginning is an essential piece to the project. My aim was to understand the project from its elemental level before I began the architectural integration. I began with creating architecture directly from my research, by tracing drawings with a 3D printer pen. This tool would later help visualize my project in 3D within minutes.

The triangulation is not only a metaphorical representation attached to a structural system, but was also a part of an idea to retain the maximum amount of sunlight. I then reached the point in which I needed to understand how light and glass interact with each other.

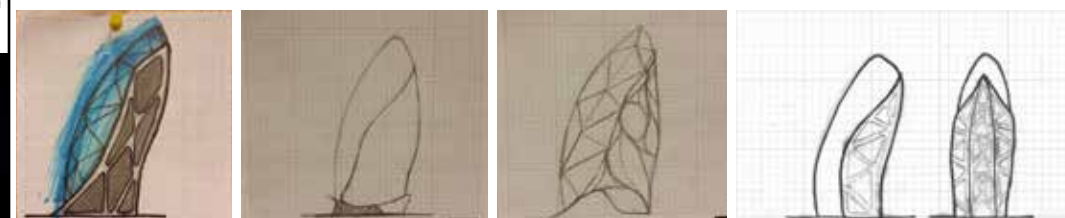
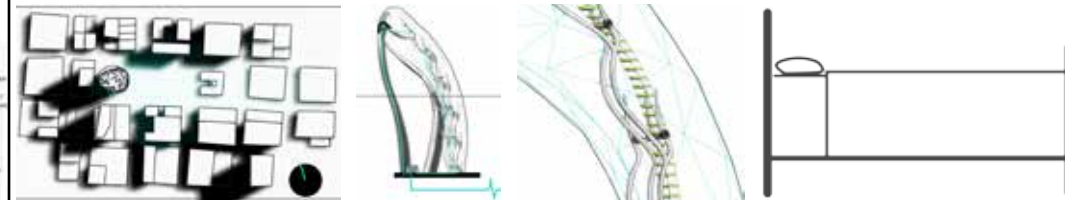
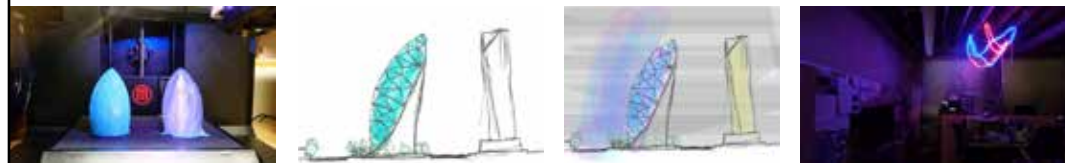
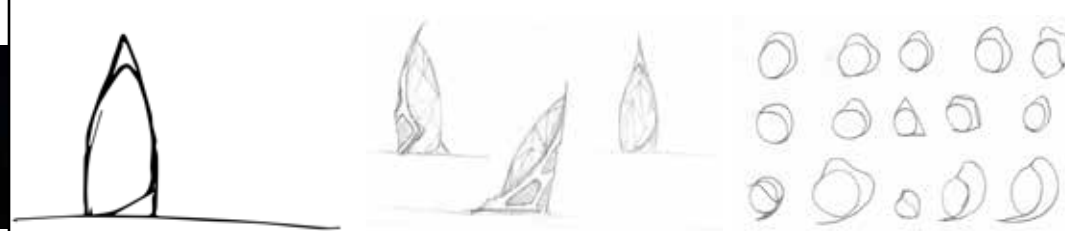
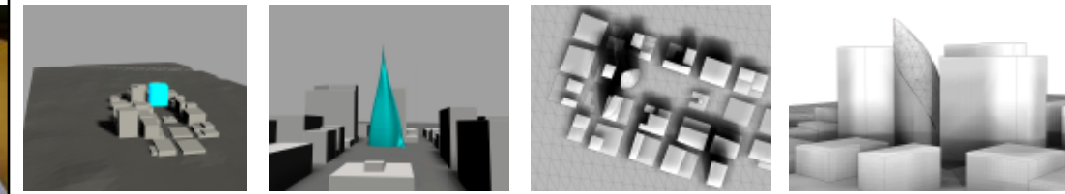
After the research was completed i began to experiment; with transparent and opaque mock prisms. I began my observing the way light interacted between the two, then at night would shine lasers onto both to see how light traveled in each condition. This would emulate a PV coated glazing system compared to standard pure glass.

With each experiment, the design morphed, but only slightly. Each new piece to the puzzle posed a change to the overall project. I began studying hydroponics to a more in-depth level, compared system types, and then relate that back to the way Plantagon grows their crops. This would then place the residential integration on the back-burner, as it was not a major player in the project at this time.

To fully understand how this massive atrium would react to light, I made the transition to the digital realm. Rhino models were then 3D printed to fully observe the interaction of light.



FIGURES 116-137 | INCORPORATION PROCESS



FIGURES 138-161 | FORMATION PROCESS

With modeling fully underway it was time to start thinking more of sunlight hours, and its impact on the project. By observing the shadows on my site and project, I began to carve out a shape that would ideally fit the most amount of light into my building. The refocusing of the residential units proved to be more difficult than anticipated.

After a general shape was found a structural frame for the plant tract was modeled to calculate the appropriate acreage. By calculating at this point my height could then be adjusted if there was not enough room to grow; however, the building put out more acreage than I had thought.

The fundamentals of the building then gave way to factors like style, integration, and presence. I began asking, 'How would the surrounding buildings and people take to my project? Would I want to live or work here?' To answer these I brought one of my bamboo plants in, strung up some red/blue LEDs above my desk, and left my midterm boards pinned up. It was here that I observed other people's reaction to what I was doing, and interpreted it into my project.

Finally I was able to move onto refinement. I determined which details needed to be called-out, and where I could improve upon style and integration. The building still felt sterile and uninviting, thus a new approach to the entry and residential were the last pieces to place in this crazy project's puzzle

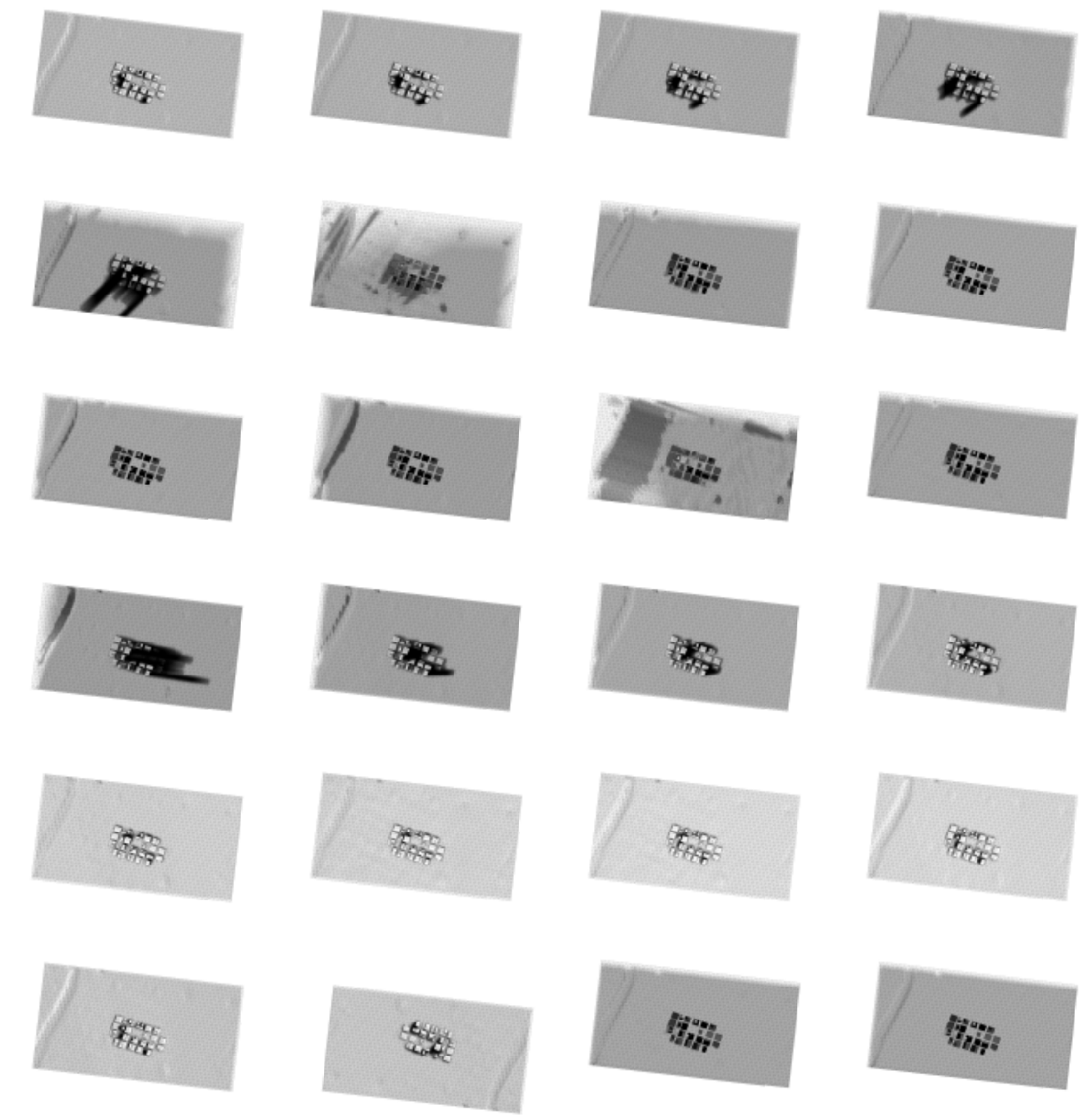


FIGURE 162 | ARIEL SUN STUDY

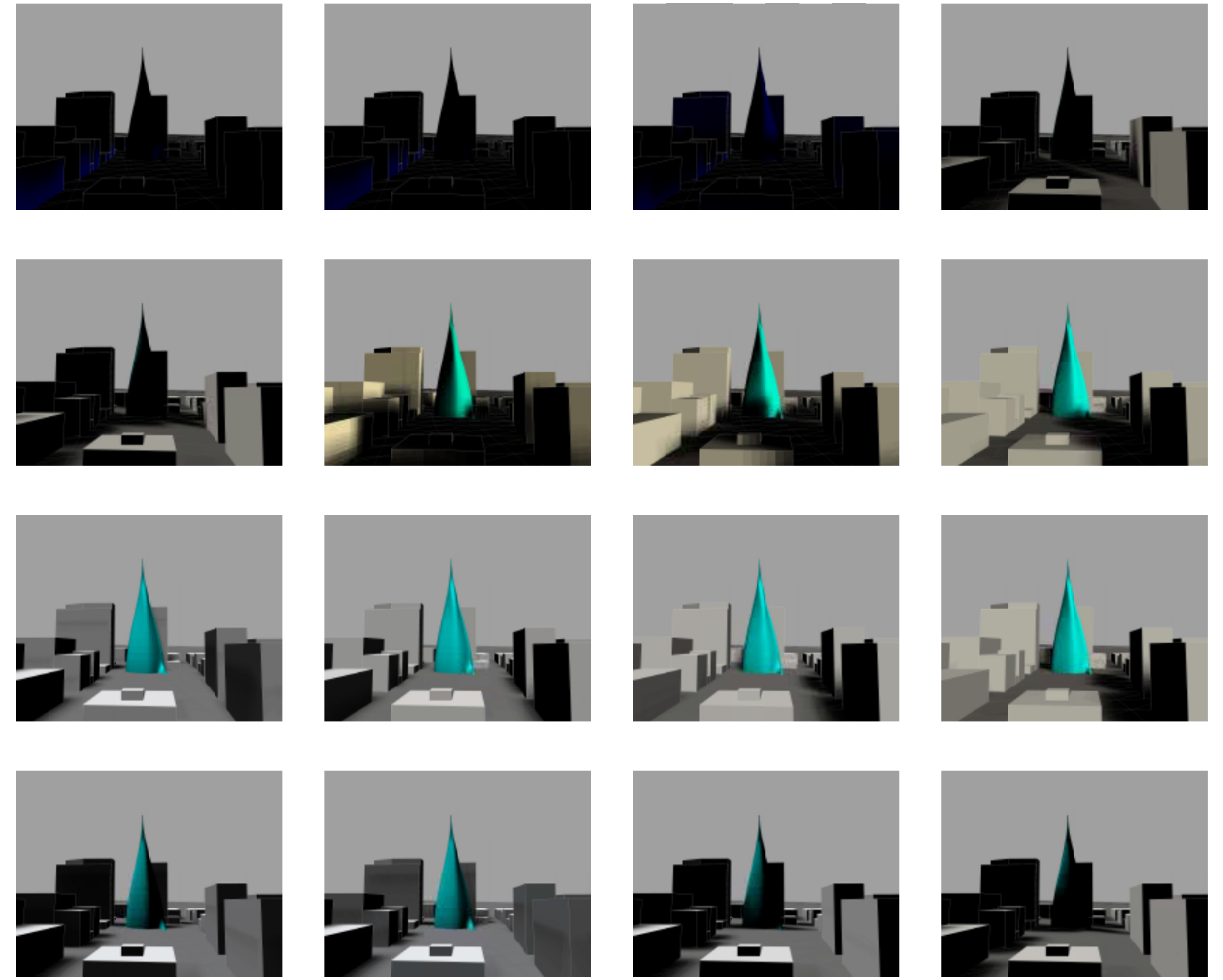


FIGURE 163 | FRONT FACING SUN STUDY

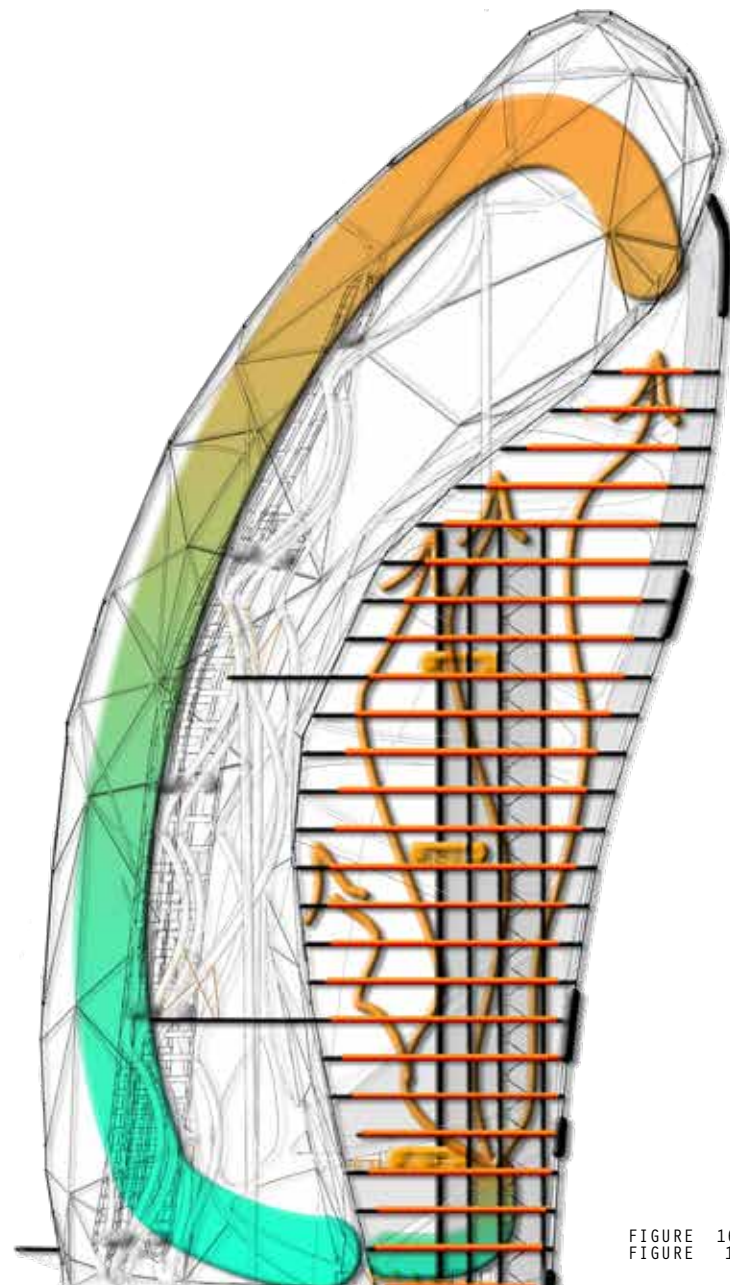


FIGURE 164 | AIR CIRCULATION
FIGURE 165 | HVAC SECTION

MUTUAL BENEFITS



AIR RECIRCULATION

HUMANS BREATHE IN O₂
HUMANS BREATHE OUT CO₂

PLANTS BREATHE IN CO₂
PLANTS BREATHE OUT O₂

WATER RECIRCULATION

THREE RAINMAKERS:
THE RAINMAKER MACHINE HEATS ANY WATER INTO MOLECULAR H₂O TO CREATE A NEUTRAL PH LEVEL WATER THAT IS SAFE TO DRINK.

THIS HEATED WATER WILL BE USED FOR RADIANT HEATING FOR THE RESIDENTS, AS WELL AS RECYCLING HEAT ENERGY FOR THE MACHINE.

MAJORITY OF THE WATER WITHIN THE BUILDING WILL BE RECYCLED THROUGH THE RAINMAKER SYSTEM TO ENSURE SUFFICIENT WATER USAGE FOR BOTH HUMANS AND PLANTS.

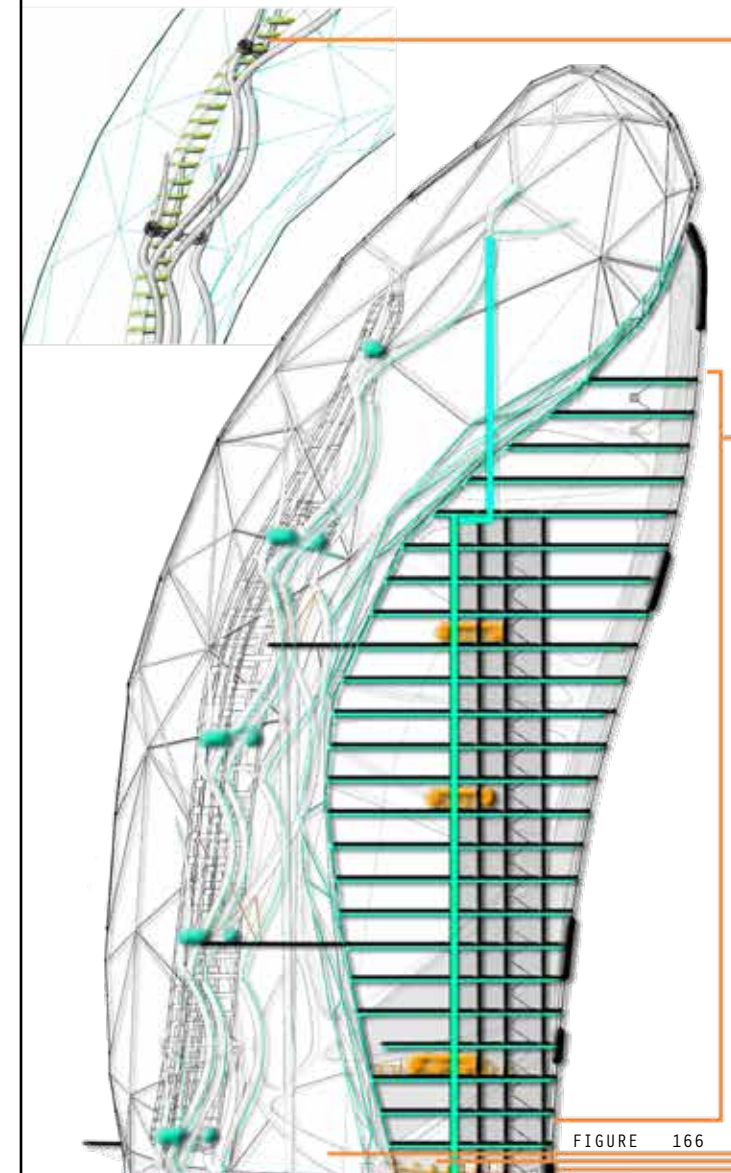
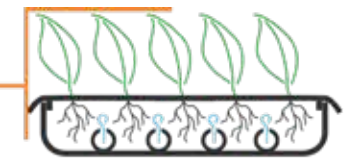
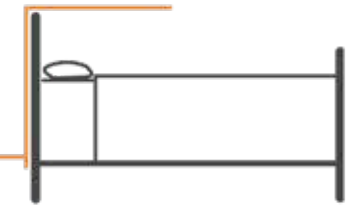


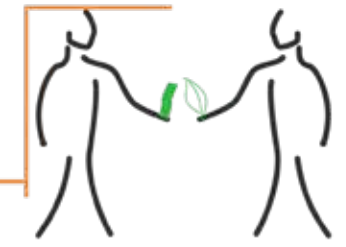
FIGURE 166 | H2O SECTION



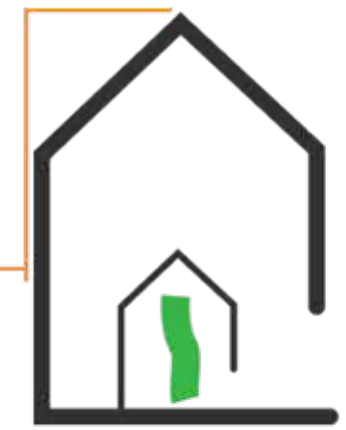
MODULAR HYDROPONICS SYSTEM
LOW MAINTENANCE
REPLACEABLE
LESS IMPACT ON OTHER TRAYS
HOUSES LEDS, AERATORS, AND NUTRIENTS



VARIOUS RESIDENTIAL UNITS
UNIQUE LAYOUTS
MAJORITY HAVE VIEWS OF GROWING FACILITY
211 BED/STUDIO
55 MULTI-UNIT
2 PENTHOUSES
COMMUNITY GARDEN AREAS



MARKET
LOCAL PRODUCE
LITERALLY SHOP AT THE FARM
ADVANCED ORDERS
TRAY RENTALS
BIKE STORAGE
PAPER RECYCLING



SMALL BUSINESS INCORPORATION
LOCAL COFFEE SHOP
FARMERS' OUTLETS
FARMER'S MARKET INCLUSION
FOOD TRUCKS



REDUCED TRANSPORTATION USE AND SIZE
DELIVERY
PICK-UP FROM LOCAL FARMERS
ENCOURAGE LOCAL USE
BRANDED FOR ADVERTISING

I wanted the building to emulate nature, so it only made sense to incorporate as many natural systems as possible. For instance the human and plant respiration process. Air quality is something that usually isn't a feature in an urban environment, so having the plants make the air better for everyone was an added bonus. Also, water isn't used for a singular purpose in nature, thus water recirculation was incorporated thanks to a machine called Rainmaker. More on that later.

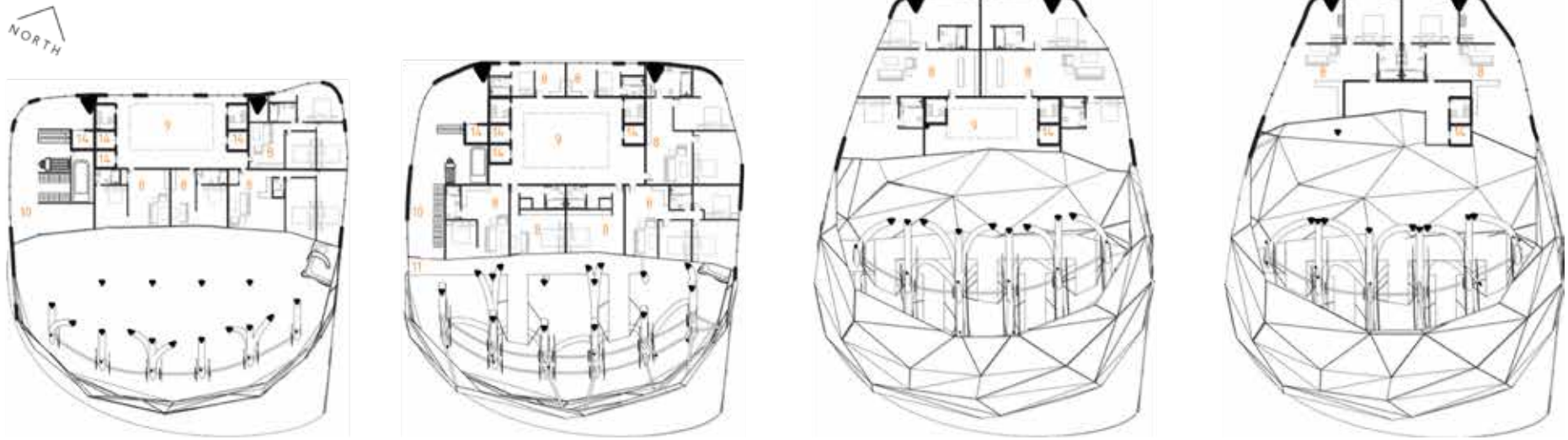
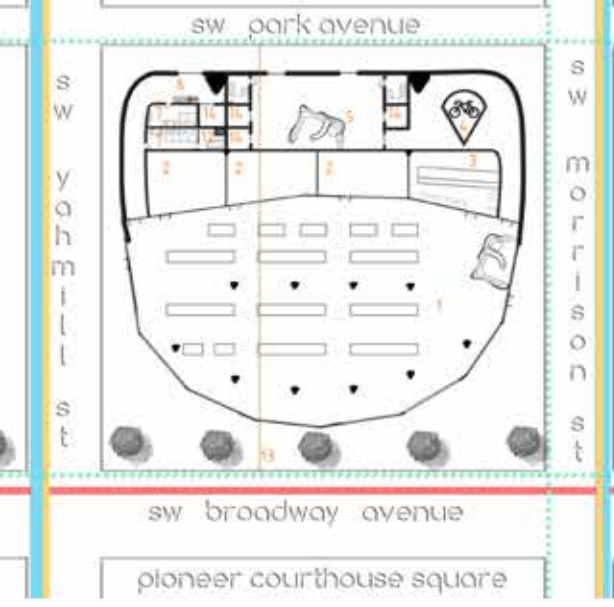
The Rainmaker machine allows me to produce my own potable water from just about any source of water, at a rate of 1000 gal/min. With multiple machines my building can store and produce the water needed, and have it travel like veins in a plant. Once the water has reached the top of the growing facility, it uses gravity to distribute the water throughout the system. Whatever water is salvageable is then recycled through the system until it is no longer fit for use.

STARTING FROM THE BOTTOM

- 1 MARKET
- 2 FARMERS' OUTLETS
- 3 COFFEESHOP
- 4 BIKE STORAGE
- 5 RESIDENTIAL LOBBY
- 6 LOADING
- 7 W/C
- 8 APARTMENTS
- 8.1 KITCHEN
- 8.2 LIVING
- 8.3 BEDROOM
- 9 RESIDENTIAL FARMING AREA
- 10 PROCESSING FACILITIES
- 11 HARVEST
- 12 SYSTEMS
- 13 SECTION
- 14 ELEVATOR

FEATURES

- SIZE**
 - 233 FT. WIDE
 - 377 FT. TALL
 - 25 FLOORS
- MARKET**
 - HELP PROMOTE LOCAL FARMERS
 - CHECKOUT/BIKE STORAGE AT ENTRY
 - LOCAL COFFEESHOP
 - FAMILIAR LAYOUT
 - VAST OPEN SPACE
 - AS ABOVE SO BELOW
- RESIDENTIAL**
 - COMMUNITY GROWS TOGETHER
 - LIVING IRREGULARLY
 - BEAUTIFUL VIEWS
 - VARIETY OF LIVING ARRANGEMENTS
 - LEASE AGREEMENTS
- PROCESSING**
 - NURSERY
 - HARVEST
 - CLEAN PLANTS
 - PACKAGING
 - STORAGE
 - FREIGHT ELEVATOR



Per the advice of Mike the ground floor plan shows just that, the ground. As I've mentioned before the site has public transit on three sides with the same going for major bike paths. Therefore no parking was introduced aside from bike storage. The market outlets allow for farmers to set up shop in the building and provide the market with produce that can't be grown within the facility.

Various apartment layouts are offered with the majority of them having some form of connection to the facility. Each floor does have a very spacious 'plot' for growing their own produce. The glazing between the residences and the facility are all incorporated with smart glass technology allowing for privacy when needed.

FIGURES 167-171 | FLOOR PLANS

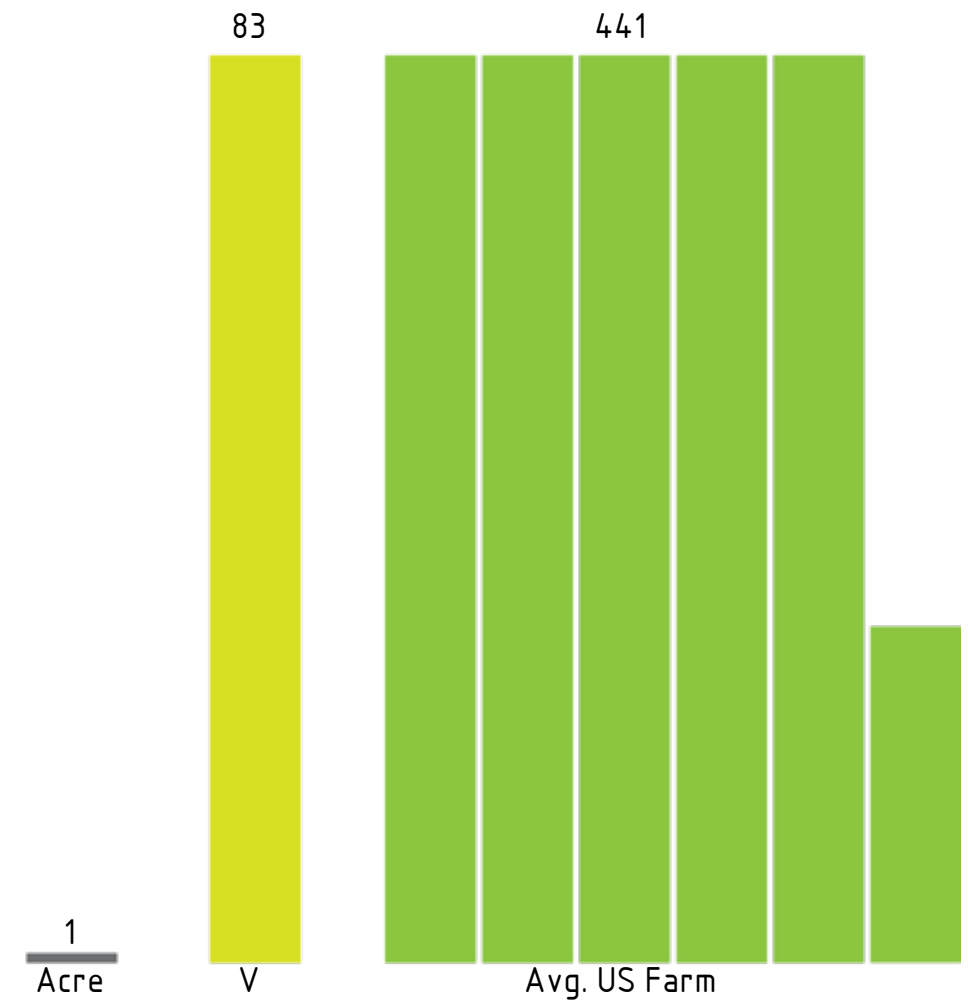
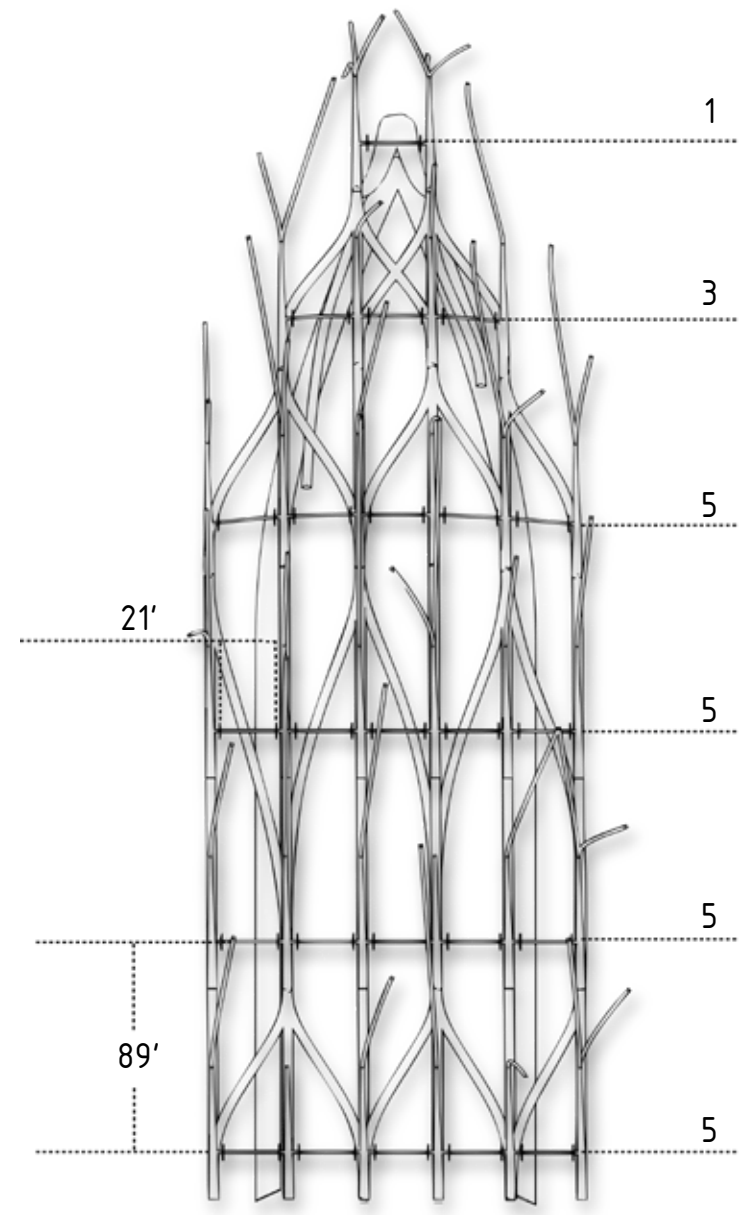


FIGURE 172 | V COMPARISON



FIGURE 173 | CAISSON

Portland has a fairly decent variety in soil types, which allows for various structural methods to take place. I chose to incorporate caissons as my method of anchoring the building. With earthquakes ranging from not-felt to light, this system, along with isolated footings was the most beneficial with the rigid frame type of structure the building has above ground.

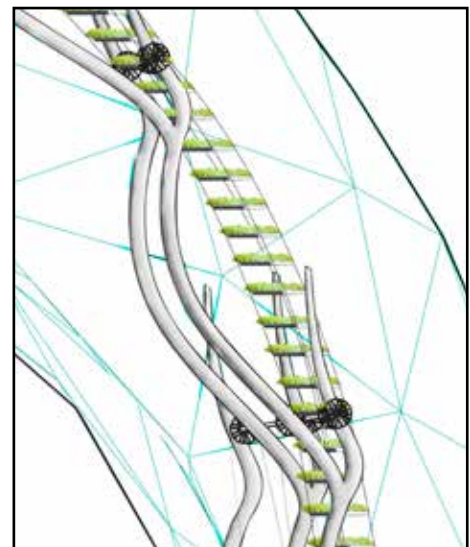


FIGURE 174 | TRACT SECTION

The plant tract is made up of modular planting units that travel around a rotisserie-like path. From seed to sale the estimated timing, due to LEDs and hydroponics, takes around 89 days. This allows for predictable harvests and for future orders for restaurants. The smaller windows allow for ventilation of the space.



FIGURE 175 | FRAME CLOSEUP

The fact that there are no 90 degree angles found in nature, was a real challenge in structural incorporation. Thus a dynamic rigid frame was introduced to give the appearance of veins in a leaf. Also, with 89 being a number of the golden section, the interior walls are positioned at 89 degrees on center.

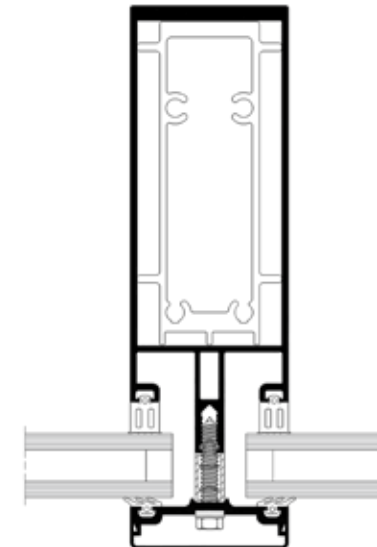


FIGURE 176 | GLAZING SECTION | KRUPNA, TROMETER

With a dynamic glazing setup, a structural system was found in the research of another student's thesis from University of Applied Sciences Munich. This system allows for a multi-angular facade with minimal interference of sunlight from the structure.

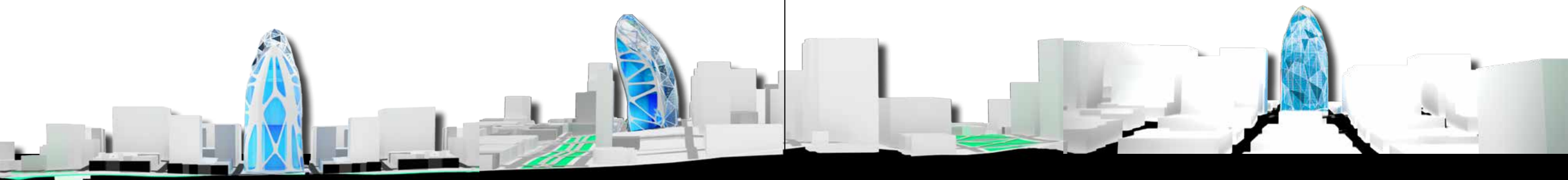




FIGURE 180 | PIONEER COURTHOUSE SQUARE RENDER



FIGURE 181 | BROADWAY VIEW



FIGURE 182 | MARKET



FIGURE 183 | HARVEST



FIGURE 184 | PLOT BOARDS



FIGURE 185 | THESIS SHOW



FIGURE 186 | MODEL LEGDE

'If I can create some space that people haven't experienced before and if it stays with them of gives them a dream for the future, that's the kind of structure I seek to create.'

-Tadao Ando

YEAR TWO

Fall | Stephen Wischer
Tea House
Moorhead, MN

Site response and integration of artifacts into architecture.

Boat House
MNPLS, MN

Contextual relationships and programming.

Spring | Phil Stahl
Dance Studio
Moorhead, MN

Integration of multiple sources of inspiration.

Metaphorical Chair

Metaphorical representation.

Bio-mimicry Dwelling.

Non-Stationary

Integration of client.

YEAR THREE

Fall | Milt Yergens

Fishing Museum
Lake of the Woods, MN

Singular embodiment of context and program.

Literary Center

Glasgow, Scotland

Urban infill and historical preservation.

Spring | Frank Kratky

STAR Institute
Fargo, ND

Adaptive reuse and community involvement.

Interpretive Center

Chicago, IL

Revitalization of an urban community.

YEAR FOUR

Fall | David Crutchfield

Urban Sustainable High Rise
San Francisco, CA

Collaboration of project with team members and extensive analytical research.

Vision Competition

Fargo, ND

Integration of theme into a sponsored competition.

Spring | Paul Gleye

Study Abroad
Brussels, Belgium

Cultural exploration to expand creativity, and site visits to fully understand and document built structures.

Inter-Beton Competition

Brussels, Belgium

Urban Planning and integration of international guidelines, team members and cultures.



FIGURE 43 | COFFEE SELFIE

name | J A R R E T T D M O R K
origin | D I C K I N S O N // N D
phone | 7 0 1 . 6 9 0 . 7 0 6 4
email | jarrett.d.mork@ndsu.edu
web | morker327.wix.com/morkitecture

Thank you.

Thank you, Architecture.
Thank you, Sleepless nights.
Thank you, 72 lights.
Thank you, GTAU

Thank you, Mom and dad.
Thank you, Linz.
Thank you, Skymiles.
Thank you, Caffeine.

Thank you, Spotify
Thank you, Table 84
Thank you, MJ
Thank you, JM

Thank you, Everyone...



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