symbiotic approaches

nature as an ecological & simulative model
for architectural design

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abstract

abstract

The impact of the manmade environments we create are of paramount importance to the welfare of our planet in the way we manage energy use, resource consumption and waste disposal. We can work to improve the welfare of our planet by looking at environmental adaptions in nature as well as emerging technologies to inform our design approach. In this project, I have created a community center that has social as well as educational functions regarding the environment. First, the center provides transparency and education about how waste products are recycled, to promote better behavior in the community regarding recycling. Secondly, the center includes biomes with differing artificial climates, using technologies that reflect processes found in nature. This proposes an ecological approach to architecture by turning to nature through biomimicry, responding to climatic challenges with efficiency and improved environmental impact.

Studying feedback climate architecture, I have learned different ways a building can adapt to its surrounding environment under changing conditions. This becomes an action of performative architecture, architecture that is a living and breathing entity. This study of architecture led me to biomimicry, learning from nature and its geometries. Nature has examples of solutions that have responded to environmental challenges after years of evolution. From this research, I was led to ETFE pillows, which are sustainable solutions to enclosure, adapting to different desired conditions. With these I have developed a system that filters light, temperature, and humidity. I designed a pneumatic recycling system that decreases the use of fuel by eliminating vehicles to transport trash. The building has several biomes, or “mini climates” demonstrating how to control manmade environments under differing conditions. People in the community can come to educate themselves about the environment, and see new green technologies that become the ideal example for future architecture. This design approach offers a glimpse of the future of our built environment, and can continue to evolve with new challenges and technologies. These parametric and adaptive processes explore the relationship between the built and natural environment. This becomes part of ‘the great performance’ how man deals with nature, and shows what we can do to evolve this relationship as a society.

The following project was done with PULL (Parametric Urban Landscape Lab) with Professor Natanel Elfassy at Bezalel in Jerualem Israel, while on erasmus in 2018-2019. The site is set in Florentin Jaffa, where I conduct all analysis for environmental impact through the use of parametric tools and simulaitons.

There is a vital need to adapt symbiotic, ecological approaches to architecture. This paper will discuss a wide range of theoretical and practical goals regarding sustainability and education in cities, carried out through architecture. With the environmental center I designed, I show how architecture can impact the health of our future, serving as a responsive and performative tool to educate the people in the community about how we must engage with the environment. The thesis is carried out in five phases: the context, methodology, strategy, precedent, and design.

Context

- Florentin in Jaffa, Israel as a site for intervention and analysis on its trash and recycling systems

Methodology

- Education as an ecological network, centered around sustainable renewable systems and mobility
- Incorporating advanced ecological solutions in architecutre on site as a proposal for the future of the city
- Responsive performative feedback systems for simulation and optimization of environmental impact
- Performance as a tool to educate and inspire people to take action in contributing to a greener

Strategy

- Mapping of trash/recycling and education systems in Jaffa
- Analyzing environmental impact of the site using parametric tools
- Examining Florentin through environmental site analysis and site intervention studies
- Conducing biomemetic approaches to architecture, researching and designing solutions for the building and its relationship with the surrounding environment
- Implementing environmental thermal control solutions with climate responsive biomes

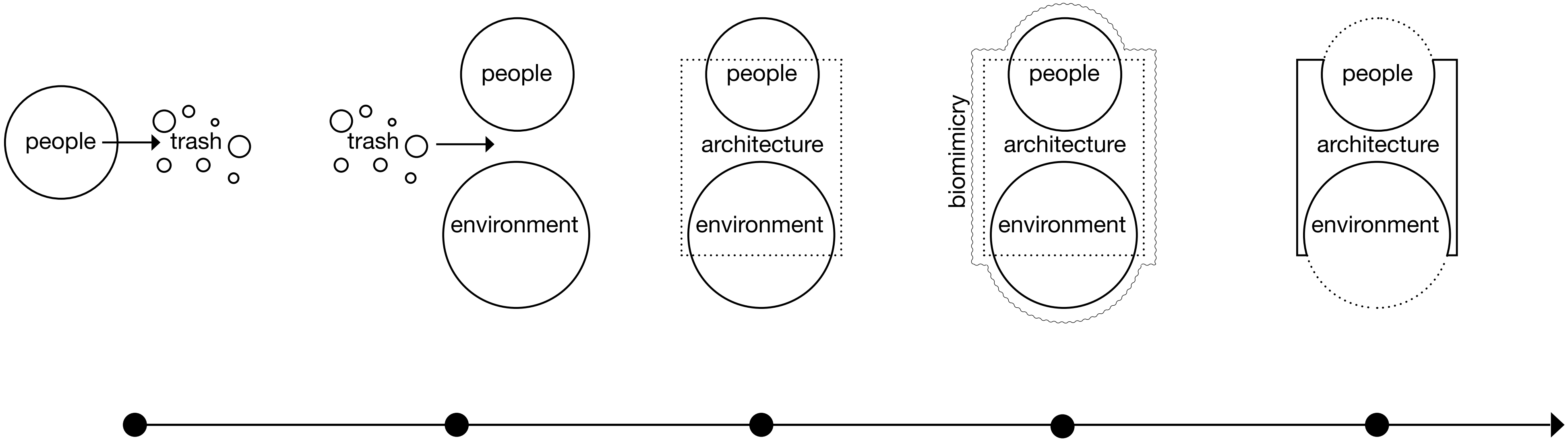
Precedent

- Reffering to design solutions in Toyo Ito's approach to architecture integrated with nature

Design

- An environmental center, served to educate, connect, perform, and inspire developing relationships with nature

trash to biomimicry : connecting back to the environment through architecture



issues of trash creating detrimental effect on the environment of Jaffa

problems with trash highlights overall disconnect with the natural world in the community of Jaffa

using architecture to breach gap in getting back in touch with systems tied to nature

biomimicry becomes the process in creating solutings to innovative natural approaches to architecture in relation to the environment, based on scientific evoloutionary research

the architecture itself becomes a clothing through which we translate information with nature, symbolizing transparency with the environment while using advanced technologies to optimize the adaptive and reflexive approach to our changing climates

Figure 1 | thesis concept diagram

context

Florentin, Jaffa
site condition

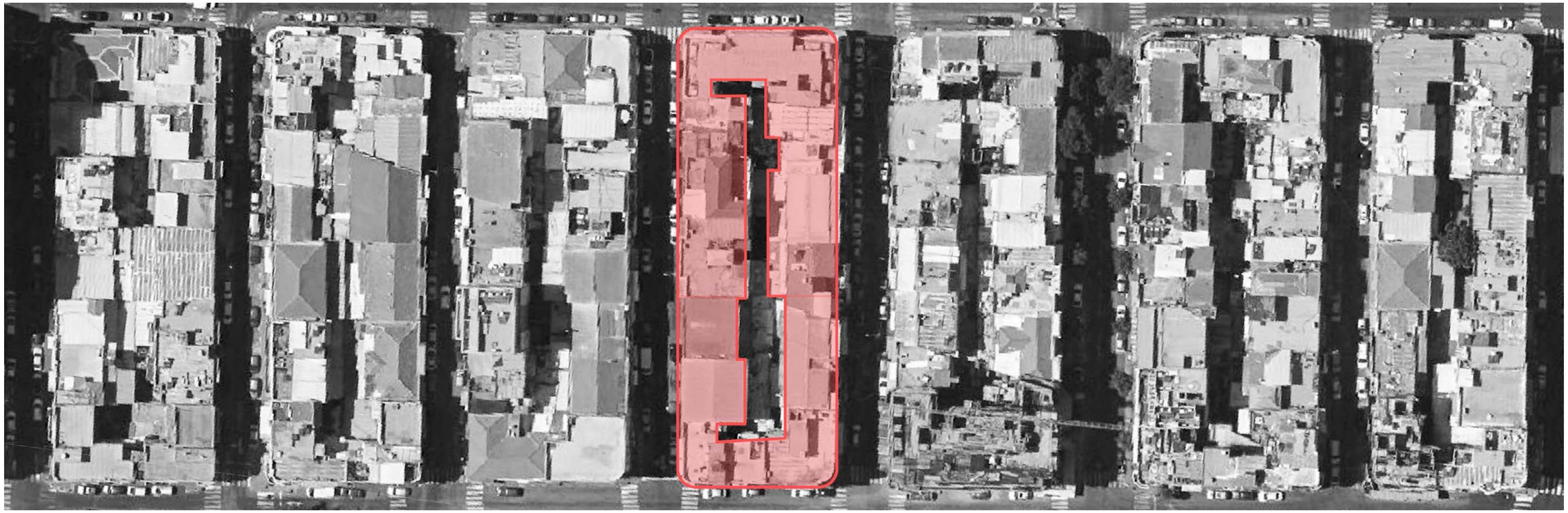


Figure 2 | Florentin typical city block

The development of Florentin was spurred by its proximity to the Jaffa-Jerusalem railway. Bought in 1921 by Jews in attempts to develop commercial relations with Jewish settlements in Palestine. It was a predominantly low-income Mizrahi Jewish neighbourhood, initially populated by poor Jewish immigrants from North Africa, Bulgaria, Turkey, Greece and Bukhara. In the 1990s however, with the opening of many artists workshops, and the decline of the traditional garment and furniture industries in the area, the area became increasingly popular with artists who came for its lower rents. The municipality allowed for industry to open on the ground floors, sparking a wave of immigrants moving to the area for jobs. Today it is a industrial zone, garment district, market place, and assembly for foreigners, along with a night scene which has helped to make it a trendy spot. From 2001 to 2010 the property prices increased by 65% along with the population doubled from 3,900 to 7,00 people, the majority being the age demographic of 25-34 years old.

Buildings have a white, modern Bauhaus style architecture, with a combination of residential and commercial life on the street level. Street facing balconies and groundfloor teraces enhance the street life that occurs in Florentin. The streets that were breached by the British in Jaffa planned the urban form. Florentin has a typical shape building block with a hollow private inner courtyard (Figure X). The facade of the building allowed adjacent construction, which created joint walls between neighboring buildings.There is no distinction between commercial areas and residential areas, and generally each building would include commerce on the ground floor and living on the upper floors, like a traditional townhouses with mixed use, serving as a guideline for urban planning. The Tel Aviv street seemed to be a fan and protector, as the inner courtyards softened the sense of dense urban construction and enabled the penetration of light and air flow between the houses in Jaffa. On the other hand, construction around an inner courtyard hidden from the street, Increased the sense of urban density. This duality between private courtyards, street facing balconies, and the mixed use of private and commercial program describes the variety of conditions in Florentin urban life.


Figure 3 | Matalon St & Ra'anan St


Figure 4 | Mizrahi St & Levinski St

Figure 5 | Derech Jaffa St

Figure 6 | Levinski St

Figure 7 | HaKishon St & Wolfston St

Figure 8 | Derech Jaffa St & Mizrahi St

trash & recycling in Jaffa

trash tracking

If we were to analyze our urban environment based on what objects we find on the street, what kind of evidence would we find?
Imagine we were able to place tracking systems on each idem of trash, how do they circulatie? Where do they end up?
If every city had a collective database of different types of found trash items, what does the inventory say about the people who inhabit the area?
I sought to investigate the systems of trash and recycling in Jaffa, Israel as it seemed inescapable, everwhere I went. The investigation is what sparked the project to come.

Trash tracking is a concept I imagined when investigating mapping the city through its circulation of waste. When thinking of mapping trash, I imagined creating a database of waste items, catalogued according to its typology (Figure 1). Each found object on the street would be flaged by color into its category of waste, given a time, date and geolocation of where it was found. Ideally, we would flag every found object with a tracker, and map over time the movement of all of the waste items, collecting big data on the typologies of trash in each area of the city, seeing how they are circulating in the city. (Figure 2). This would give great information about the people living in these areas, noticing how they distribute their household waste, to see what kind of changes can be effectively made. Since tagging individual items of trash with trackers wouldn't allow for a large enough scale to provide big data to derive conclusions and insights about how waste is being handled throughout the city, I used different ways of obtaining big data to use in simulations. The data used in this project is real-time data, obtained from Tel Aviv Municipality's GIS system and Ladygug environmental data, and simulated using grasshopper plugins and parametric coding.

On-Site Trash Inventory

Furniture

Textile

Plastic Bottles

Paper

Personal Object

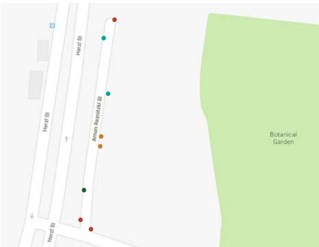
Wood

Plastic Bags

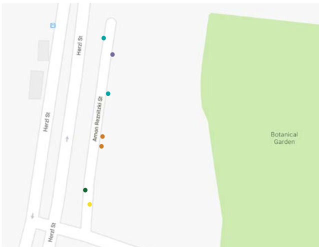
Packaging

Household Items

Trash Database



November 20th, 12:00



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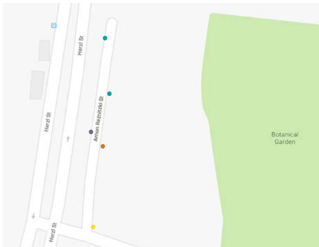


November 22nd, 12:00

Trash Movement Tracking

Figure 9, 10, 11 | trash database, trash tracking

Trash Statistics:

- The average person in Tel Aviv - Jaffo produces 2.2 kg of waste every day, 51 kg every month, and 612 kg of waste every year

- 1.8 million tons of biodegradable organic waste are produced in Israel every year

- 5.4 million tons of urban and comercial waste are produce in Israel every year

- Only 20% of the waste in Israel is transferred for recycling, with the remaining 80% being sent for landfilling

- 1.8% is the rate of increase in quantity of waste each year

What are we doing to change this relationship toxic with our environement?

How can we use design to evoke change in our behavior?

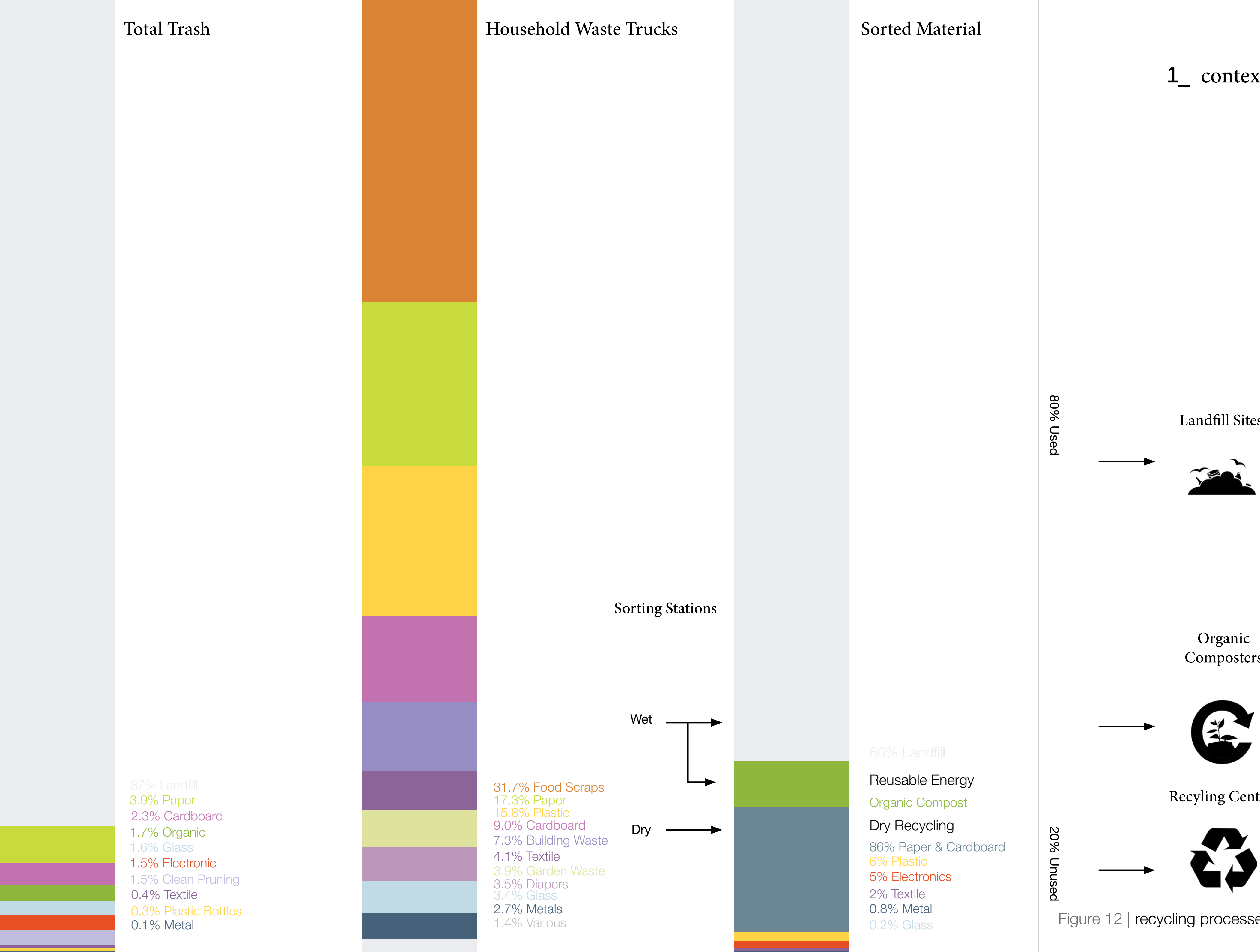


Figure 12 | recycling processes

Israel has developed a nation plan to adapt to recycling with planting numerous colored bins around the country, however it still holds one of the lowest recycling rates among developed countries (Lidman). The process is organized in clear stages, however most of the failure comes in the lack of education among people about how to properly recycle.

Bins are allocated among various parts of the city, receiving waste from both large industries as well as household disposal. Waste can be separated into landfill, paper, cardboard, organic, glass, electronic waste, clean pruning, textiles, plastic bottles, and metal. Among households the largest categories remain being food scraps at 31.7%, paper at 17.3% and Plastic at 15.8% of all household waste. From the recycling bins, the waste is brought to sorting stations, where it is separated into wet or dry waste. Wet waste is often food scraps, living matter, that has the potential to either be reused as organic compost, or otherwise sent to landfill, where it is left to sit and decompose, often polluting the land, causing environmental problems, as well as leaving a great odor in the area (Lidman). Rotting trash leaves methane gas in the air, contributing to climate change. Israel is developing “waste-to-energy” programs that include using trapped methane gas instead of coal as fuel industries, which is a better alternative then letting the landfill continue to build, however it doesn’t try to reduce the amount of total waste, which is the cause of the problem.

The reason why so much of what is disposed of by humans ends up in landfills is because people do not know how to properly recycle their waste. Most of what is sent to landfills are contaminated uncleaned items such as cardboard pizza boxes with grease or plastic containers with food scraps. These items that you may think you are recycling end up getting sent back because they are not of the right quality to be sent through the recycling process. Most of the recycling is sent overseas to China, however China ended up refusing to accept recycling anymore due to the quality of unusable materials, and the vast quantity they were receiving, that was having detrimental impact on the local area. There are few domestic recycling plants as recycling can fail in being a lucrative option. This is why 80% of waste ends up in landfill, while less than 20% is recycled. Very little amount of organic waste ends in composts as there are no industrial compost plants. All composting is done in homes or with small initiatives, because the city claims large systems for organic waste poses a health threat. With over 30% of household waste derived of organic waste, composting provides the largest potential while it is the least attended to in terms of recycling. Many people have even started composting in their own backyard, as the compost is used as great fertilizer for plants. These small initiatives of organic compost would greatly impact the amount of rotting landfill, and help decrease the environmental impact it is causing on the planet.

The main issue is in people assuming there is no purpose in separating different materials into respective bins, because they assume it will all end up in the same place. The sorting stations do a good job of sorting items, however it takes a lot of energy, and many trucks to transfer all the materials, a lot of which is sent back to other places because it is not of the write material. Plastics for example must be separated from plastic bottles. China would only accept separated plastics because they cannot recycle the low-grade plastic, therefore it is not economically sound to continue the operation. The deposit law in Israel has helped this process in separating plastics, as about 60% of the plastic bottles are returned to where they were bought and can be properly recycled at the ELA Recycling Corp (Lidman). This financial incentive to place a deposit on plastic bottles has proven effective in helping inspire change in people's behavior. As recycling is a better option than rotting landfills, we must learn recycling is not the ultimate sustainable solution, we must make strides in reducing the amount of waste in general. This can only be done through the education of people, to inspire change in our behavior.

Figure 13 | recycling plant in Atarot, Israel. source: https://www.timesofisrael.com/ministry-says-the-public-is-key-to-sorting-out-israels-trashy-recycling-record/

Jaffa trash & recycling sites

Midron Yaffo Park

- Between 1970 – 1989, the area of Midron Yaffo park was once construction waste dumping site, where large parts of the sea were drained and turned into a landfill

- The landfill was the center of trash and illegal activities, becoming a hazardous area in the city, reaching 15 meters high of waste, much of which was pouring into the sea, contaminating the water

- 2005 marked the start of the rehabilitation of the landfill, removing over 1 million tons of waste, and covering the rest with soil, to become a restored park for the area of Jaffa

- The park restored the damaged shoreline, created visibility from neighborhoods, and created a typographical design of the area, a public promenade

Source: "Jaffa Landfill Park." Jaffa Landfill Park - Braudo Maoz - Landscape Architecture, www.bm-landscape.co.il/en/projects/122-jaffa-landfill-park.

Figure 14,15 | renovated landfill site, site map. Source: www.bm-landscape.co.il/en/projects/122-jaffa-landfill-park

Jaffa trash & recycling sites

Ariel Sharon Park

- Hiriya Mountain, a massive landfill outside Jaffa which grew to contain more than 25 million tons of waste, closed in 1999, and is now being transformed into an ecological park

- The site caused problems for years due to its odor and the abundance of birds that flocked to the garbage and sometimes affected departures and landings at nearby Ben Gurion Airport

-Salvaged concrete was used to reinforce the slopes of the garbage mound. The landfill was then capped, trapping methane produced by the rotting garbage and allowing Ayalon Biogas to collect it and use it to power a nearby textile factory.

-The idea was to rehabilitate the park into an ‘educational theme park’ with facilities attached to the recycling centers below to educate people how to better recycle

Source: Virskus, Jenn. “Massive Landfill Transforming into 2,000-Acre Park.” From the Grapevine, From the Grapevine, 7 Oct. 2016, www.fromthegrapevine.com/nature/massive-tel-aviv-landfill-converted-2000-acre-park.

Figure 16,17 | landfill site, site map

Jaffa trash & recycling sites

Hiriya Recycling Center

- Hiriya Recycling Center became an industrial park in 1998 below Hiriya Garbage Mountain, providing waste treatment to the Dan Cities Association (Tel Aviv-Jaffa, Holon, Ramat-Gan, Bnei Brak, Givatayim and Bat-Yam)

- 1,000 garbage trucks enter Hiriya everyday
- 500 tons of alternative fuel generated from garbage are sent to fuel factories daily.
- 120,000 visitors come to the Center for Environmental Education to learn about the site

Operational Objectives:
1. Flexibility - selecting technologies that can handle a variable composition of waste, to sort and manage
2. Synchronization - technologies that complement each other, providing efficent optimal response in sorting
3. Education - implementing education and informational activities throughout the union

Source: "Hiriya Facts, Quantities & Numbers." Hiriya Recycling Park, www.hiriya.co.il/eng/Hiriya_facts%2C_quantities_%7Cfamp%7C_numbers.

Figure 18,19 | recying plant, site map. source: https://www.hiriya.co.il/eng/The_RDF_Plant

methodology

2_

education in cities -
an ecological network

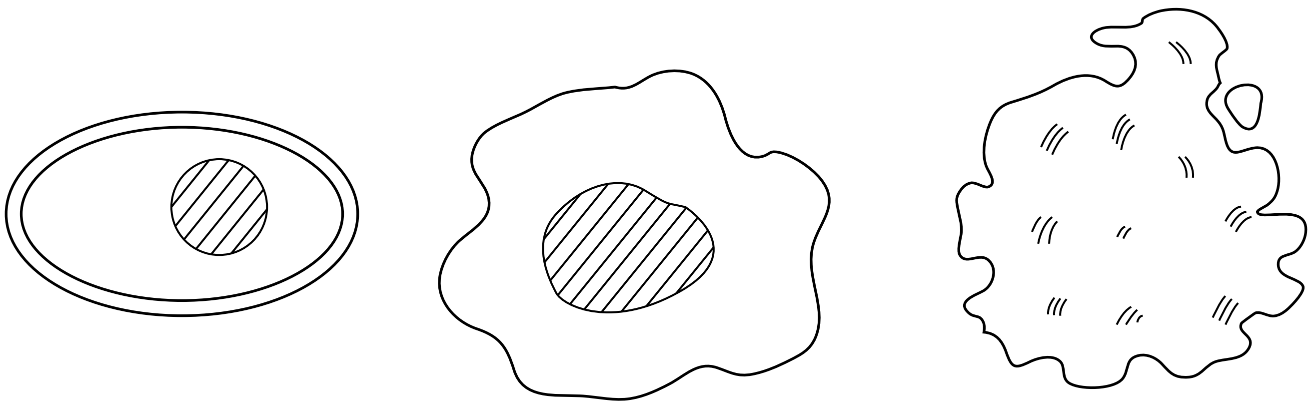
The focus on sustainability brought me to the theories of Cedric Price. One of his most famous philosophies is his idea of 'The City as an Egg" (figure X). This idea is described through three different types of eggs, hard boiled, poached, and scrambled, as metaphors for phases of evolution of the city. Hard boiled refers to the ancient city, the dense center surrounded with defensive walls to protect from the evils of the outside world. The poached egg refers to the 17th-19th century city, when cannon power made the city walls obsolete. The core remains as ancient reference, while outer rings of residential and industrial areas expand. The scrambled egg refers to the modern city. The center cannot dominate, it as becomes much cheaper and easier to live and work in the outer rings. How will the scrambled egg model sustain with the prohibitive rising costs of transportation? Will renewables-based transportation be successful enough to enable cities to continue sprawling into earth's increasingly rare open spaces? (Jacobs). Looking at the future of the city and its use of transportation, Price came up with a radical, innovative model for education, transportation, and living. This project was called Thinkbelt Potteries.

Thinkbelt was proposed in 1966 by Cedric Price, published but never actualized. It sought to change relationships between universities and their surrounding city, along with its wider social setting. The 100 square mile site in Staffordshire England connected three industrial areas in a triangle configuration, with transfer areas at the points, connecting air, rail, and road networks. The Thinkbelt incorporates movable classrooms on the railway, in an effort to make use of time spent on your commute to school. This system can move and adapt to the shifting needs of education and the people who commute there. Not only would the Thinkbelt hold classrooms and adjustable lecture platforms, it would also accommodate housing for residents and faculty, in various modular forms connected to the larger infrastructure. The housing included four types of housing units, named sprawl, capsule, crate and battery. The Thinkbelt rejected previous ideas about appropriate university architecture, with Price's use of industrial forms such as the container, rather than what he perceived to be the standard of twentieth century university buildings. He viewed traditional university campuses as being like medieval castles, removed from the rest of the town. He wrote in 1970, "while students are at present one of the most mobile social groups of technologically advanced societies their own particular production plants- schools, colleges and universities, is static, introspective, parochial, inflexible and not very useful" (Price 4). Price criticized theories of universities at the time, its architecture along with educational approach. His interest in education for the people of the city involved a wider role in society, straying away from the often elitist epicenters of university settings. The Thinkbelt inspired shifting values in learning of applied knowledge rather than pure knowledge, by basing education on city industries themselves, and by use of architecture that is "functional, flexible and impermanent rather than ornamental, fixed in purpose" (Martin). Do universities hold responsibility in sustaining cities and economies that give them a home? How do universities and its students interact around education, and our neighboring populations? (Martin).

Upon analysis and questions sparked by Cedric Price's theories, I have come up with my own program for education. The circulation of the city is what connects recycling with the education system. Seeing the recycling move to its designated locations will provide transparency, educating people exactly where their waste is going, and in what quantities. The site is a drop off zone for the underground pneumatic trash and recycling system, distributing to given sorting centers outside the city. In the center itself will be informational events and pop-up classrooms used to educate the people about what is happening in Jaffa and ways to become a green city. This awareness of seeing how your trash is being circulated will provoke inclusive community behavior in handling waste. The network created through centering the community around waste and the environment will help to connect people and local communities. Schools can teach what is happening directly in their local communities, as well as learning from other communities. A environmental center that educates people about systems will bring together school systems with the community, integrating in a new way. Industries themselves will have direct contact with these routes of recycling, potentially enabling a large change in the mass amount of materials they produce there and dispose of. What better way to educate people about the environment than at the point of contact we make it effecting it? The green center is a place to take part in recycling, education, nature, and making closer connections to networks in the local community.

Cedric Price ‘The City as an Egg’

Boiled | Fried | Scrambled



Ancient

The dense centre is surrounded with defensive walls to protect from the evils of the outside world.

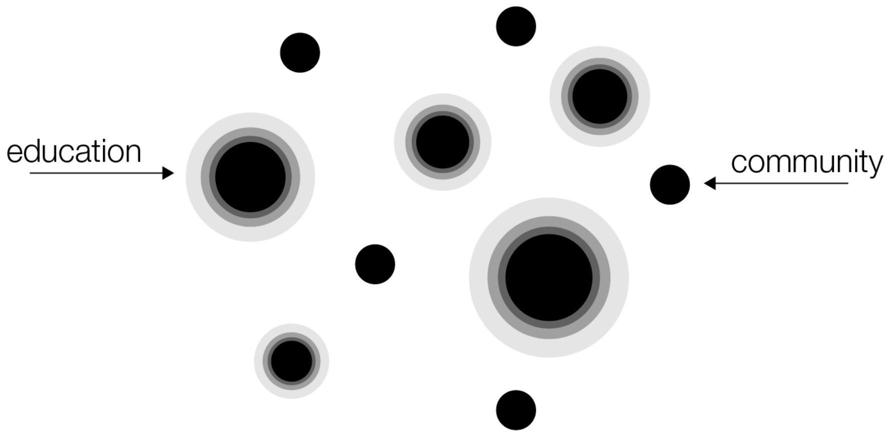
17th-19th Century

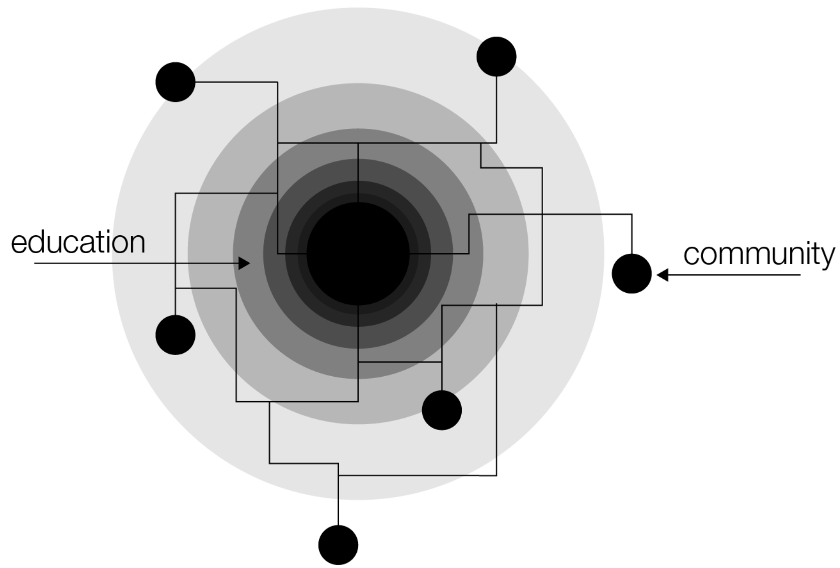
Cannon power made the city walls obsolete. The core remains as ancient reference, while outer rings of residential and industrail areas expand.

Modern

The city centre cannot hold, it becomes choked. Transportation has allowed it to become much cheaper and easier to live and work in the outer rings.

Figure 20 | city egg diagrams





In the old system, student activities occur only on the static university campuses, influencing only those who are in its radius of influence. The architecture remains like a monument of its time. Knowledge is only available to those who can afford the proper tuition. Industries and communities are isolated from one another. Systems are not updated in real time as to how the environment is behaving, and how the city can be informed.

In the new system, student activites are integral to the community life as a whole. Architecture adapts to the complexities and emerging socialities made possible by new technologies. The city environment informs the architecture of the building just as much as the building informs the people of the city. This creates an interconnected web of knowledge and social structure, constantly in responsive feedback to changing times.

Figure 21 | education & community diagrams

ecological approaches -
a proposal for the future

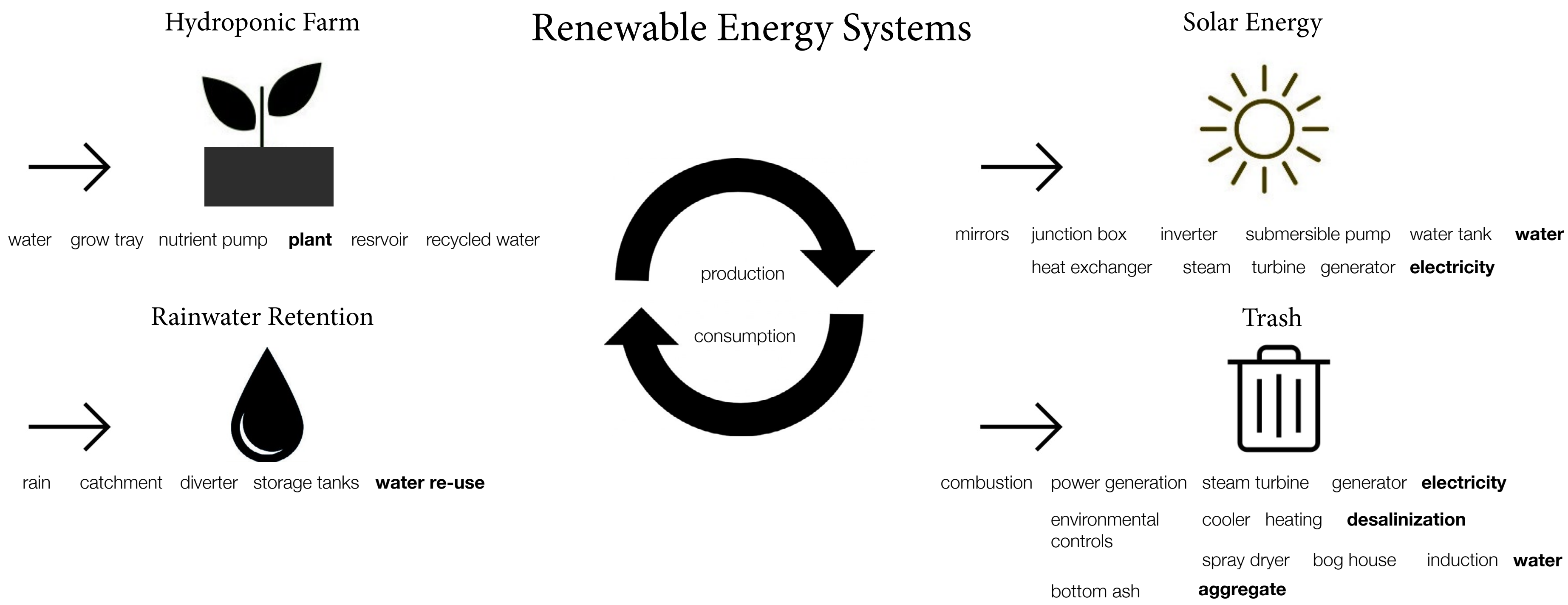
Sustainability has played a large role in architecture in the last several decades, and now is becoming an inescapable issue, as we deal with the future of our planet. The role and prominence of sustainability is obvious, but not when it comes to its approach. Sustainability is no longer just an applied change of material or production, but an entire new approach to building systems and 'Green Technology.' This new ecological approach to architecture develops new tools and approaches to deal with the emerging sustainable design strategies. Oke defined three main causes of climate change in cities, including: "interception of short and longwave radiation between buildings, reduced heat emission in longwave radiation due to reduced sky visibility, and increased storage of sensible heat in building materials" (Naboni & Havinga 135). The installation of indoor air conditioning systems increases the overall urban temperature, creating a negative circular effect in which the energy demand and greenhouse emissions continue to grow, creating the termed 'Urban Heat Island' (Naboni & Havinga 136).

Detrimental urban microclimatic conditions limit outdoor life, socializing and relationships between people in good health. Due to UHI effects, evidence of health risks and increased mortality rates among the elderly and people suffering from cardiovascular and respiratory problems have been widely reported. For example, warmer days and nights along with higher air pollution levels can contribute to general discomfort, respiratory difficulties and illness, heat exhaustion, and heat related mortality due to lack of night ventilation and trapped heat in the city. As such, countermeasures to UHI effects have to be implemented with great urgency (Naboni & Havinga 136).

Design choices such as the form and the materials of buildings and open spaces alter local thermodynamic phenomena, which in turn influences the outdoor thermal comfort. The outdoor thermal comfort, as opposed to the indoor one, is ever changing, with wide spatial and temporal variability due to weather changes. The scientific community has become increasingly interested in the topic and has encoded a few modelling tools to support the simulation of microclimatic conditions. The scientific community has become increasingly interested in the topic and has encoded a few modelling tools to support the simulation of microclimatic conditions. The potential users of microclimatic modelling tools are often confronted with a lack of specific information about their calculation and applicability to the type of contexts and climates (Naboni & Havinga 136).

This ecological approach to architecture redefines what architecture is itself. In Experimental Design Strategies, author Terri Peters states Aaron Betsky's definition of all-encompassing architecture: "It is how we think about building, how we draw buildings, how we organize buildings, how buildings present themselves. buildings are buildings; architecture is something different" (Peters 14).

Architecture is taking an ecological approach in which cannot ignore the entirety of the environment that it is in. In his book The Technology of Ecological Building, engineer Klaus Daniels outlines principles for ecological building including the need for “a variety of detailed site studies, building form and orientation analysis, and local climate considerations. His approach is concerned with optimization, integration of building systems, and combining technological solutions with passive systems to improve performance.” (Peters 14). This ecological approach must take place on a variety of scales dealing with architecture and a green approach. The design must be bakes around each site’s unique ecology and climactic conditions. The differing scales must consider everything from the biological level to material and building components, as well as the larger scale of landscape and urbanism. (Peters 18). Architecture itself is not a ecologically sustainable practice. In order to become attuned with the changing environmental processes, architecture must transform to become a system that is adapted to its variable biological clocks and the activities of the people inside. (Peters 62-70).



Renewable energy systems can help maintain ecological equilibrium in construction processes. Surplus resourcescan eventually be translated into energy sources in architecture. For example, buildings can use passive or active solar energy or hydro energy for heating and hot water. Water sources are usually drawn from the natural groundwater that lies beneath the surface of the land, and becomes depleted much faster than it is able to replenish itself when there is a great demand. Therefore, alternative water sources such as rainwater recycling has important impact in architecture for heating, sewerage disposal, and household water use needs. Hydroponic farming, solar energy, rainwater retention, and energy thorugh trash (Figure 12) are main examples of sources of renewable energy. The diagrams depict all of the different proccesses the energy translation occurs through, and which architectural outcome can be produced. The goal remains to keep production rates equal to consumption, in a circular system so that we do not overuse dimish our natural resources on earth.

Figure 22 | renewable energy system processes

environmental simulation

In order for the ecological design strategy to be accurately in tune with the building and the surrounding environment, a large amount of scientific research must be done to back every approach. Architects can no longer only rely on their own architectural knowledge to create these green systems. Architects must collaborate with ecologists and environmental engineers, to design systems that are properly integrated with the environment. In this principle, it would be possible to design an entirely artificial environment in a given architectural project. In my project I explore the importance of this study of ecology in connection with architecture. By doing so, I designed an entirely artificially created interior environment, enabling a completely different climate in which people can use as an experiential and educational tool to learn about different climates.

Architecture is evolving beyond creating 2D or even 3D drawings to communicate ideas. Architects are now responsible for communicating entire processes. This demands architects to focus on different ways of documenting research, simulations, experimental processes, and implementations. The future workflow incorporates an entire understanding of various flows of energy and its accurately tested performance. This way of accurately testing energy performance requires an expert use of new sorts of technologies that can give feedback to the system. Technology becomes the most integral role in green systems. Technology is used as a tool to get us most in touch with responsive information about the environment (Peters 82-92).

It is essential to understand how pedestrians are experiencing the environment when designers are working on modelling the outdoor thermal comfort of a given site. Local comfort surveys prove the most valid information when understanding human physical, psychological, and psychological adaption to the environment. To help control impact of heatwaves in cities, designers are testing the use of wearables to create human-centric knowledge. “The aims should be to develop wearable weather stations, obtain unprecedented real time climate data, and determine the complex impact of urban heat on humans in cities” (Naboni & Havinga 135). The outcomes of this research can include crowdsourcing of urban climate and heat stress, and evidence-based guidelines to build climate smart cities. Such outcomes would provide significant benefits to planning and environmental health (Naboni & Havinga 135).

aesthetics of sustainability

It is important to address core issues around the use of sustainability in the discipline of architecture. As the current trends prove that architects should adapt sustainability measures to become more marketable in their profession with evaluation standards such as LEED, BREEAM, and C2C certification. (Lee 8). While these certifications in themselves are beneficial drivers to the health of the environment, its critical to address implications in architecture that are tied with them. Greening becomes a kind of commodified trend that creates economic opportunities through the use of sustainable aesthetics in appearing to have new and desirable green technology.

Independent environmental problems are often improved and replaced when addressing sustainability in architecture, the problem lies however in the inability to look at the entire environmental structure, and the role they play intertwined in a larger complex system. (Lee 8). Transparency should translate through to the entire environmental system when dealing with sustainability. If a building is built 'green' it should be evident how it is situated in the larger context, making it clear how it is fit under the conditions, educating those who make use of the building. Sustainability should not be an added element merely decorating the façade, it should have roots in a larger purpose, clearly speaking to the context of its surroundings.

To be sustainable means to outlast and endure degradation and failure over a long period of time, giving purpose throughout the full life span of an object or building. One cannot overlook the importance of durability of materials in green architecture, focusing on "materials, techniques and assemblies of production in relation to the supposed use of the object" (Lee 12). Sustainability measures become invalid if the materials of use themselves cannot support the supposed lifespan without intervention. This informs a careful selection of materials, that are equally good for the environment, while withstanding many conditions. This selection of materials effects the overall aesthetics of the building, when taking into account the continued use of techniques and materials.

The role aesthetics also plays an important role in incorporating nature into the built environment, as it establishes emotional attachments and respect. In human society, beautiful places tend to be valued more. By designing aesthetically pleasing things, we can help their conservation. Aesthetics in architecture have been debated throughout time, by architects, scientists, philosophers and populations in general. Some see the beauty reflected in the laws of mathematics and others focus on the curves and proportions found in the human form and nature. There is disagreement about the value of simplicity, complexity, symmetry, detail, balance and proportion in architecture while determining what is a pleasing aesthetic. Given all of the options to pursue beauty in design, nature provides valuable inspiration. As humans we are drawn to the aesthetics that have evolved in nature. Biomimicry in design offers an approach to create built environments that will be valued and preserved throughout time. Neither architecture nor science can agree upon which attributes constitute beauty, as there is no universal definition of it. Biomimicry might seem to embody objective aesthetic notions because humans are hardwired to find nature attractive (Mazzoleni & Price 17).

The design of the building is done so with ecological approaches in mind, responsive to adhere to the climate conditions of Florentin. The idea of a park space itself has great environmental effects. Decreased green space has detrimental effects to a city as citizens are discouraged to spend time outside, making it imperative to refocus on intervention to obtain microclimates that favor and promote people's health and well-being. Greening a city can have many outcomes, such as improving urban inhabitants' psychological well-being, helping with flood protection, as well as noise reduction. It positively influences air quality via CO2 mitigation and outdoor thermo-hygrometric comfort. Greenery is the only known solution without detrimental consequences against heat in cities (Naboni & Havinga 139). Allowing the ground floor to be an open floor plan of the totems and a park space allows for ventilation in the building, preventing increased urban heat gain. The shape of the block itself has the courtyard in the center, functioning to breathe air through the buildings, like the other surrounding neighborhood blocks. The water recycling system in which rainwater is collected along the sides of the totems and recycles it underneath the building in its filtered tank system, allows a regeneration of clean water in the city, sprouting life to new plants that it gives life to. The plants in turn positively affect air quality, and sustain biodiversity, especially with its varying climatic conditions. The responsive skin of the ETFC pillows change interior climates in a way to allow for natural heating and cooling systems, using less energy than HVAC systems. Other technologies including a green roof for rainwater collection and insulation. The daylight operated curtains prove to be essential in the building's need for shade, reacting to the changing conditions during the day. Using these green technologies will not only improve the health of the building and its users, but it has a large impact on the entire surrounding urban environment. Improving urban inhabitants' access to green spaces and water is important for the urban agenda, as it is ever vital during times of rapid urbanization and its effect on the environment.

performative feedback architecture

The ecological impact of the built environment can be lessened by utilizing performance-based design strategies. Innovations in integrated design systems optimize complex systems such mechanical, electrical, lighting and building envelope, to maximize functionality as well as human comfort. "Performative design can encompass complex geometry, parametric and algorithmic design while moving the process beyond the mere formal observation of natural forms and patterns" (Mazzoleni & Price 15). Thus, the goal of performative systems is to develop of meaningful, flexible and adaptable relationships between architecture and its emerging processes (Mazzoleni & Price 15).

In connection with ecological studies on architecture, and parametric tools, comes the ability to create performative feedback architecture. This evidence-based approach to architecture develops tools and methods to create projects with live constraints and deliverables. (Peters 36-44). The tools and methodologies created provide feedback loops from design to operation, that allow creative input to the ever changing dynamic systems involved, including engineering, finance, economics, psychology, and environmental factors. The system developed is a database created though computational tools of evaluation, aiding to embed long term environmental quality and performance at various scales. (Peters 36-44).

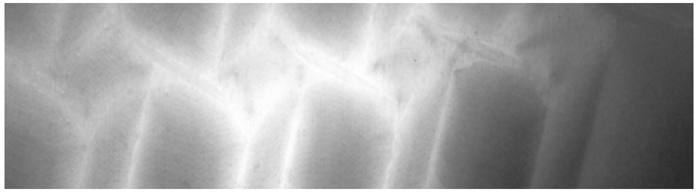
"For centuries, traditional Middle Eastern architecture has been well known for its sustainable features such as wind catchers, solar screens, cooling courtyards, ventilated domes and self-shading geometries." (Peters 38). Architecture becomes a living, breathing thing, a self-adapting system that responds to the current conditions. Through various means of collecting data with computational systems, the architecture reads the data and responds geometrically, in response to the environment. This feedback serves as a performative action, one that can be seen and observed by the people of the area. This performance serves as a tool for not only how the environment is in that given time but can also serve to be a visual tool for how we as humans are treating the environment.

What if architecture could be used as a performative tool for the environment? The architecture would adapt and respond like a living animal, creating a resilient system that communicates with its users. This real time responsive quality allows for energy optimization, as the computational reaction to different conditions can save optimal energy when it comes to things like controlling sun shading or catching wind. Today virtual approaches to analyzing the building result in thorough measures of both quantitative and qualitative means. These digital practices can not only allow for performance-based optimization through simulation, it can also help to create physical form. Creating the building envelope is of greatest importance using this process. The envelope encompasses most of the architectural and engineering systems. "The envelope connects and separates, and acts as a filter between the exterior world and the internally controlled environment. It mediates and enhances all relationships between natural elements and the conventional notion of human comfort" (Mazzoleni & Price 15).

There have been a number of architectural projects designed to respond to changing, dynamic, and responsive environmental conditions, but few have been actually built. Therefore this concept has yet to be understood by the general public. The challenge exists to create building systems that adapt throughout the lifespan of a building, and demonstrate the benefits of this approach. The operability of the building proves to be the hardest challenge in seeing this vision. Designers must be able to innovate mechanisms to allow for this adaptability in its engineering, determining its success. There is need for a greater demand for environmentally responsive buildings, and architecture must take steps towards its future (Mazzoleni & Price 20).

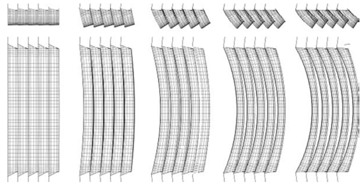
precedents

Although there are limited architectural projects that accompish symbiosis with the environment in a responsive and adaptive way, few projects today are taking leaps towards this future for architecture. As the envelope encompasses the greatest transitional barrier between the building an the environment, most of the precedents seen are adaptive facades. In the Prarie House by Ombra (figure X) the building skin is of a smart color-changing material. The material is a fabric skin made with thermochromatic inks that change color in response to the changing temperatures of the environment. On hotter days the skin turns blacker, and on warmer days the skin turns whiter, allowing for naturally controlled adaptive climates, while saving on energy and carbon emmisions by almost half. Both the Thematic Pavilion Yeosu Expo by SOMA and the Al-bahr Tower by Adeas use daylight sensored tectonic facade systems in a similar way. The panels adjust to changing sun conditions throughout the day, adapting to adjust for shading needs while saving on energy. The HygroSkin - Pavilion by Achim Meges responds in a similar way while tackling issues of humidity in climates. The difference in this design however is the programmable wooden material used. It was designed to have a metabolic response in the material itself. Self actuating and closing its pores in the building in response to humidity. Plastique Fabrique is a firm dealing with adaptability and mobility, creating inflatable structures in response to different environments. with the Loud Shadows - Liquid Events, the mstructure takes shape to the forrest, encompassing surrounding trees as its kind of structure. Nature itself becomes the changing space, like an origianl performance. In a similar performative way, their installation on Sound of Light reads daylight, and transfers it into a sound vibration, as changing hues of light can be percieved in a new and performative way. While some of these examples are more architectural, and some more artistic, they all achieve an impact through their performative dynamic flux with the environment.



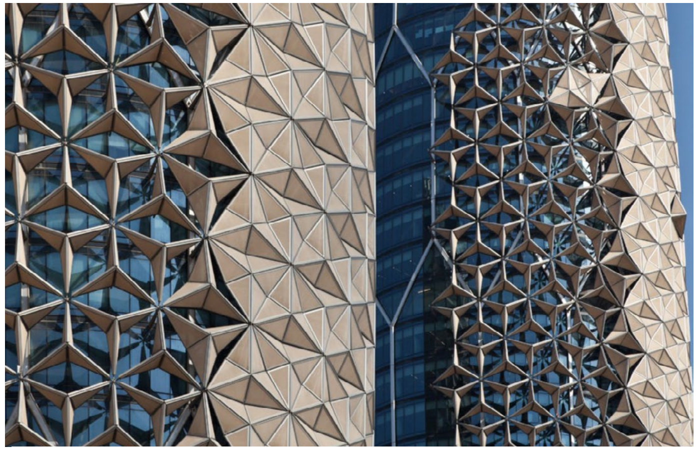
Prarie House, by Orambra, 2010

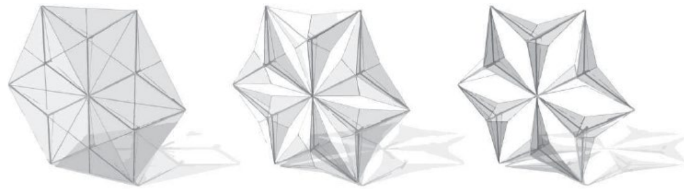
Figure 23, 24 | color changing building skin - thermochromatic inc. source: http://www.orambra.com/~prairieHouse.html



Thematic Pavillion Yeosu Expo, by SOMA South Korea, 2012

Figure 25, 26 | kinetic daylight facade. drawing of facade panels. Source: http://www.soma-architecture.com/index.php?page=theme_pavilion&parent=2# source: https://structurae.net/en/structures/one-ocean-thematic-pavilion-expo-2012/photos





Al-Bahr Tower, by Adeas
Abu Dhabi 2015

Figure 27, 28 | daylight responsive facade. drawing of facade panels. Source: https://igsmag.com/market-trends/super-tall-buildings/the-al-bahar-towers-shading-the-real-envelope/ Drawing source:https://www.archdaily.com/270592/al-bahar-towers-responsive-facade-aedas

HygroSkin-Meteorosensitive Pavilion, by Achim Menges Architect + Oliver David Krieg + Steffen Reichert, 2013

Figure 29 | humidity responsive facade. source: https://www.archdaily.com/424911/hygroskin-meteorosensitive-pavilion-achim-menges-architect-in-collaboration-with-oliver-david-krieg-and-steffen-reichert

Loud Shadows-Liquid Events, Plastique Fantastique, 2017

Figure 30 | moblie architecture, inflatable, adaptable to surrounding environments. source: https://plastique-fantastique.de/LOUD-SHADOWS-LIQUID-EVENTS

Sound of Light, Plastique Fantastique 2014

Figure 31 | daylight translated into sound frequencies source: https://plastique-fantastique.de/SOUND-OF-LIGHT

In my project I developed this idea of feedback architecture to create bio-climates that sustain their climates inside, while the outside climate is constantly changing. To allow this, I have designed the bioclimates as totems, wrapped in pillow panels made of temperature controlling ETFE skin that inflates and deflates to regulate the interior climate. The air chambers include solar powered sensors that cause the chambers to contract and inflate in response to the amount of sunlight that hits them. In summer, the membrane acts as a sunscreen, filtering heat and UV rays by 85%. The filter is created by inflating the chambers with a fog-like Nitrogen mix, which blocks solar rays and creates cooling shade. In winter, the membrane opens to soak up solar rays, maximizing the transmission of light and heat to the interior (Zimmer). Not only do the pillows inflate and deflate for sun control, but they also catch water on the outside, to filter and circulate water recycled. Water pours down the sides of the totem to be reused into the rest of the building as a renewable system. The act of collecting water becomes another performative action, that occurs when it is raining and cycles the water continually when it is not raining by pulling water from the underground well system and circulating it back up through the water pipes inside the biomes.

Similarly to Plastique Fantastique's inflatable adaptable strucutres, the builidng responds in a way that alows viewers to be in nature in a new way. This unusual way of being in a new environment within an exterior environment can change people's views of our existing relationship with nature. The dynamic diversity of plants, the vast range organisms working collectively in an ecyosystem, changing climatic conditions of sun, rain, wind, and moisture, these are performances occuring around us, in the architecture of the planet. Creating spaces that continue these symbiotic relationships is the principle in this ecological design approach.

space as performance
architecture

Artists today are often overwhelmed by possibilities with current technological advancements known as the Digital Revolution. To explore given potential, architects have been capable of conceiving new complex forms and geometries, often criticized of relying solely on image related parameters. To react against this criticism, architects and designers have been incorporating parameters based on environmental or programmatic aspects. This gives purpose to the complexity, while keeping away from the reductionist perspective of 'form follows function' as that is an outcome of a mechanic system, void of addressing "form as a cultural, social, and political product" (Grobman & Neuman 9). Performalism in architecture allows for a breaking of boundaries, a wider frame of conception that goes beyond and in-between the formalist and image-based approaches.

Performance in architecture presents new dichotomies of space as an objectified form, with humans as the subject. Space in is no longer static, it has an animated continuous relationship, one in which this very dynamic is the performance. "Form in this case is animated, acting and interacting with the surrounding objects/forms and the human subject, creating possibilities for the emergence of new realities" (Grobman & Neuman 9). This relational approach to form allows for the incorporation of processes found in nature and in culture. Observing the processes of form call for both looking at the technical and functional aspects of processes, along with the environmental, social, political, symbolic, and behavioristic process that can be addressed. In this way, form is something that caters to its programmatic and sensual needs. Space becomes an experience, one which evolves to be more flexible, adaptable, and free.

Advancements in the digital age of architecture allow for performance in architecture to be a type of information flow, adapting form and function through computer generated code and simulations for examination and optimization. The computer helps to assess the relationship between form and function in the way that it helps define their connection, arriving at performative measures to help actualize the intended goal. This is often thought of as quantitative measurements, empirical performance, associating physical data such as amount of sunlight. However, there are broader definitions of performance including a cognitive dimension, focusing on "the way human cognition can be translated into space, and the way space can be translated into human cognition" as well as a perceptual dimension, focusing on 'the way human perception can be translated into space, and (…) the way space can be translated into human perception" (Grobman & Neuman 14).

Performalism has the contemporary narrative of seeing architecture as a performative art. With this purpose, the processes taking place have an effect on participants, "in a world which is more and more often defined in terms of occurrences rather than as a collection of objects and relations" (Grobman & Neuman 21). Contemporary art and philosophy have a growing rhetoric on the idea of "what happens" emphasizing process as the prominent idea. The art of a production performs at various levels from ecological criteria to visual effects; architecture is at the forefront of employing the concept.

performance as educational tool

Performative art is often a tool used to reveal truths about a process or situation, inspiring change of thought. This is used as a tool of awareness for the piece #AllMyMovies. Actor Shia LaBeouf watched all his feature films back-to-back at New York's Angelika Film Center over three days, while a camera transmitted his reactions to the internet via live stream for the world to watch. The concept is based on the idea of irony, following the pattern of recursion, when a thing is defined by the terms of itself, nesting infinitely in a reality of inception. We are watching Shia Lebouf on our computer screen, watch Shia Lebouf on the big screen. Just as the irony of this is clear, so is the irony of his performance. Shia Lebouf acting in these films that he watches is an obvious act of fiction, but what about the act of this performance? Shia Lebouf has been scrutinized in the public and felt as though he has been made into an object for the public audience. Shia Lebouf reconciles with the metamodernist movement, which is described both with and in reaction to the relationship of modernism and postmodernism, "championing the idea that only in their interconnection and continuous revision lie the possibility of grasping the nature of contemporary cultural and literary phenomena" (Cliff). These metamodernist performances have become indistinguishable from the performance of being a celebrity, based on their own irony. The lines get blurred between what's an act and what's real life, and the indistinction is fine, because the focus and intention changes.

The intention is to take the attention off of these large performances which are the obvious points of attention or 'light' and instead to focus on the darkness, on everything in-between these monumental highlighted moments in time. The darkness becomes these subtle, intimate human responses we are observing in Lebouf, and thus in ourselves. The piece was live streamed entirely in silence, to allowing for the activation of these 'off cells' to perceive the depth behind the performance, engaging with viewers to come to their own conclusions as explanations are absent. He creates a space of community as the public watches the films with him, and a sense of community through the dialogue around it.

What is contemporary and relevant today is what is democratic, what is accepted in the eyes of the public. The art takes a shift away from needing approval from film or art critics, but instead to how the people perceive the actor himself. All of the barriers are broken down for this interaction to happen, and the distinction between artist and the audience is blurred, everyone is equal, everyone is human. Here lies an example of using performative act to enlighten and inspire change in perspective. This is better than direct traditional educational means, as the lasting effect the performance creates is more powerful.

While performance can be used as means to evoke change, it comes with many paradoxes as distinctions can get blurred. As performalism inspires a sense of realism about what happens critics wonder what this is really saying about architecture. Is it a catalyst for change, or a "stabilization of the way things are?" (Grobman & Neuman 21). Performance is the connection between architecture and event. The dialogue stems from whether events are merely occurrences with sometimes unexpected results that do not seem to affect the larger perspective of the world, or if these events help to inspire innovation. I believe we must make use of occurrences and processes in nature, as well as daily life, to highlight and expose realities, invoking this reinvention and change. While this still relies on human potential to actively make a difference, performance can be a powerful tool to educate and help to do so.

In my project, performance was used in the both technically efficient ways, along with visual and sensorial artistic. The performative feedback systems such as the temperature controlling ETFE pillows are a performance, responding to the environment and in constant flux, maintaining indoor needs. The pillows, inflating and deflating with nitrogen pumped air chambers that act in response to solar sensors, become a source of movement, transparent in its process of changing light and temperature conditions (Figure 61). Another performance includes the rainwater recycling. When it rains, water is filtered in through the roof, it drips down the sides of the totems, and is sent to the underground well system, and then pumped back up to water plants. This circular process performs to demonstrate water conservation (Figure 63, 64). The presence of the different bioclimates in itself is a performance, showing the complexities of different climates as you walk through the totems in the park (Figure 71). The daylight curtain systems operate on a sensor response system, responding to the shifting shading needs to help save energy (Figure 65). Their movement becomes like a dance, sliding along the glass façade. A more conceptual performative measure is the behavior of the trash deposit site and underground pneumatic trash system (Figure 66). The act of throwing your trash and recycling in the bins becomes a highlighted and valued action. The many different processes occurring at the same time make it a highly performative experience, as the building becomes a dynamic, ever changing organism.

strategy

3_

trash & education mapping

To begin with the analysis of current problems and select a site in Jaffa, I used parametric codes created during my research with the program PULL, Parametric Cities in Jerusalem where I took Erasmus at Bezalel Academy of the Arts. By mapping Jaffa, Israel, tracking its trash and recycling system, I found poorly managed waste disposal in which processes were hidden and didn't help to educate the community (Figure 13,14). Several landfill sites in Jaffa were once large dumping grounds, with destructive social and environmental implications. Following a set of mapping analyses on trash and how it is linked with education, I developed different tools to simulate trash and recycling routes to optimize both the collection of recycling and to minimize the energy utilized for collection (Figure 16-18. These parametric mapping tools created a measurement system of environmental data, used in performance.

The visualization of performance is helpful to understand certain processes. Making the process of recycling transparent and understandable could improve behavior regarding waste disposal. People need to see the trash they are creating, and what happens to it, in order to change their behavior about sustainability.

After mapping waste handling, I set out to find possible areas for intervention. Through linking possible points of energy sources and education such as schools, compost sites, factories, and super markets, I was able to create a network of linked points (Figure 22-25). Next I analyzed different parts of the built environment that intersected with these points such as facades, roofs, and courtyards (Figure 26-29). The intersected surfaces would help direct what area of builing blocks I would use as a project intervention, as this area with many intersections of connection points would be an ideal central place for the community. With this analysis, I identified an area in Florentin, Jaffa. This area is becoming highly gentrified, while having little to no green space, and areas with greatly contaminated soil (Figure 19, 20,21). This made the site attractive for a green intervention. The area has a typical building block on a rigid city grid, with an inner courtyard for private use. The site needed a green space, one that worked with the existing city grid, which would become a space of learning and transparency, all based on bettering the environment. The proposed community center is a prototype building in the center of the area, to be a meeting place for people of the community to learn about and enjoy the environment.

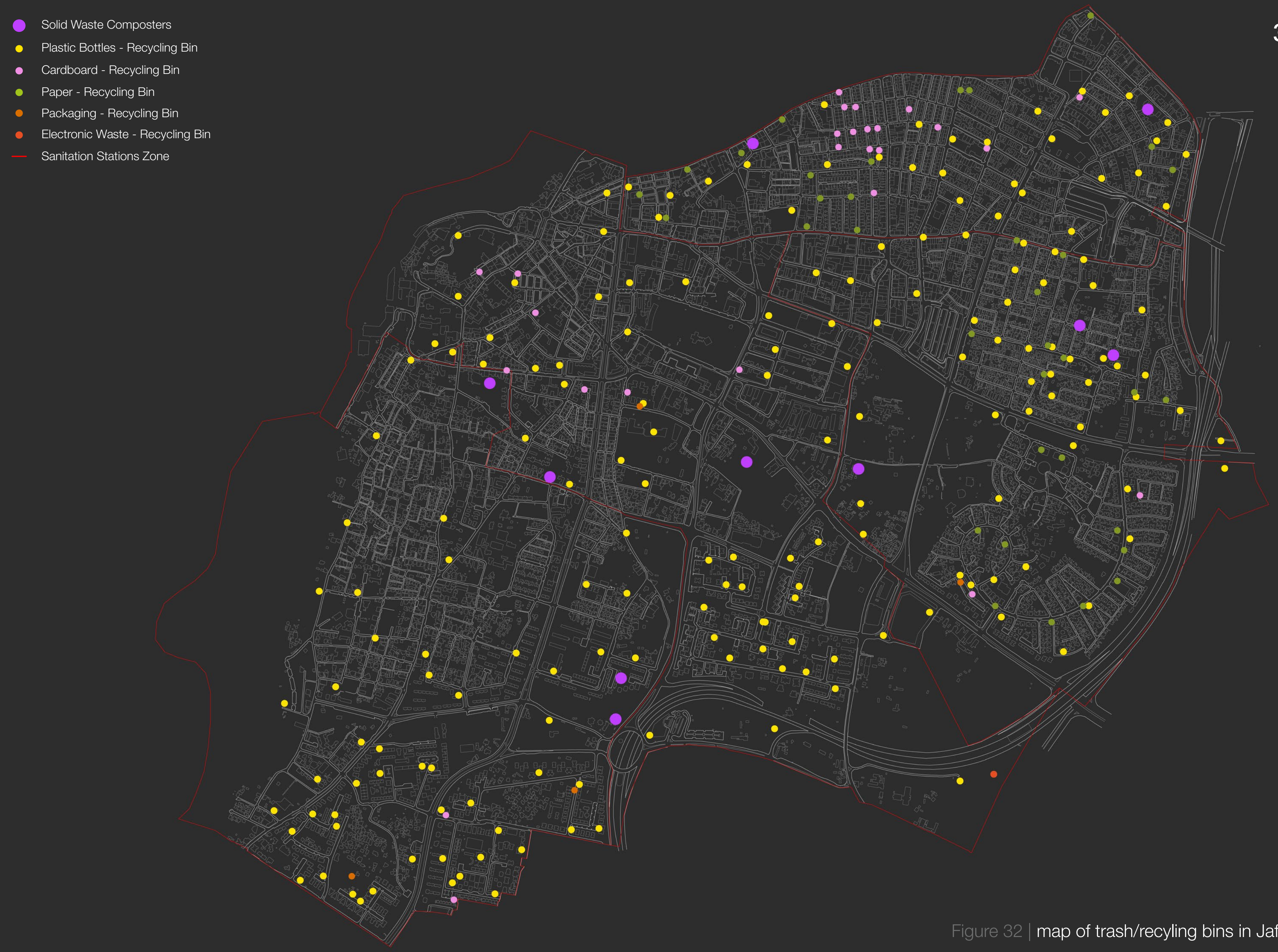


Figure 32 | map of trash/recyling bins in Jaffa

Figure 33 | map of education centers

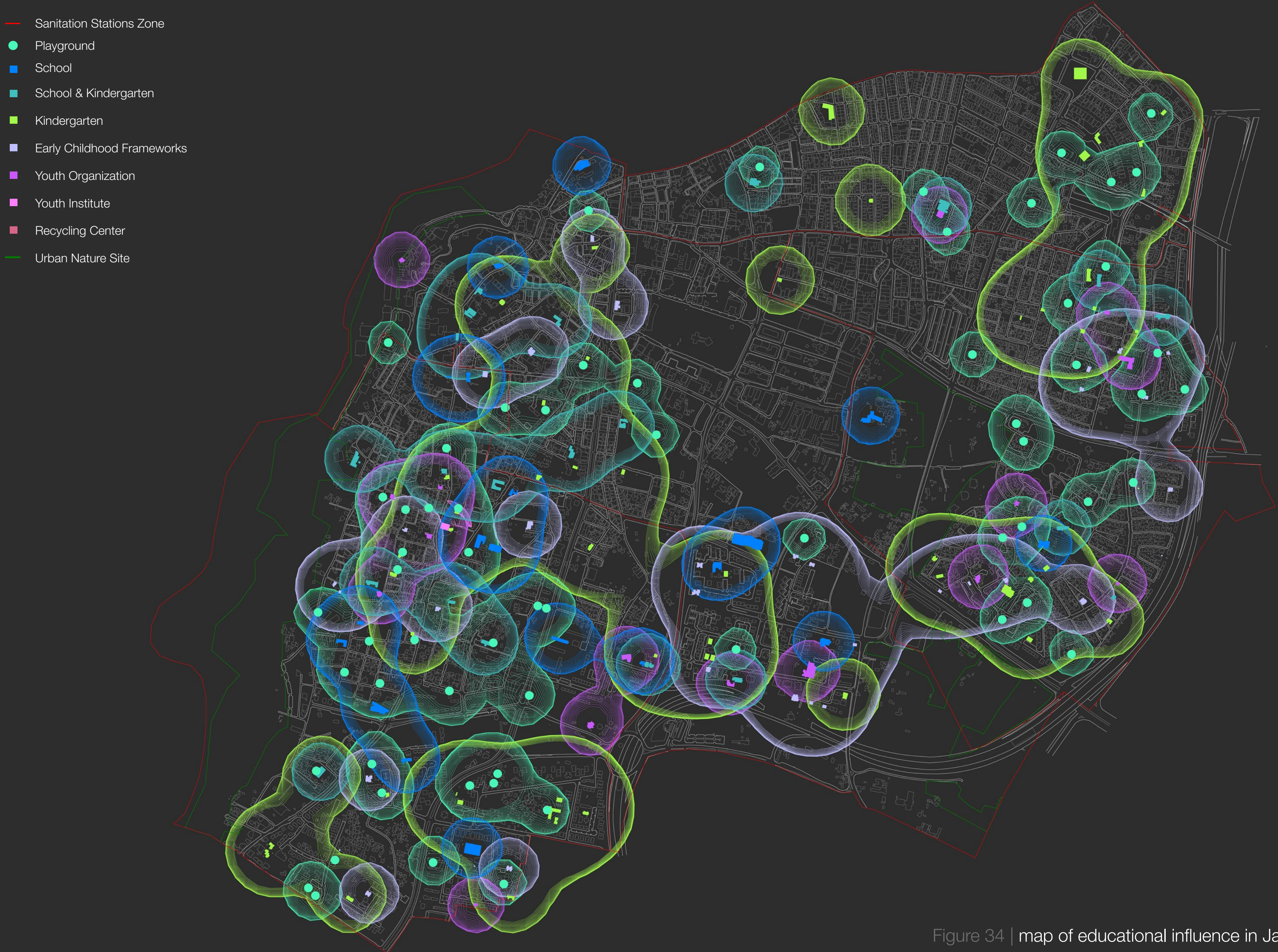


Figure 34 | map of educational influence in Jaffa

Figure 35 | trash route simulation

Figure 36 | map of trash route simulation - destination points

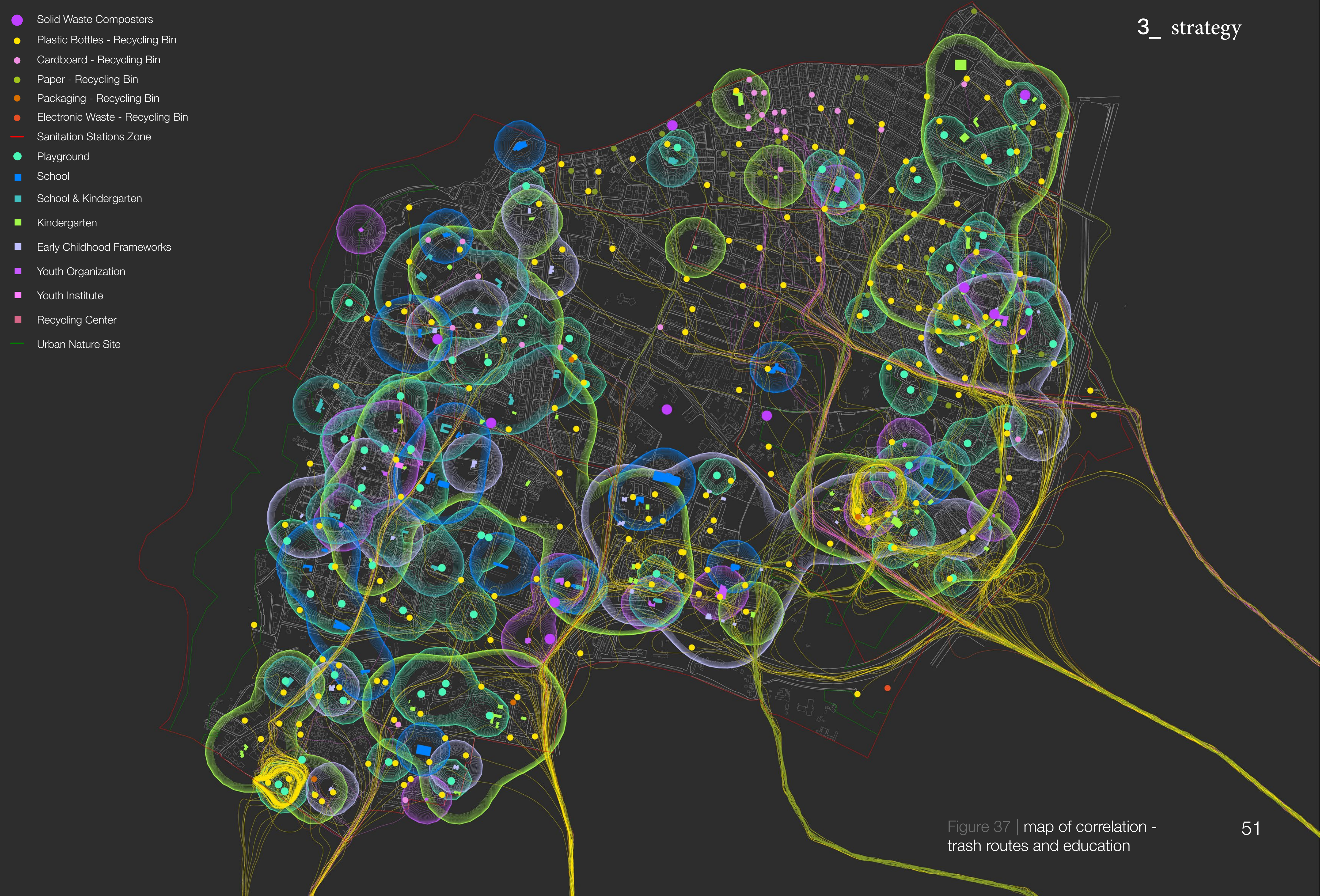
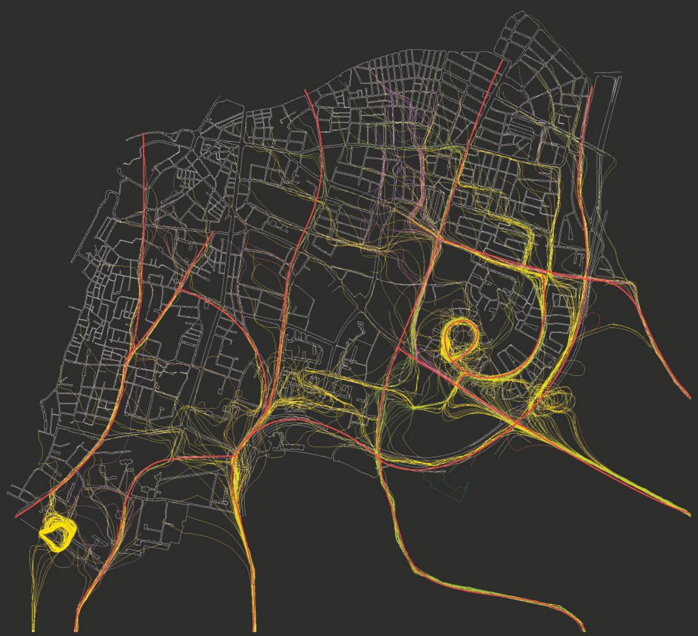


Figure 37 | map of correlation - trash routes and education

Trash Route Circulation

After simulating the closest flocking path for trash pick up in a city, a series of main roads became highlighted on the map of Jaffa. As the routes circulate, the lines branch out in a linear fashion when stepping off main roads into the smaller secondary streets in neighborhoods. The grid that I analyzed would be later used in a pneumatic trash circulaiton system throughout the city (figure 69)



trash route circulation

linear axis grid

Figure 38 | trash circulation simulation, linear branching of routes

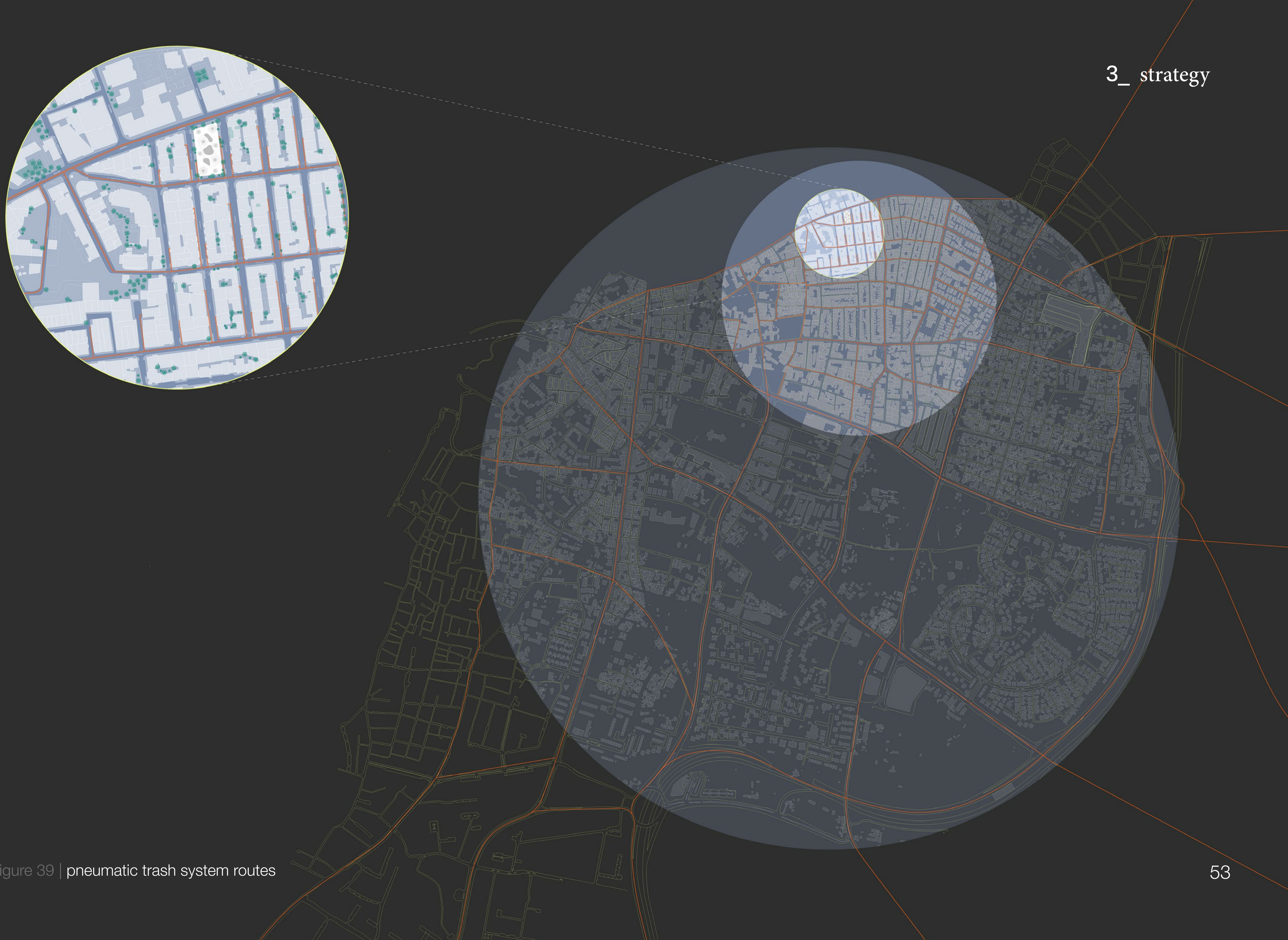


Figure 39 | pneumatic trash system routes

parametric tools on environmental analysis

While architects must be in coordination with ecological and environmental engineers, they must also be in coordination with software developers, to enable the use of tools to test and use this found data. The development of computational design tools is integral to the creation of appropriate, responsive, architecture. Although architecture can often be described by the "discourse between the systematic and the symbolic, the computational design tools can be described as an equivalent discourse between the abstract and the intuitive. Computational design tools can be viewed as interacting systems of programming abstractions and also as 'information artefacts' with their own 'culture of use' supporting human intuition." (Peters 23). The use of computational tools and parametrics goes beyond supporting human intuition, it can also allow geometries and solutions that may have not been previously imagined by architects or even the original software developer.

Parametric design is an emerging design approach which is being used in future generations of design to explore a multitude of tools it enables. Tools can give many possibilities and outcomes, challenging the thinking of the designer to open the range of approaches to a problem. Parametric tools can open the door to many possibilities and also close the door to its centralized form of optimization. Parametric design can test multiple iterations simultaneously, collecting and computing data to give the smartest, most intuitive solutions. These tools can also help to create a more conservative approach, developing boundaries, restrictive parameters that allow it more easily adaptable to real life realities. Using these tools may relieve much effort on the designer using it, but it is meant to challenge and further the designer, not to be the relying factor.

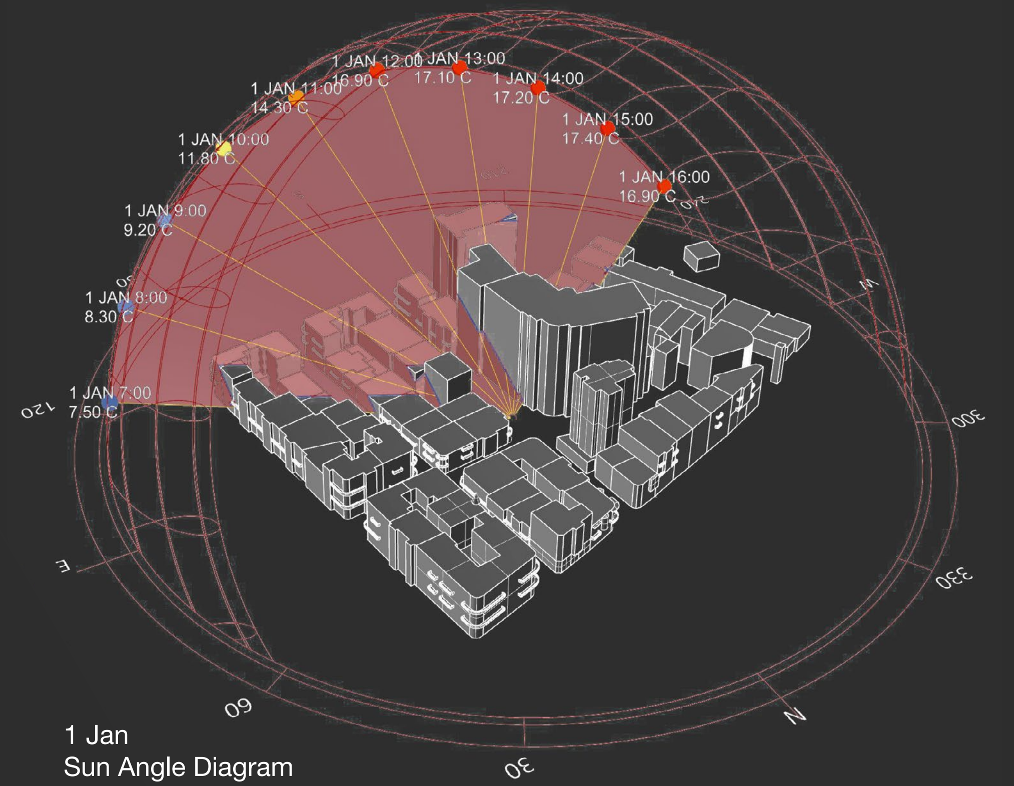
The act of creating architecture is a "predictive act of experimenting with possible futures" as architects envision and inform the cities of the future. (Peters & Peters X-1). Simulation moves beyond modes of graphic presentation in this sense, into a way to test future performance, connecting the building environment and natural sciences, to a calculated tool used to provide informative predictive knowledge, providing feedback from the design environment. (Peters & Peters X-1). Simulations can provide quantitative information on parameters of energy related to building physics, transforming to qualitative studies on the sensory experiences as intended outcomes. Sensory behaviors can be observed such as daylight studies, human traffic circulation, airflow, shading, comfort, aesthetics, and many other unexpected emerging factors. This tool is used to relate the complexity of many correlating factors, demonstrating their effects over a period of time.

While many fear digital design tools allow for a 'loss of materiality', the argument for computational tools in design is one that lies in a heightened vison of architecture, seeing aspects of the environment that were not previously thought of before its use in the practice. Three of these areas include: "more detailed modeling, building integration, and becoming an indispensable part of any design process; that is, simulation as a design tool" (Peters & Peters 3). Simulation moves beyond a scientific experiment, to something that is a creative process in itself. The use of visualization can provide intuitions on performance, leading to new possible outcomes along the way that were not conceived before. Several different iterations can be tested and trialed, leading to an optimized approach to design selection. The 'design computation era' becomes a new chapter for the practice, moving past the age of 2D drafting though CAD, and 3D building information modeling (BIM). This generative process of the computation era centers around building an algorithm to dictate the building, instead of directly modeling the building. Inside the code lies everything pertaining to the building. Adjusting one effects all other aspects simultaneously. This is a move past time consuming manual modeling that will consequentially change after multiple iterations, and move towards a behavioral definition of the building, extending beyond just physical form (Peters & Peters 3).

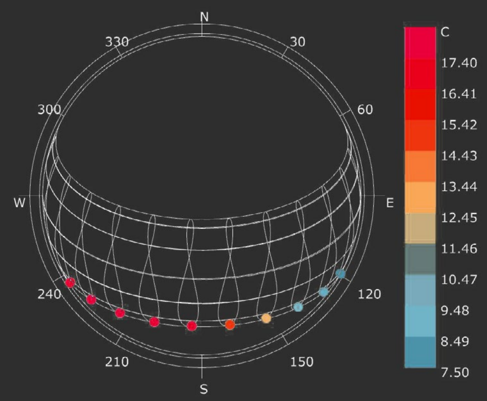
It is undeniable our climate is in crisis for change as extreme weather events are having a huge impact on our buildings and the future of our environment. The building industry alone consumes a large sector of the total amount of energy consumed in a city, and creates a considerable amount of pollution, and material use (Peters & Peters 4-5). As sustainable efforts such as renewable energy, passive environmental design low-energy techniques, life-cycle assessment, and integrated neighborhood and community designs become increasingly vital, simulation and digital design techniques tested these strategies. (Peters & Peters 4-5). These sustainable efforts go beyond the reach to the ecosystems, to the health and well-being of those who inhabit the built environment.

In my project I used a variety of parametric tools to challenge and gain better understanding of the work I was doing. I used grasshopper as the tool for me to make sense of the data I was processing. This approach not only processes the data but it presents the findings in a visual way for users to understand. One example I used for my project was to take the data provided by the Tel Aviv municipality of GIS data points of trash and recycling, and simulate circulation routes between these points. The parametric tool created ran a simulation of trails finding the nearest route to their destined recycling center, creating a 'flocking behavior' simulated using the Culebra plug-in. In this analysis the mapping system also set a 'radius of influence' around each point of education as a site for impact. The parametric tool used created a megaball, grouping different programmatic places of education together, to discover sites of high impact intensity. This allows for various analyses of areas of intervention, and ways of circulation optimization.

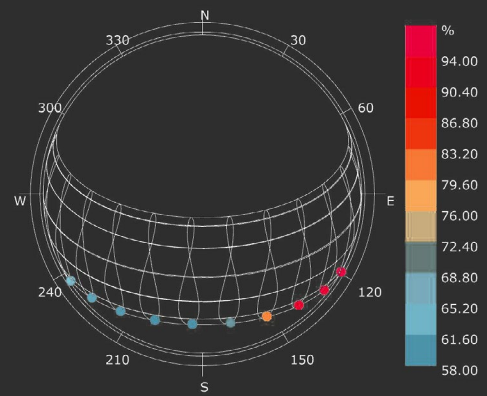
Another example of how I used parametric tools was for environmental analysis of the site. Ladybug is a plug-in for grasshopper that takes stored environmental data that is continually updated in time, to analyze the given area. This analysis includes studies on wind, sunlight hours, radiation, humidity, and thermal comfort. I used a variety of these studies to map environmental conditions on the physical environment I was looking at in Florentin Jaffa.



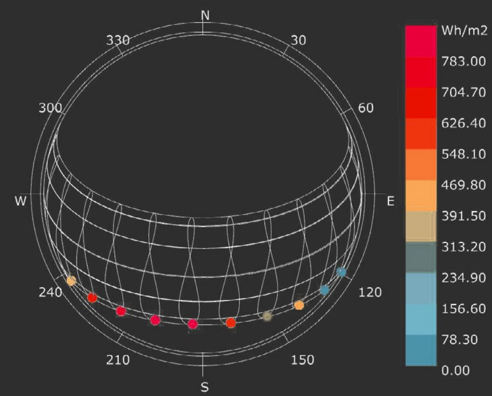
1 Jan
Sun Angle Diagram



1 Jan
Dry Bulb Temperature (c)



1 Jan
Relative Humidity (%)



1 Jan
Direct Normal Radiation (wh/m2)

Figure 40-43 | Ladybug sun path diagrams

1 Jan
Sunlight Hours

1 Jan
Radiation Analysis

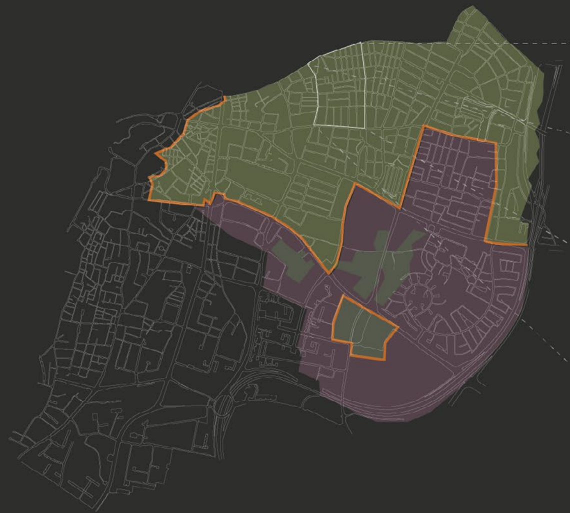
The following environmental analysis were done with Ladybug plugin in Grasshopper. The plugin takes real time environemental data and maps it on the 3D built environment. On the left shows the amount of hours different faces of the buildings on site are recieving. Our building site is reciving is all white, showing to recive more than 10 hours of sunlight in a day. The weather conditions in Tel Aviv are made of strong direct sunlight as it is near the equator, and therefore needs adequate shading. On the left is a radiation analysis, shoing how most of the intense radiaton is on the roofs. Longwave radiation yields infared radiation that causes people to feel heat. Longwave radiation includes the heat energy emitted by all built environment objects, such as buildings and trees, and influenced by objects, trees, and architectural characteristics such as sizes, shapes, and materials (RD 138). The intense radiation and heat gain analysied on site allowed for an informative approach to tackling climate control when designing the building.

Figure 44, 45 | Ladybug sunlight hour & radiation site analysis

Florentin Jaffa site analysis

Florentin Sustainability Intervention

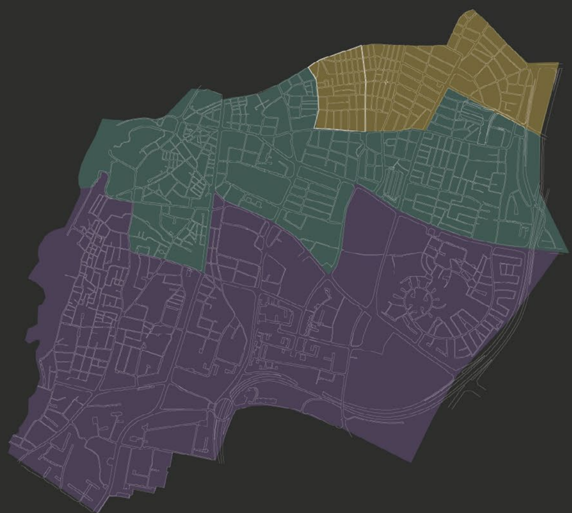
Upon studying sustsainability data of Jaffa, it became aparent Florentin would be an ideal area of intervention. A few reasons for this includes its rising buisness rates, due to increased gentrification. Gentrification is a big threat to sustainability as unused land is being torn down and covered in new apartment rennovations. This causes drastic demographic uprooting, shifting traffic routes, land use, and overall decrease in green areas. Economically it is not sustainable as housing prices increase, pushing people further out from the city center. Florentin also shows great land contamination due to its largely industrialized territory. This is poor for the area in its ability to grow trees, and signals a larger issue in the processes that are damaging the environment in the area.



mandatory soil gas testing

introduced surface runoff into groundwater

land inspection



high buisness rates

medium buisness rates

low buisness rates

contaminated

rehabilitated & protected site

clean

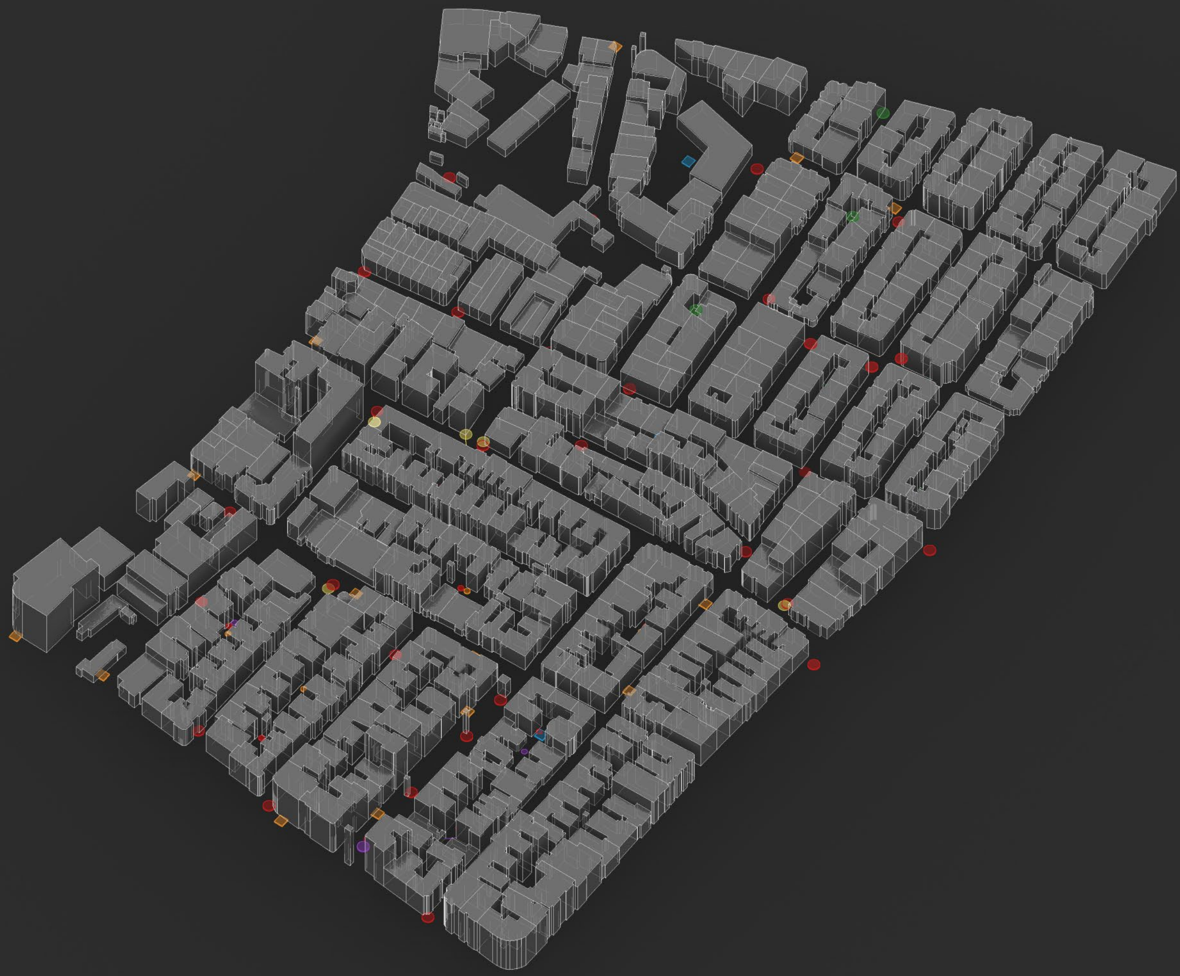
suspected poluted site

other

Figure 46, 47, 48 | Florentin site sustainability analysis

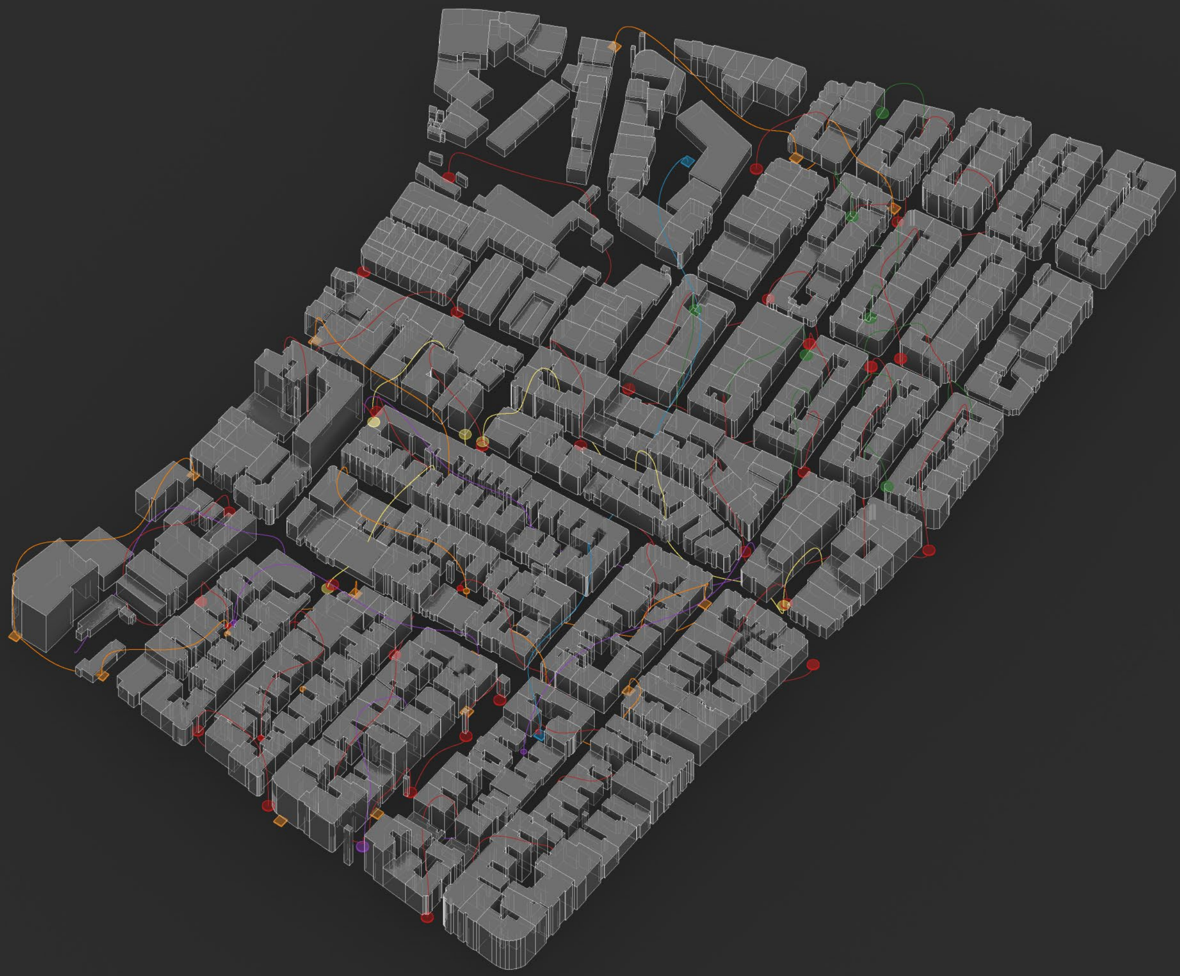
Figure 49 | map of Florentin - community education / recycling points

Figure 50 | connecting community resources



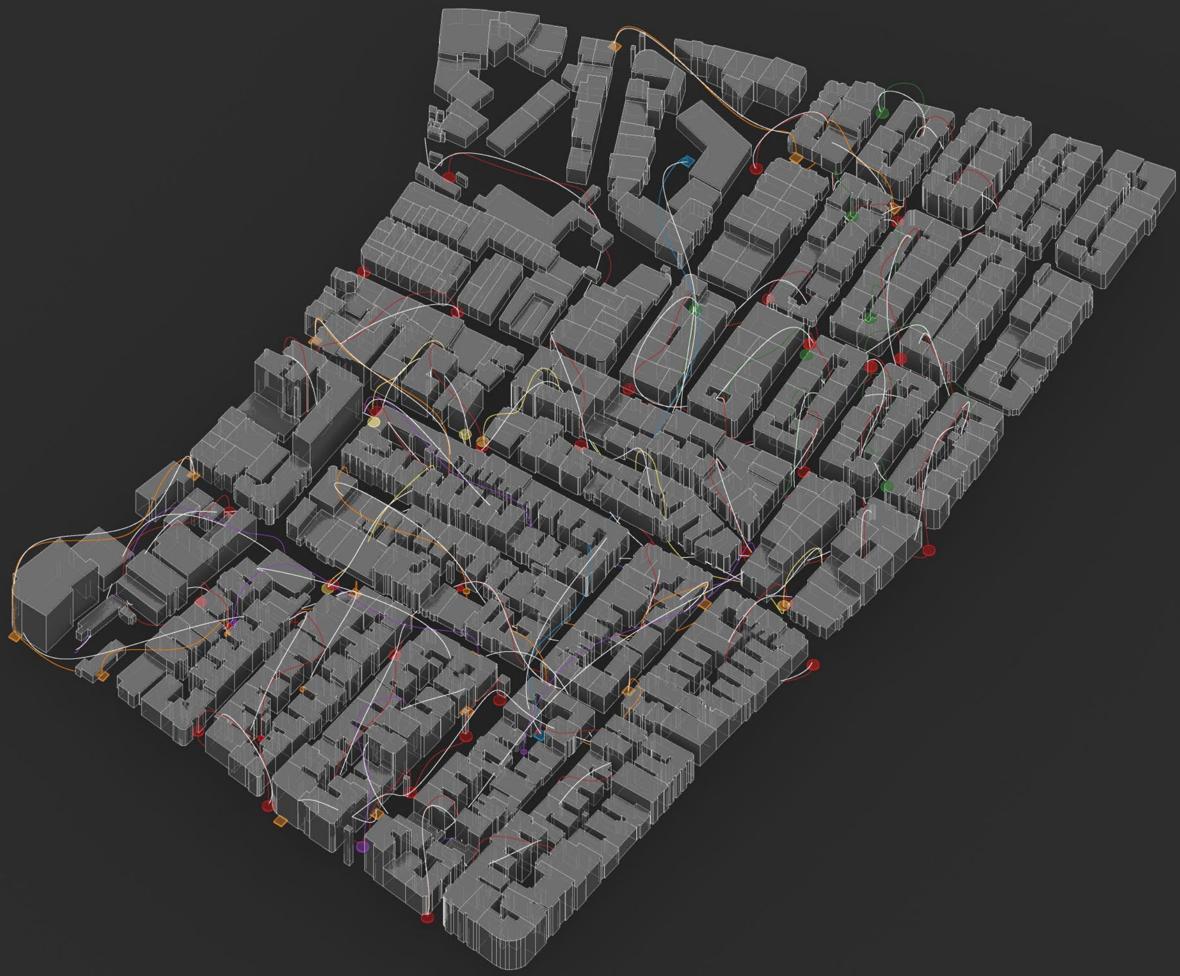
Trash/Recycling/Education Points

Figure 51 | Florentin trash/re-cycling/education points



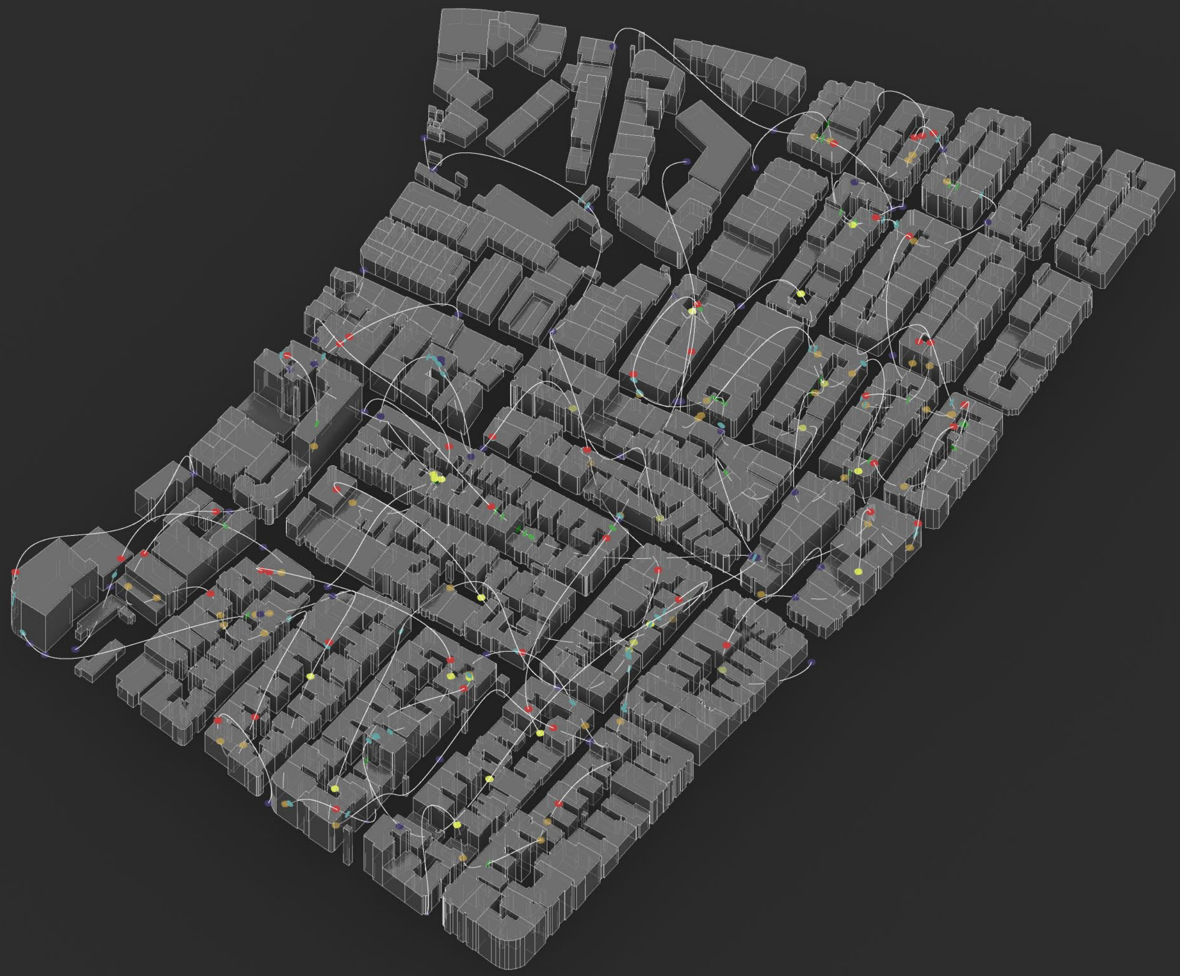
Network of Curves Through Points

Figure 52 | networked curves
through site points



Rebuilt Curves

Figure 53 | rebuilt curves for energy efficency



Points of Intersection

Figure 54 | new intersection points through built environ-

- ground
- inside courtyard
- roofs
- facades
- underground buildings
- ground inside courtyards

Points of Intersection

After mapping the points of interest for eommunal places of exchange regarding trash/recycling systems and education, I connected the points through one continuous line of energy, rebuilding the curve to allow for optimal efficency. Where ever the curve cut through the built environment, I would take not at which type of facade It was hitting for places of intervention. These points would help dictate an interesting building block to place the site on, due to its high traffic of diverse intersections. These curves were mappedin the built environment through grasshopper code simulation.

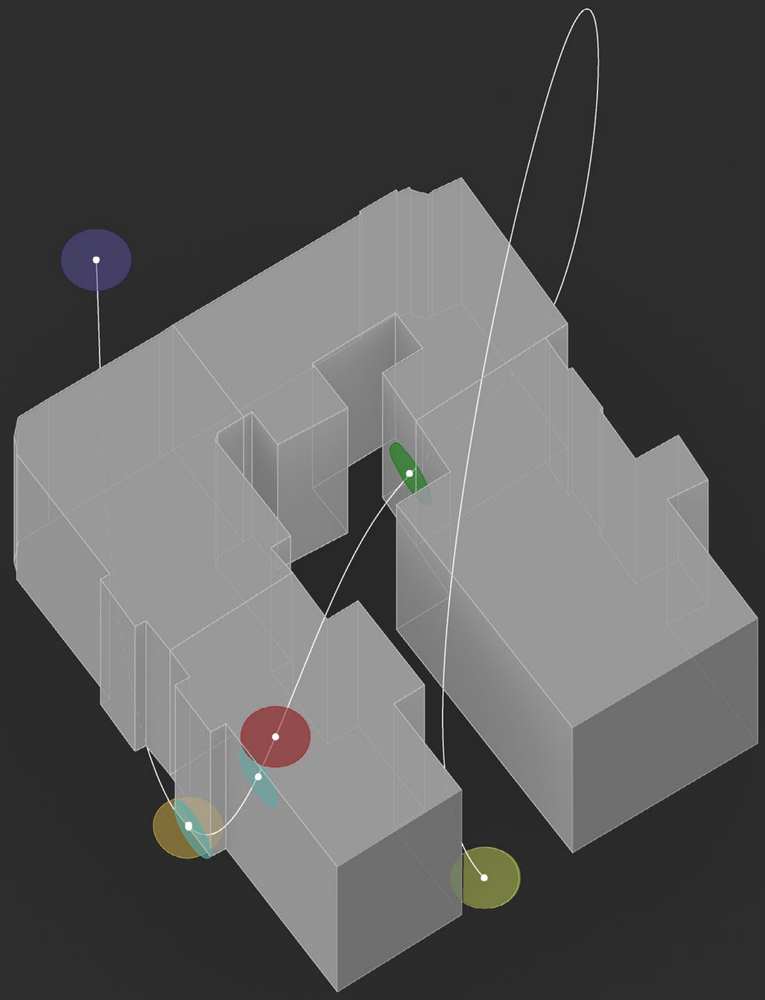
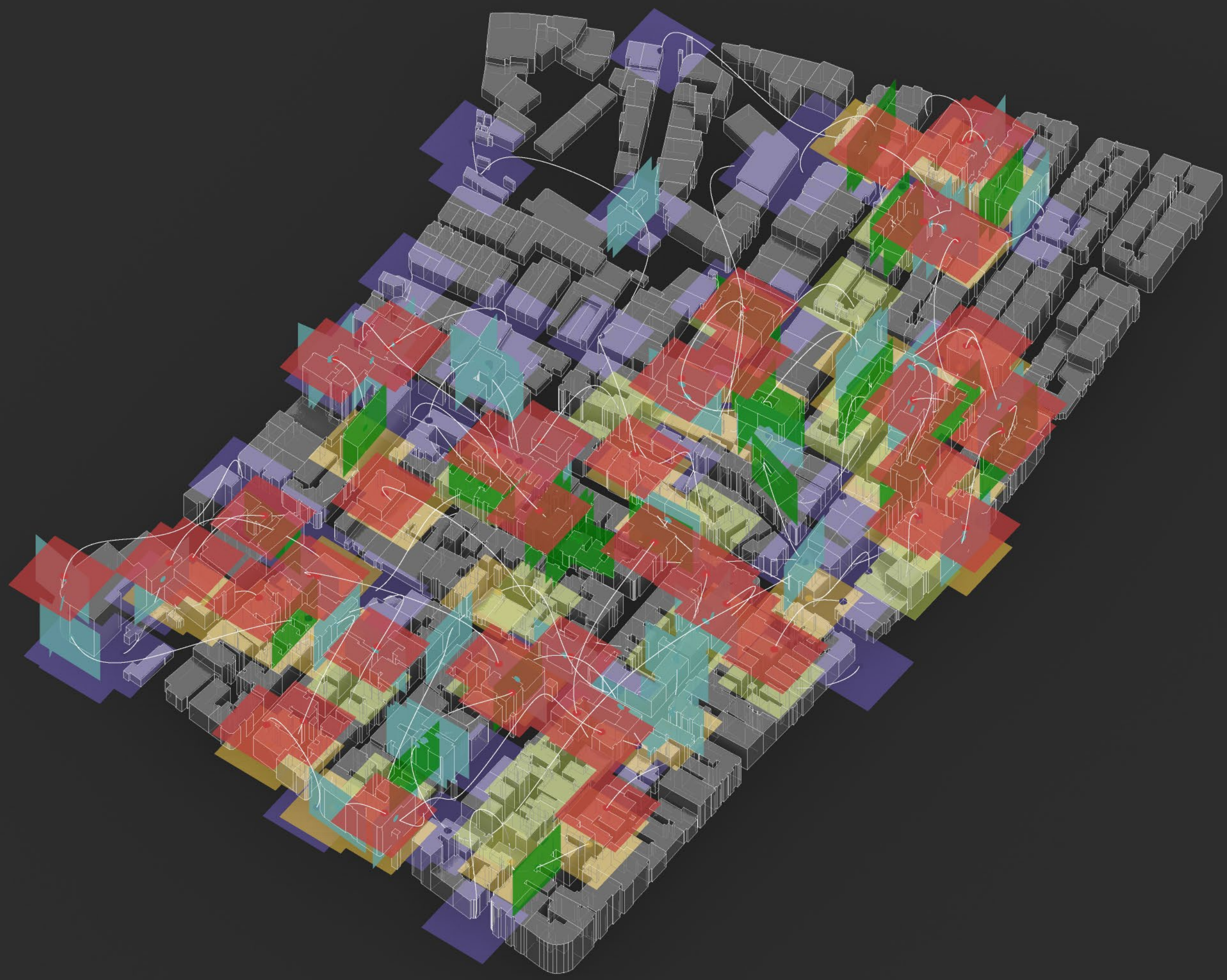
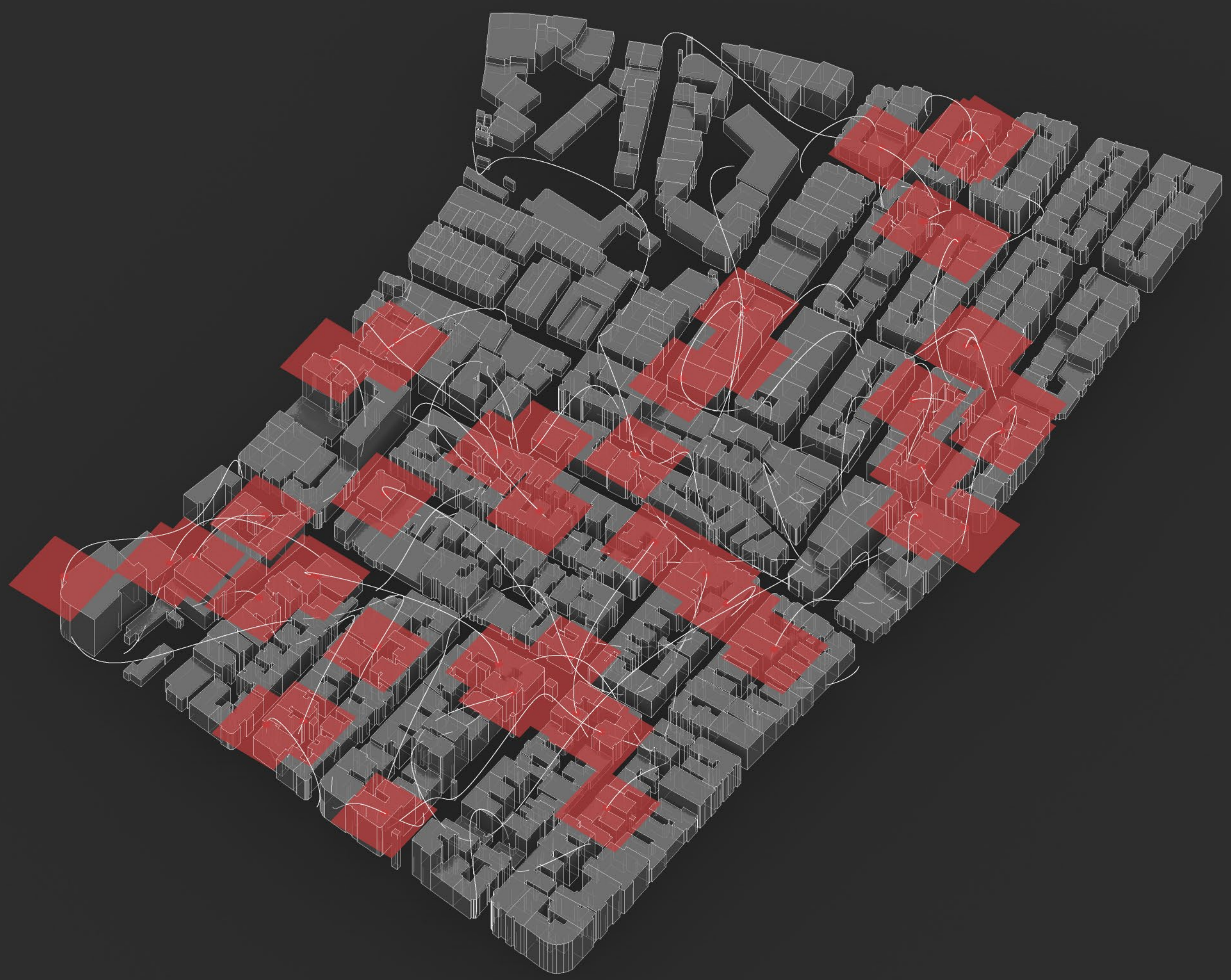


Figure 55 | building intersection points



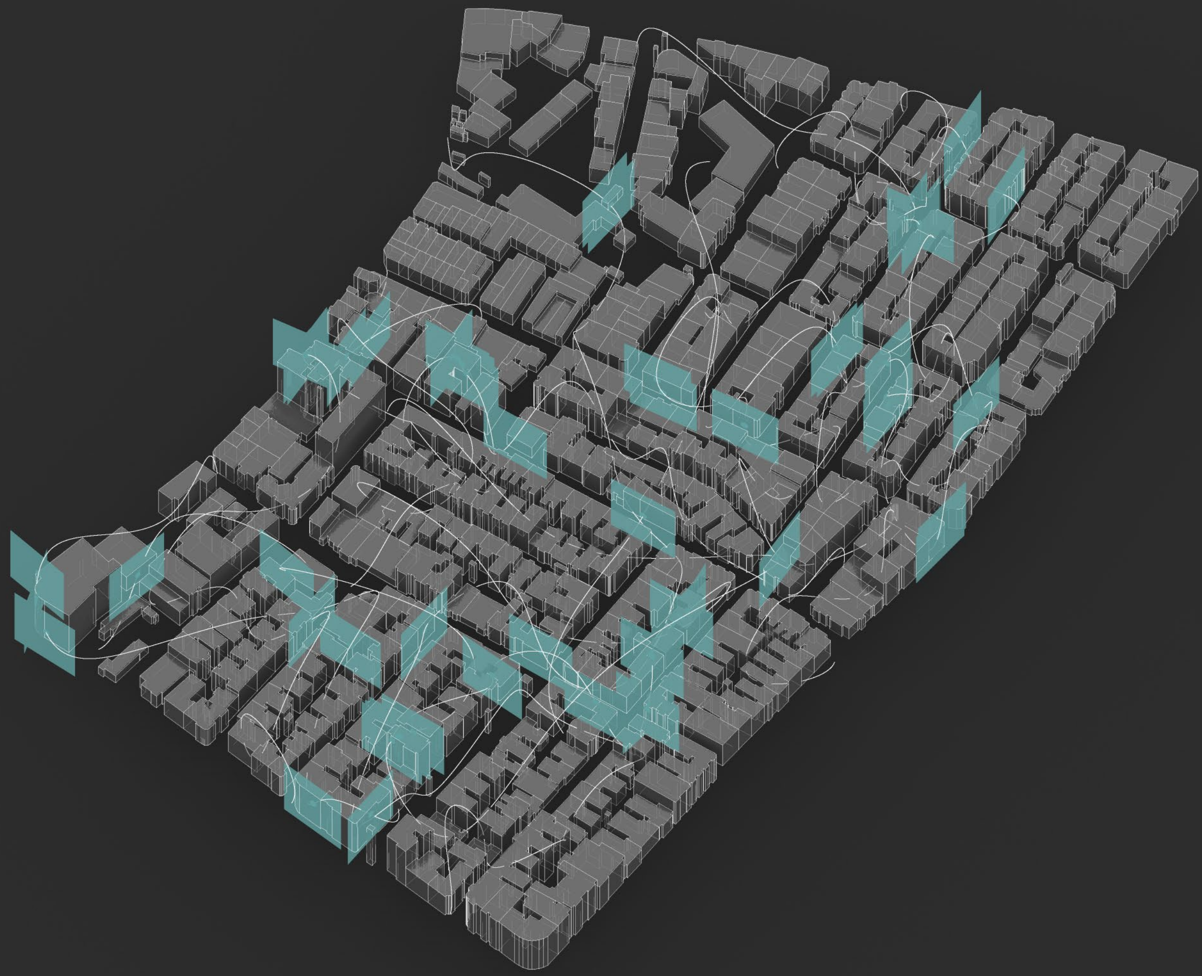
Surfaces of Intersection

Figure 56 | building intersection points



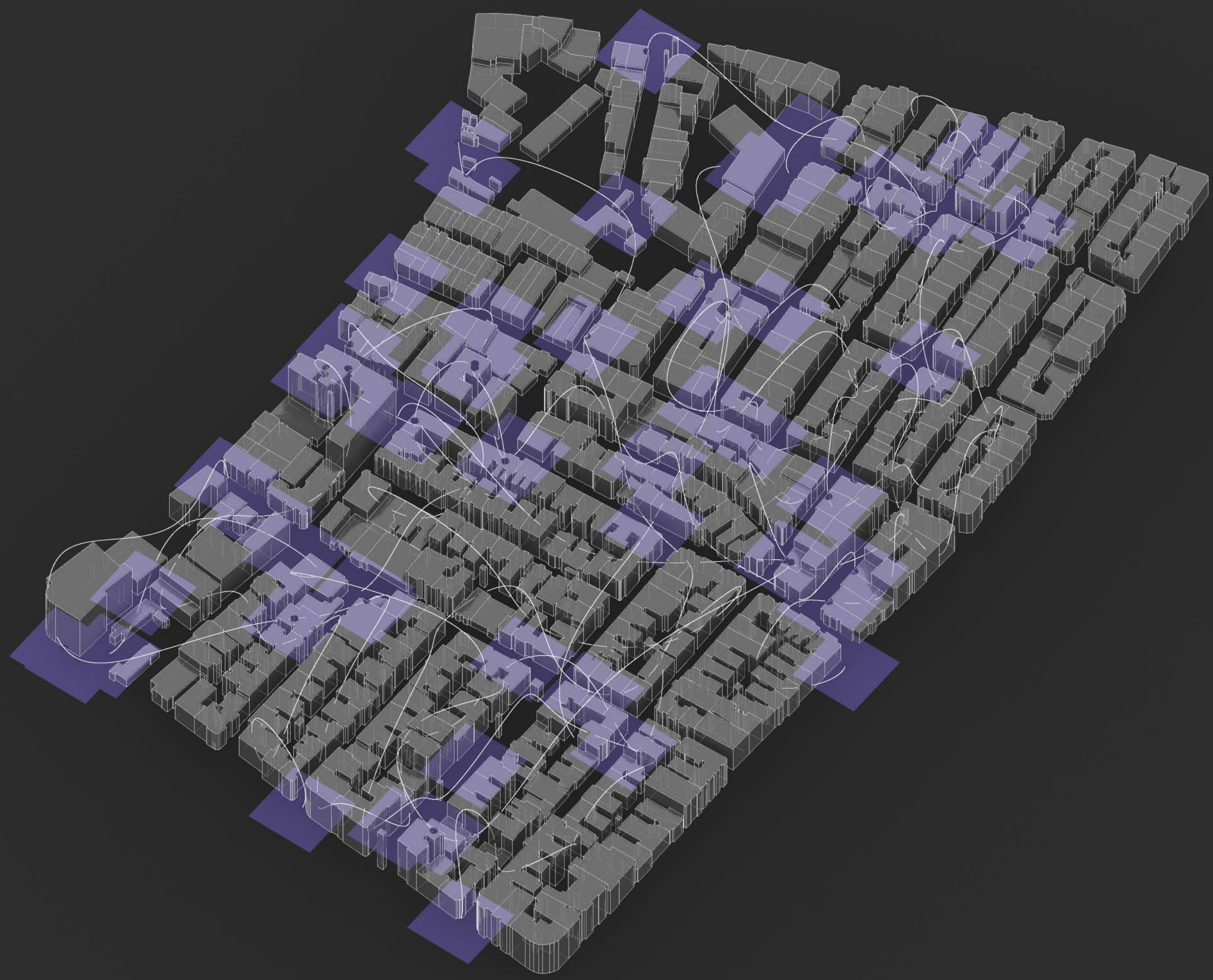
Surfaces of Intersection - Roof

Figure 57 | intersected surfaces - roof



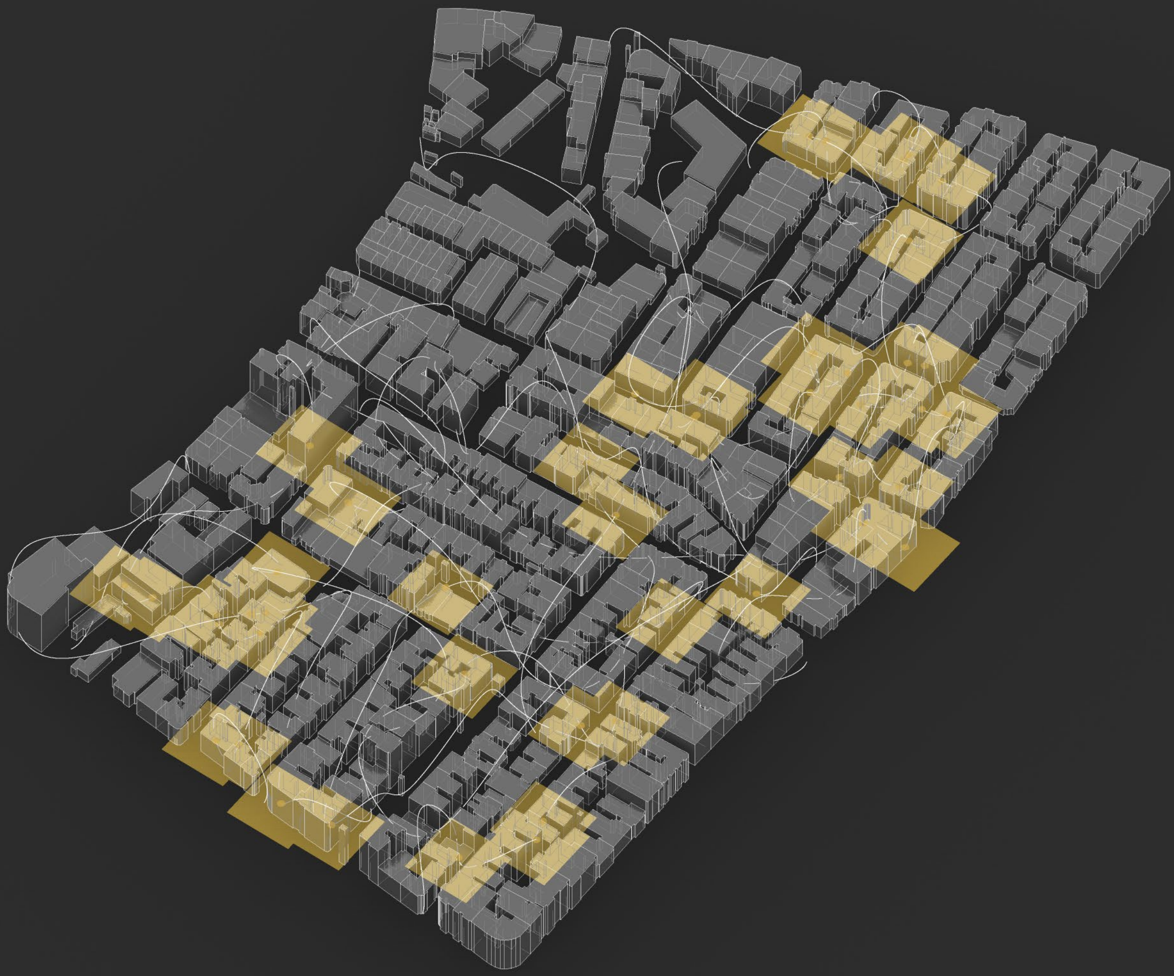
Surfaces of Intersection - Facade

Figure 58 | intersected surfaces - facade



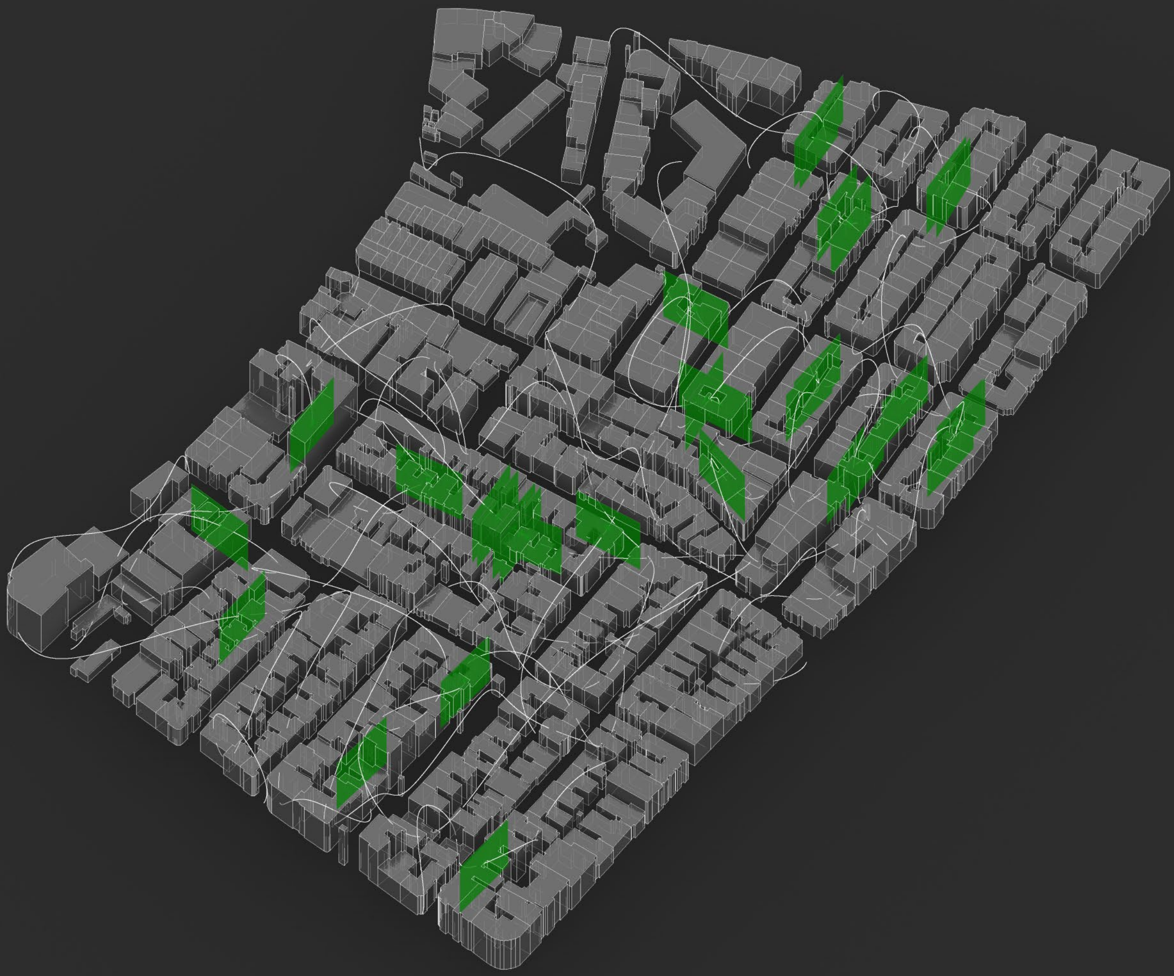
Surfaces of Intersection - Ground

Figure 59 | intersected surfaces - ground



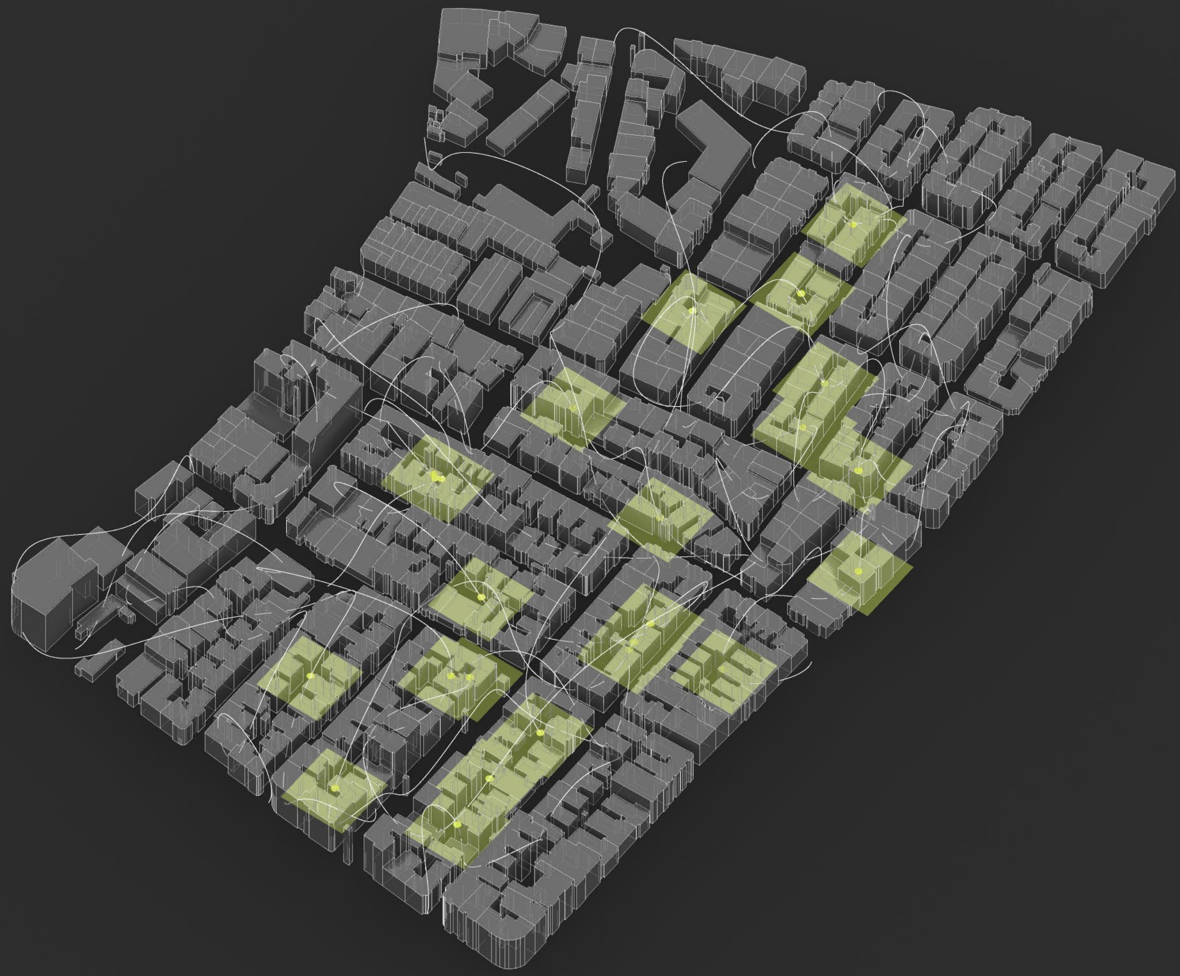
Surfaces of Intersection - Underground Building

Figure 60 | underground building



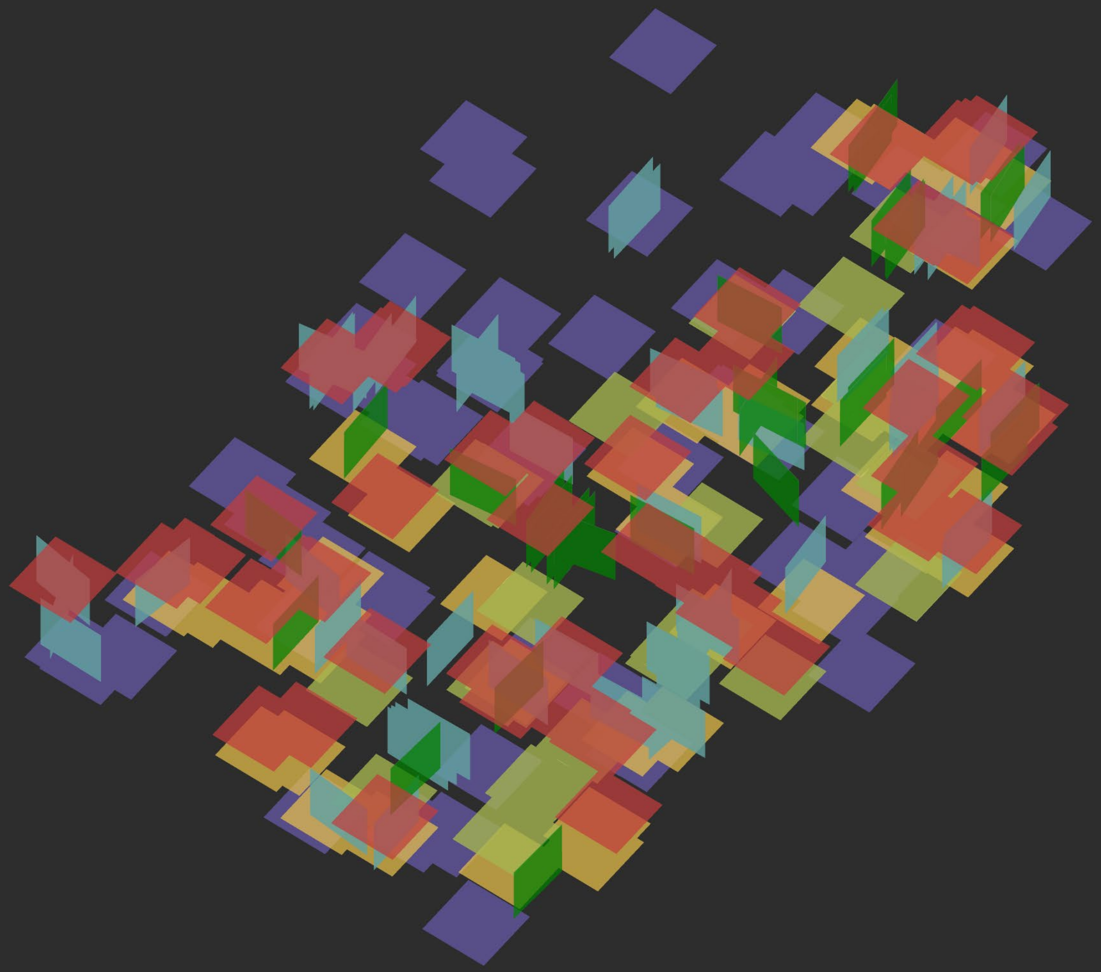
Surfaces of Intersection - Facade Inside Courtyard

Figure 61 | intersected surfaces - facade inside courtyard



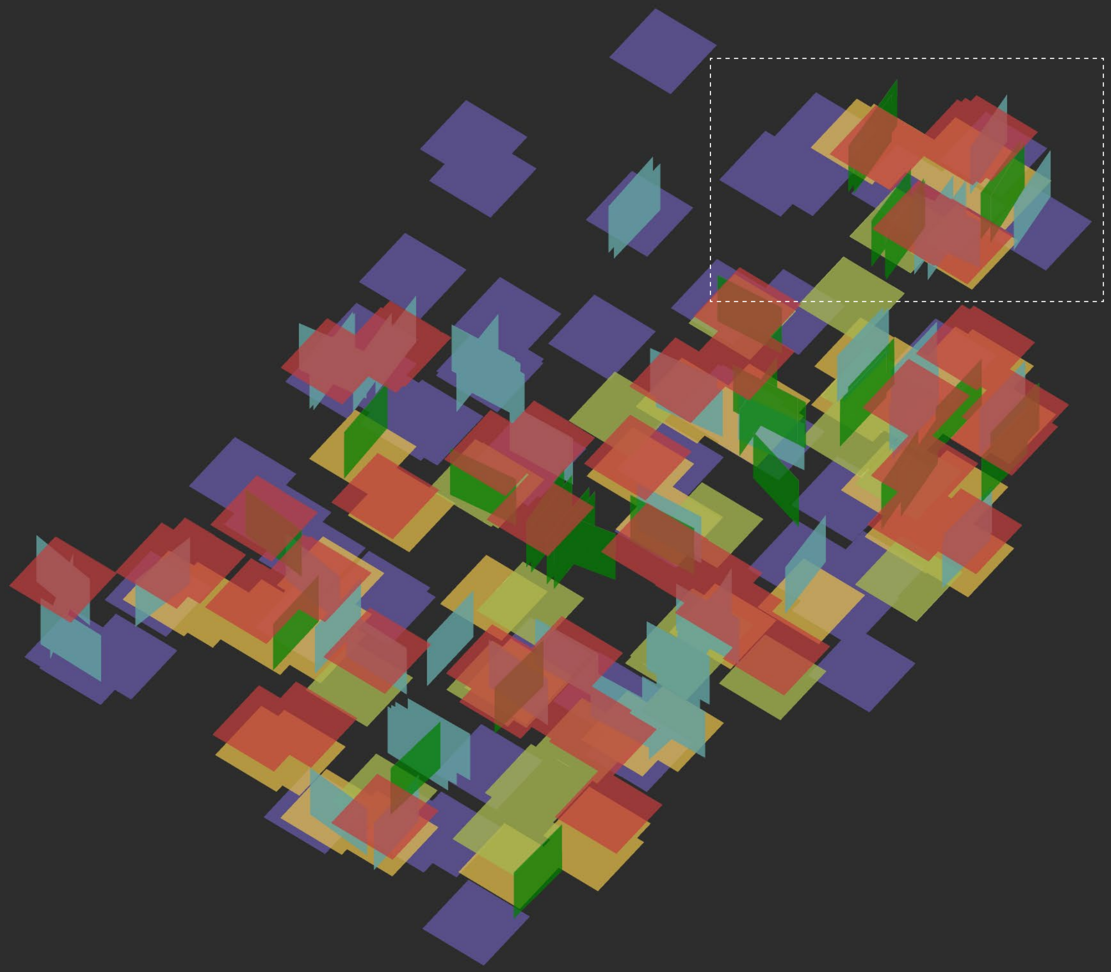
Surfaces of Intersection - Ground Inside Courtyard

Figure 62 | intersected surfaces - ground inside courtyard



Surface Intersections

Figure 63 | intersected surfaces



Area of Intervention

Figure 64 | area of site intervention

Figure 65 | existing site program

biomimicry for ecological solutions in architecture

biology informing architecture

The field of biology seeks to understand the patterns and processes that govern all living things. Biological patterns and processes are incredibly diverse and complex, and many disciplines of biology exist to understand how life works. On a larger scale, evolutionary biology seeks to understand how species originate and how they change over time, while ecology is concerned with broad scale patterns of interactions among organisms and interactions among organisms and their environment (Mazzoleni & Price 26).

The scientific method of study is evidence-based and objective. Scientists make observations and look for patterns in nature. They create hypotheses to explain the findings and make predictions to test the hypotheses. An experiment tests whether the hypothesis is true, and the results must be reproducible with repeated testing. Over time, new observations and experiments either support or refute accepted knowledge, and scientific knowledge is advanced. The scientific method is an iterative process, tested repeatedly all while new evidence in science is emerging, creating an ever-changing knowledge of ideas. In contrast, the design or creative process is a deductive reasoning process, beginning with the knowledge and study of general principles which in turn lead to specific solutions. The building design "emerges in response to the rise of contextual questions and the necessity for a specific population to provide for needs related mainly to function, protection and comfort" (Mazzoleni & Price 28).

biomimicry

Biomimetics is the merging of "biology + technology", mainly used in the field of engineering. Biomimicry is the "process of applying biological principles that underlie morphology, structures and functionality of biological entities to manmade design" (Amer 1). Living organisms are comprised of complex assemblages of material communication systems, synthesizing a relationship with its environment to maintain its basic life functions: nutrition, relationship, and reproduction (Martín-Gómez 1). Biomimicry has been adapted to architecture since the early 2000s, adapting the use of biomimetics to architectural systems. While it's been known as limited imitation of morphological aspects of the biological world, its potential to imitate the functional aspects has been largely overlooked. (Amer 2). The biomimicry approach to architecture has possibilities to study the full capacity of nature, and apply the found knowledge in a systematic way. Nature has been solving many problems for millions of years, and evolved systems of genetic biology that are best suited for given environments. Some scientists consider Earth as a single interconnected ecosystem or biosphere, discouraging smaller views of separate systems. They collaborate in a dynamic,

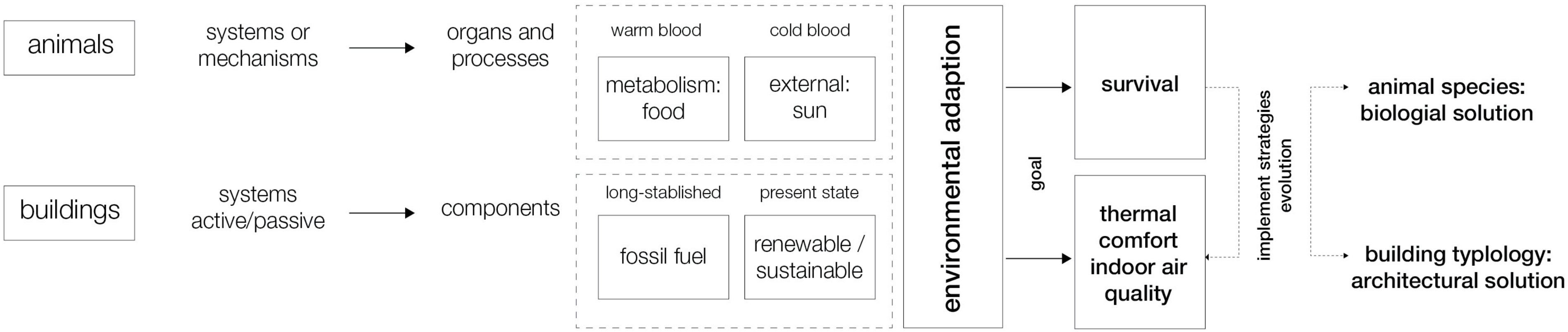


Figure 66 | biomimicry workflow

constant transformation, subject to the laws of physics. (Amer 2). Architecture can be looked at in this same way. The built environment is its own interconnected system of connected parts, that must come together in a productive way. Aiming for zero waste system is proving to be a worthwhile goal but hard to obtain in terms of energy, carbon, waste, and water consumption. Buildings should be aiming to have net positive impacts, being a source of regenerative design, giving back to the environment through the transfer of solutions from biology and ecology into architectural design (Martín-Gómez 1). This way of looking at architecture as a living organism is not only crucial to the health of the building, but the health of the ecosystem it inhabits. The building should be adaptable in its environment, while improving its "capacity for regeneration of the health of ecosystems" (Amer 1).

Biomimicry can often unfairly be associated with simply mimicking the physical form of an organism, becoming a kind of stylistic imitation. However, biomimicry can go far beyond mimicry according to Janine Benyus, the researcher who coined the term. She believes the biomimetic approach "favors ecological performance research and metrics over shape making" (Peters 46). Architects and designers can go beyond the visual aspects of mimicking form and geometry, to a more in-depth approach of studying performative behavior to link knowledge on local ecosystems and their processes. For example, HOK developed an urban design problem in Lavasa, India, dealing with challenges of rainwater management during monsoons. To research possible solutions, the firm took to studying biology on the micro-scale in the local area. They were able to observe the way in which ants create nests within mud mounds that do not wash away with rainwater, along with studying how tree canopies can deflect and filter rainwater. These findings can be translated into usable ecological research measuring the site over time to see how systems relate together in nature.

In order for designers to avoid the stylistic imitation approach, mimicking the forms of organism, designers must use technology. Understanding the technology of natural systems, designers can abstract the concepts and implement them in a problem based and solution-based approach. Through the problem-based approach, designers and biologists can match the identified problem to a living organism that has a practiced solution. This is called 'Design to Biology' (Amer 2). The opposing method 'Biology to Design' involves a solution-based approach in which the biological system informs and inspires design ideas, starting from scientific knowledge instead of a human design problem. The nature of what is happening in biology is abstracted and translated into a design context before any site-specific problem is found (Amer 2).

The concepts of biomimicry can be used in architectural design by considering both the context and function of a building. Architects can learn more about adaption and interconnectedness by learning about ecosystems. This will inspire more focus on the complex interconnected interactions and impact of human behavior and the built environment on the natural world. "Biomimetic designers strive to be more considerate of the environment, to be less invasive and more conscious about the fact that humans live among other components of nature" (Mazzoleni & Price, 29). Architects can also benefit by studying functional adaptions of specific organisms, in response to challenges in their environment. For example, animal skins or membranes could inspire building envelope materials or larger scales can relate to the interrelatedness of ecosystems and urban design of cities. The biological form becomes the basic precept of the architectural study. Biomimicry can happen on three different levels: organism, behavior, and ecosystem. On the organism level, a building can mimic characteristics of a single organism. The behavioral level involves mimicking processes or behavior patterns of an organism and their relationship to a larger context. The third level mimicking ecosystem involves a larger reflection on how many parts are relating together in a greater context. After these levels are distinguished, there are 5 sublevels involving mimicking form, material, construction, processes, and its function (Amer 2). Mimicking the functionality of organisms can solve architectural problems such as how we deal with waste and regeneration, integrating looped lifecycles into architecture itself, just as processes are done in nature. This way of looking at functionality inevitably drives a focus towards sustainable systems.

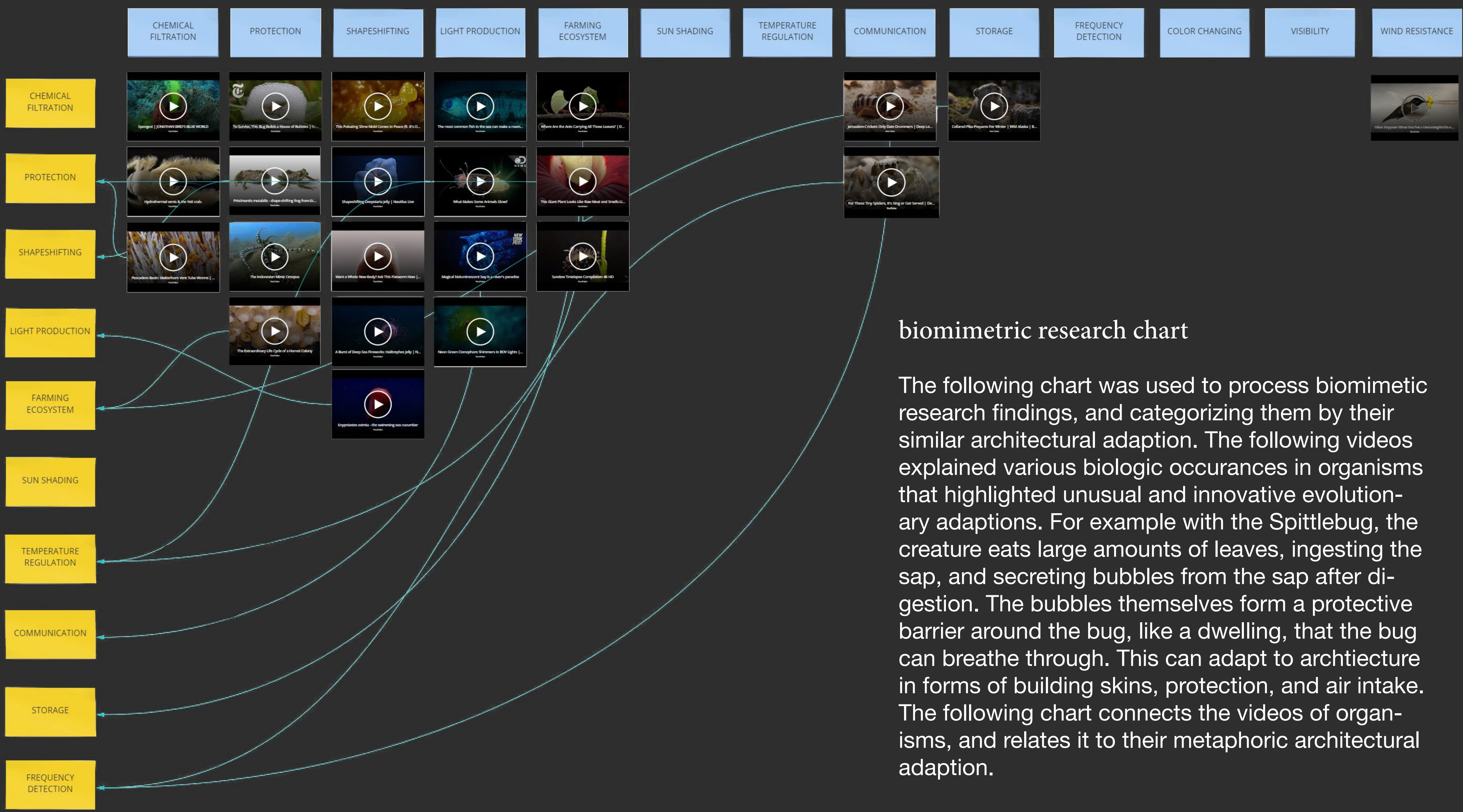
Figure 67 | biomimetic research process. Spittlebug produces spit bubbles for protection and habitat. source: https://www.trending-news-network.com/inside-the-spittlebugs-bubble-home/

biomimicry research

As a biomimetic research process stuying ecological solutions to the environment, I found many informational videos revealing different creative mechanisms in nautre, that could have potential to be translated in architectural means. These videos can be categorized in many different metaphors to the built environment, including chemical filtration, protection mechanisms, shapeshifting processes, light production, ecosystem farming, sun shading, temperature regulation, communication, storage, frequency detection, color changing abilities, wind resistance, and more.

architecutral adaption

biological adaption



biomimetric research chart

The following chart was used to process biomimetic research findings, and categorizing them by their similar architectural adaption. The following videos explained various biologic occurances in organisms that highlighted unusual and innovative evolutionary adaptions. For example with the Spittlebug, the creature eats large amounts of leaves, ingesting the sap, and secreting bubbles from the sap after digestion. The bubbles themselves form a protective barrier around the bug, like a dwelling, that the bug can breathe through. This can adapt to archtiecture in forms of building skins, protection, and air intake. The following chart connects the videos of organisms, and relates it to their metaphoric architectural adaption.

Figure 68 | biomimicry research process

When looking at solving issues of waste in Jaffa, while incorporating regenerative circular systems, it was important to incorporate biomimicry in design solutions for my project. To start my biomimicry research I created a chart to map and tie connections between the biological data and uses in architecture. To do this I created a spreadsheet in which I made columns of the following: Chemical Filtration, Protection, Shapeshifting, Light Production, Farming Ecosystem, Sun Shading, Temperature Regulation, Communication, Storage, and Frequency Detection. Each of these topics I used to classify different functions in the natural world that are also studied functions in architecture, specifically related to sustainability. Finding informational videos of different organisms, I classified the studied behavior and drew connection lines from their behavioral processes to its metaphorical architectural function. From these, I was able to find one mostly relatable to my project, that being the leatherback sea turtle, specifically its mechanism of thermal control.

Leatherback Sea Turtle - Environmental Control

One of the issues I focused on solving is climate control within a building, controlling indoor temperature and humidity, to respond to the changing outdoor weather conditions. The goal is to do it in a sustainable way, using renewable resources. In order to study how it is done in nature, I researched cold blooded animals that have adapted through evolution to their changing environments.
Animals have several ways of dealing with environmental control. Allen's rule states that body shapes in animals will adjust to climates as to minimize surface area in cold climates (endotherms) in order to minimize heat loss and to maximize surface area in warm climates in order to increase heat loss (ectotherms) (Martín-Gómez 19). Homeotherms are a type of animal that keep a constant body temperature though metabolic activity, while poikilotherms vary their internal temperature depending on their environments. Buildings can also vary depending on their use, some which have discontinued use and can be turned off, and others like hospitals which require a constant temperature all the time (Martín-Gómez 20). Since my building deals with different temperatures inside one building, while outside temperatures are fluctuating, it must be held entirely constant without regard to its environment. One animal that has a unique way of regulating temperature is the leatherback sea turtle.

Leatherback sea turtles have evolved in unique ways to allow them to search for food in great depths, at ranging temperatures. They prey on gelatinous plankton which live in great depths, while maintaining core body temperatures as the water gets colder with depth. (TB 3340). To allow this, they have several adaptive functions, including changes in their tracheal structure in response to pressure changes of diving and exposure to cold. (Davenport 3340). The structure of the trachea is unique in that it is composed of an elliptical tube of continuous cartilage, that is easily compressible as pressure increases at greater depths of pressure underwater (Davenport 3345). The trachea is also lined with “dense erectile vascular plexus that will warm and humidify cold inspired air and possibly retain heat on expiration” (Davenport 3340). This vascular plexus is lined with connecting blood vessels within the mucosa that function to retain heat and maintain body temperature (Davenport 3345). This process is similar to veins found in human nasal mucosa, responsible for warming inspired air. The blood vessels increase the blood flow around the trachea when diving, when the warming function is necessary. The vascular lining functions alongside the nasal blood vessels so that as altitude increases, the turtle will breathe in air of much lower temperature than its core, it will move along the mucosal vascular plexus in the trachea, warming progressively along a thermal gradient (Davenport 3346). It is believed the mucosal layer is an adaption to then reinflate the collapsed trachea after dives, as these two systems work in sync to allow for maintenance of respiratory temperature and water balance (Davenport 3346).

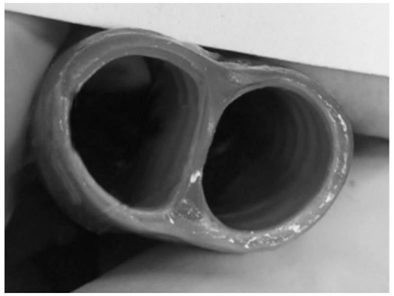



Figure 69, 70 | leatherback sea turtle trachea lining. cross section. side view. source: http://seaturtle.org/library/DavenportJ_2014_JExpMarBiolEcol.pdf

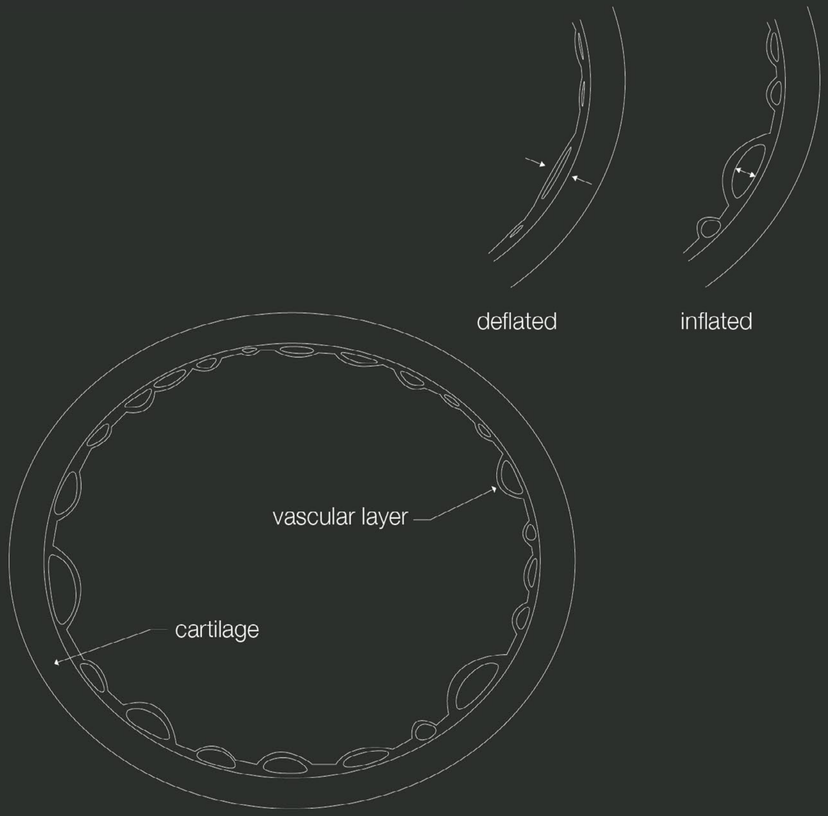
ETFE Pillows

In buildings, often the largest source of energy consumption comes from lack of thermal comfort and low efficiencies of HVAC systems (Shahin & Samir 346). Using high performance passive design strategies that incorporate integration with natural daylighting, shading, and ventilation systems has the possibly to notably decrease energy usage in the building through its adaptive and intelligent building skin. Different ways in which a building can respond to climate control within a building are (1) permitting natural light to penetrate into spaces; (2) stopping undesired solar heat gain to enter spaces; (3) preventing heat transference due to insulation; (4) blocking air and moisture from entering the building; (5) permitting natural ventilation to enter, enhancing room temperature and air quality (Shahin & Samir 346). Many of the concepts mentioned are studied in biomimicry though different processes in nature, offering different solutions to adaptive, intelligent building skins, creating a dialogue between the building and the environment in real time.

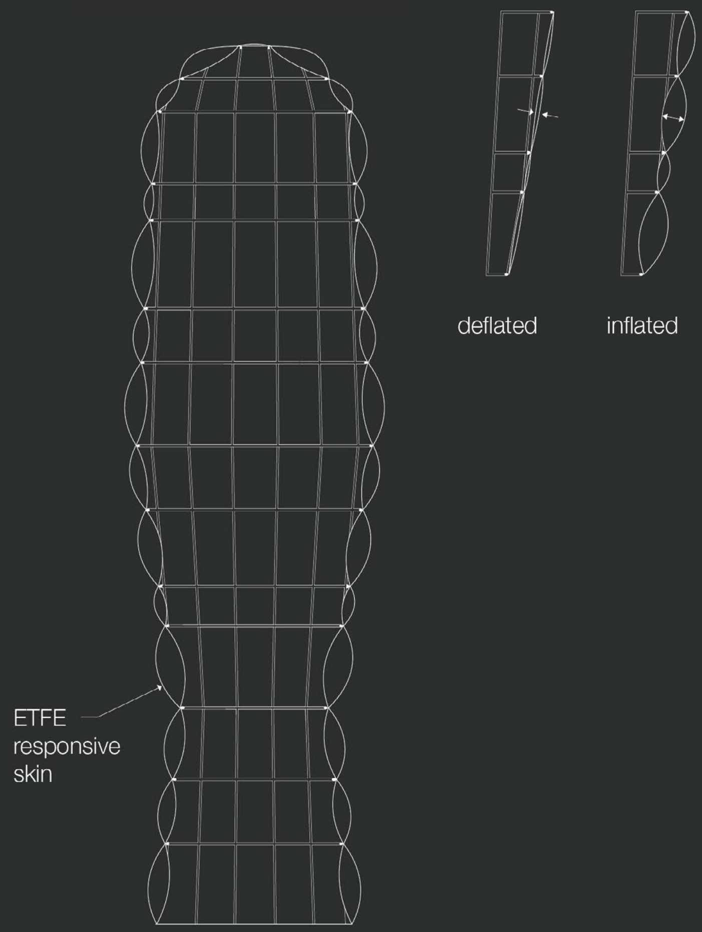
From studying the thermal control of the leatherback sea turtle, I was able to pull design concepts to help problem solve controlling environments in architecture. Through studying architectural methods of inflation/deflation, plastic linings, and humidity retention, I came to a design concept of incorporating Ethylene Tetra Fluoro Ethylene (ETFE) pillows as an outer skin of my building. These pillows have air chambers that have sensors, allowing them to contract and expand, inflating and deflating due to the amount of sunlight that hits them. This will then adjust to allow for a temperature controlled interior environment. The membrane also acts as a sunscreen, filtering UV rays by 85% (Zimmer). The filter is created by the inflation of a Nitrogen mix, blocking the rays and acting as a cooling mechanism. To reverse this process and allow for heating, in the winter. The membrane opens to transmit heat and light (Zimmer). It is a translucent polymer, offering a better solution to glass, as it allows more daylight transmission and greater insulation. It also costs and weighs less, and is a more flexible material (Shahin & Samir 349). It is triggered by pneumatic mechanisms with light sensors that activate automatically independently the processes of inflation and deflation through synchronized air chambers (Shahin & Samir 349). The pillows have three layers, with 2 different air chambers, to adjust air and sunlight penetration independently, all thought adjusting to the outdoor environment to achieve energy efficiency. Air in between these layers creates a temperature gradient across the air chambers, through both convective and radiant heat transfer, enhancing and adjusting thermal performance of the building. In Arup's design of the National Aquatics Center in Bejing, the facade was made entirely of ETFE pillows, saving more than half of energy used on lighting due to natural daylight intake (Figure 73). It also recycled water through catch systems in its roof, providing water for the pool systems, and distcharging it back into its connected suage system.

This performance of the ETFE pillows mimic the inflation and deflation of the cartilage in the trachea of the sea turtle. The veins in the mucosal layer are pumping to retain humidity and heat in the body, causing a temperature gradient as air moves to the core. Just as the veins pump blood, the air chambers pump Nitrogen into the pillows, creating a temperature gradient across its chambers, adjusting to effect thermal conditions. While heat may be from different sources, the turtle from the blood vessels, and the cushions from the solar and radiant heat transmission, both systems are working in sync to control and maintain optimal temperatures, as outside factors are in flux. In my design I chose to mimic the tracheal structure in creating column totems of enclosed biomes, lined with ETFE pillows as the adaptive envelope.

Figure 71 | ETFE pillow facade. Bejing National Aquatics Center by Arup, 2008. cross section. source: http://www.etfe-cushions.com/sell-translucent_etfe_cushion_fa_ade_triple_layer_etfe_pillows_etfe-2117959.html



Leatherback Sea Turtle- Trachea Lining



Indoor Totem Biome - Performative Skin

→

Biomimetic Proccess Adaption

Figure 72 | biomimicry adaptable skin solution

bioclimates -
controlled environments

biomes

In order to educate the people of the community about these emerging sustainable technologies and ways in which we can respond to the environment, it is important to demonstrate environmental control capabilities by creating different types of climates. This inspired the idea of creating multiple different climates inside the same building. Each totem is its own biome, with a unique climate, functioning and sustaining its own type of habitat and vegetation inside. This creates a performative, immersive park experience of different climatic senses.

A biome is defined as “an area of the planet that can be classified according to the plants and animals that live in it. Temperature, soil, and the amount of light and water help determine what life exists in a biome” (National Geographic Society). Biomes encompass climates that migrate and change over time, offer different seasons, and conditions of temperatures, humidity, light, etc. The different biomes and their proportion of earth’s terrestrial area are pictured (Fig X). Architecturally, recreating a specific biome indoors requires a highly controlled used of parameters, adhering to these different temperature, soil, light, and water conditions. Creating these biomes in my project is the performative measure used to demonstrate the optimization of climate control and energy usage. Establishing a closer relationship with the built environment and the natural world is needed to address the health of the planet.

Climate consists of characteristics such as temperature, sunlight, precipitation and wind, throughout the seasons in a region. Weather encompasses the same characteristics over a shorter time frame or at a particular point in time. Global climates are affected by the earth’s shape, orientation and position relative to the sum. Regional temperature is affected by the the angle of sun exposure, and distance from the sun. The equator, being nearer to the sun, receives more solar radiation than the poles, where sunlight travels farther to reach the surface, allowing for the driest areas closest to the equator. Precipitation is influenced by cycles of air movement. Warm air is less dense, and rises. Sunlight warms the air and evaporates water at the equator. The warm, moist air rises, cools and condenses, then falls as precipitation. As the earth rotates, it creates air currents to the north and south, and cycles of evaporation, condensation and precipitation. The equator receives the most moisture, and regions 30 degrees latitude, to the north and south, are the driest. Ocean currents affect both water and air temperature. These currents are influenced by air circulation, the earth’s rotation and the amount of solar radiation, creating cycles of evaporation, condensation, and precipitation. These factors are in constant flux and these patterns create distinct and varied climates in different ecosystems. Biomes contain distinct communities of animal populations that have evolved to thrive in these specific climates. As climates change over time, so do the animal populations (Mazzoleni & Price 35).

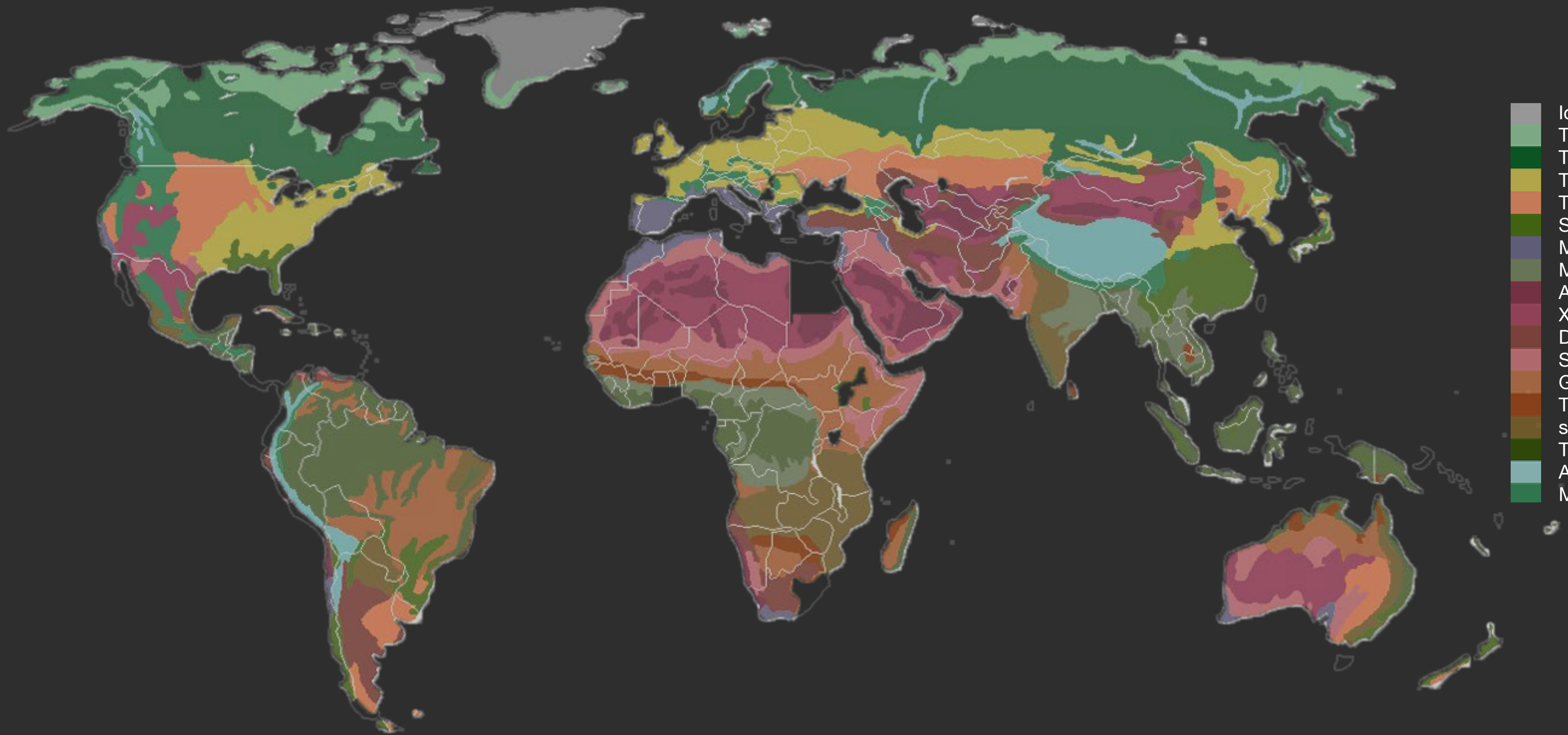


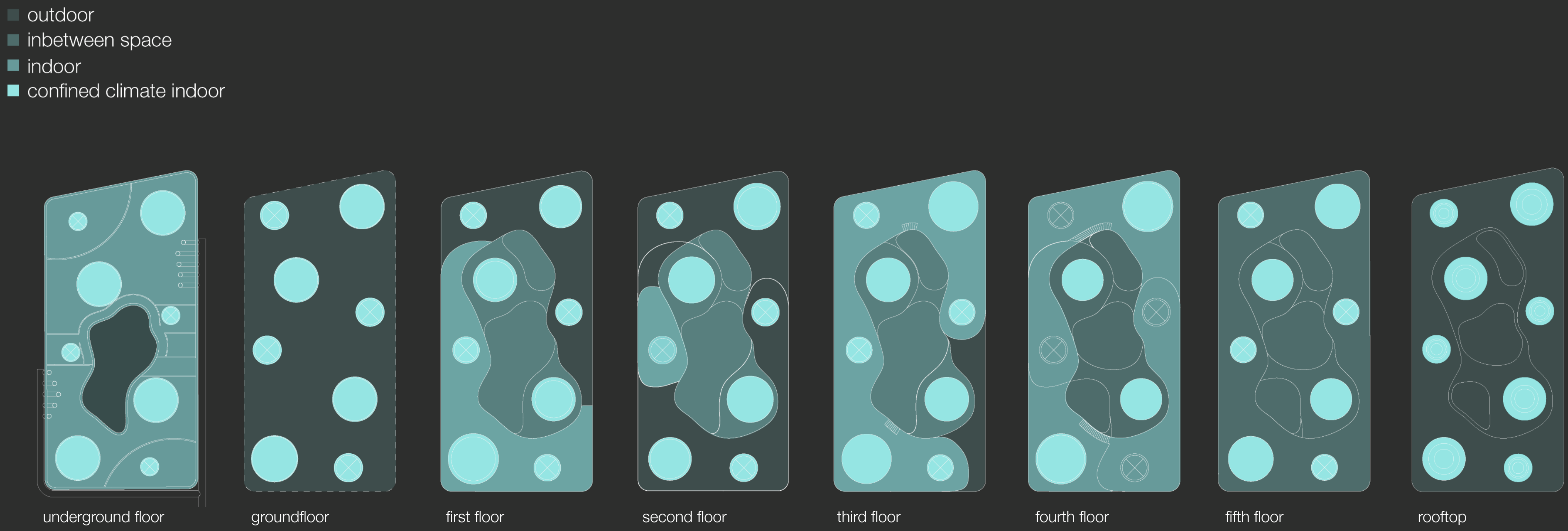
Figure 73 | biome world map

biodiversity

Biodiversity is the range and variety of species in a particular region. Ecosystems include the organisms and physical conditions in a given area functioning as a given unit. Biodiversity is essential to maintain stability in an ecosystem. Ecosystems may have great biodiversity, as in the rainforest, or little biodiversity, as in the tundra with sparse amounts of species (Mazzoleni & Price 36). Human activity is disrupting biodiversity and function in ecosystems at a high level. Examples of this include destruction of habitat, climate change and introduction of foreign invasive species. The resultant loss of any species disrupts an ecosystem. This can adversely impact the resources that humans and other organisms depend on in these ecosystems. Protecting biodiversity maintains the resilience of valuable ecosystems and protection from mass extinction (Mazzoleni & Price 39).

indoor biome

Evolution occurs everywhere in nature, evolving species of different climates, proving the Darwin theory of natural selection even in domesticated plants and animals. As the world is urbanizing, we turn our attention to how humans form habitat, focusing on addressing a new type of biome, the indoor biome. Estimates show residential and commercial buildings are occupying 1.3% to 6% of global ice-free land area (Martin et al. 264). As climate changes are occurring such as flooding of grasslands and shrinking of tropical rainforests, the indoor biome is growing rapidly, as geographies are getting more densely packed with indoor spaces. This growing field of environmental research turns to integrating humans into the evolutionary study of biology, ecology, anthropology, and building sciences, as we have a vital role in the ecosystem concept (Martin et al. 264). While humans initially designed buildings to fit into their surrounding climate, many adaptions in technology have allowed for a different relationship with houses and their environment, resulting in similar style homes facing contrasting outdoor conditions. Much of this is a result of changes in indoor plumbing, electricity, air conditioning, ventilation, and insulation systems. However, alongside is a growing narrative of designers to get back to a localized relationship with its surroundings, adapting modern and historic ways of building, with great diversity of conditions (Martin et al. 264). Many studies suggest our own human behavior effects the evolutionary trajectories of the biome itself. The indoor human biome is one which is largely affected by aspects of human culture, how they see germs, and pollution, and the type of actions taken to create a type of indoor ecosystem within spaces. Culturally these visons of 'cleanliness' can greatly differ, causing contrasting conditions in which different microscopic species inhabit. Theory also suggests different types of spatial arrangements can create different densities indoors, which can impact the evolution of species. This includes relationships with the outdoors, and regions that may act as a buffer between indoor and outdoor, all curating a different type of climate to persist among buildings. Biogeographical patterns have been identified among bacteria in residential kitchens for example, where inhabitants can drastically alter the microbiome in a matter of days (Martin et al. 226). The influence of human behavior and architectural decision creates an entirely designed ecosystem indoors. As indoor spaces are increasing, research and education on this evolutionary biome is important as humans adapt to changing conditions.



Outdoor/Indoor Spatial Relationships

In order to test out different bioclimates through creating controlled biomes in the building, I designed a spacial organization with clearly defined separations of indoor and outdoor relationships. This ranges from outdoor, to inbetween buffer space, to indoor, to confined indoor climates, that area controlled through environmentally responsive systems. To create these different experiences of space, I arranged the 'totem bioclimates' on a free plan, like trees in a forrest. Outside the confined bioclimates are the three different areas of outdoor, indoor, and the buffer space, which is a sheltered space with open air. These varying conditions show the complexity of the building, like an organism, with its different funcitoning chambers. Users can experience the wide range of experinces of space, in a controlled, systematic manner.

Figure 74 | indoor / outdoor space diagrams precedent

Toyo Ito -
Sendai Mediatheque

Figure 75 | Toyo Ito, The Mediatheque, an electronic library in Sendai. photo: Naoya Hatakeyama. source: https://medium.com/@Steve1996/floating-object-46751c4f1a64

Sendai Mediatheque is a cultral media center designed by Toyo Ito & Associates in Sendai-Shi, Japan in 2001. It is a center completely transparent to the surrounding city of Sendai, a staple of revolutionary architecture in its engineering an its aesthetic. The light and trasparent building has ethemeral qualities, linking with the nature of its surroundings.

The building is described as being prototypic and conceptual rather than formalistic. The design is composed of three elements, plate, tube, and skin. The plates are the six steel-ribed slabs, appearing to float as they are only suppored by the vertical tube elements, that being the structural column lattices, giving it is characteristic image of a forrest. The columns are organized in a free form plan, independent of the facade, as they fluctuate in diameter stretching from floor to floor, independently supporting the strucutre of the building. These columns not only function as the stucture, but also work as light shafts, storage, circulation, and technical systems. The third element skin is the double-skinned glass facade wrapping around the building. The simple concept allows for an impactful visual while also functioning to incorporate complex information systems inside the building.

The building's purpose is to provide a large space for the community to meet an gather around mixed medias. The ground floor is a double height plaza, serving to hold a cafe, retail shops, and large spaces for events and screenings. The upper floors include a multimedia library, a cinema, and flexible exhibiton spaces with moveable walls.

The technical systems incorporated in the building support the idea of being in psync with nature. The functionality takes a biomimetic approach, comparing the systems to biological activities of a tree. The air conditioning systems have equimptment on the rooftop and basement, with connecting tubes in the columns. This mimics elements in nature using photosynthesis to obtain and produce energy in the roof and the roots, and to allow the energy to flow through the trunk of the plant. The air is let into each floor though ducts near the floor surface. Light filtering in from the rooftop through an optical mechanism, and transmitted down the columns through an optical reflection sheet inside the column tube and then diffused into spaces by means of prisms and lenses. The system incorporates an integration of natural and artificial light with arrangements made inside the tubes, and adjusting color temperatures of the mixed light for optimal brightness throughout the day. This is an intelligent, environmentaly respnsive use of natural light, saving on energy and creating an ambience of nature inside the building. All of systems work in coordination like a hightly functional natural organism.

In an intervew on Designboom, Toyo Ito shares his theory on his essay regarding 'architecture in the electronic age.' He shares how the electronic age is a configuration of information from the primitive age.

“The human body has been linked with nature as a member in which water and air circulate. People today are equipped with an electronic body in which information circulates and are thus linked to the world through networks of information by means of the body. This virtual body of electron flow is drastically changing the mode of communication in family and community, while the primitive body in which air flow, still craves for beautiful light and wind. The biggest challenge for us is how we can integrate these two types of body. The same applies just as well to architecture today. Our architecutre has traditionally been linked with nature through figuration of movements of vortices occuring in water and air. With contemporary architecture, we must link ourselves with the electronic environment through figuration of information vortices. The question is how we can integrate the primitive space linked with nature and the virtual space which is linked with the world through electron network. Space which integrates these two types of body will probably be envisaged as an electronic biomorphic one. for, just as the figure of a living body represents the loci of movements of air and water, the virtual space will most likely be figured as the loci of human activities in the electron flow” (designboom).

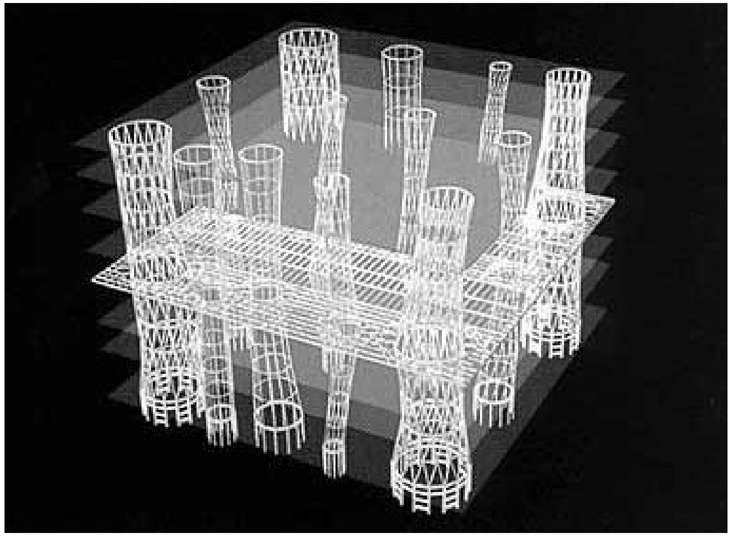
Through connecting back to nature, Toyo Ito compares man to ‘Tarazan.’:

“Tarzan in the jungle creates his body and develops it in contact with nature, in relation to the surrounding environment. Modern man is a sort of tarzan who lives in the world of media, within a very developed technology. Architecture should be a sort of media-clothing, which is necessary in order for man to have a relationship with and integrate himself into the environment. The idea of media-clothing is a metaphor. (laughs). In 1960s, m. mcluhan said that our clothing and shelter are the extended form of our skin. From old times, architecture has served as a means to adjust ourselves to the natural environment. The contemporary architecture needs to function, in addition, as a means to adjust ourselves to the information environment. It must function as the extended form of skin in relation both to nature and information at once. architecture today must be a media suite. people, when clad in a mechanical suit called automobile, had their physical body expanded. People clad in a media suite have their brain expanded. architecture as media suit is the externalized brain. in the whirlpool of voluminous information, people freely browse through information, control the outside world and appeal themselves to the outside world. Instead of appealing to the outside world by armouring themselves with a hard shell-like suit, people do so by wearing a light and pliant media suit which is the figuration of information vortex. People clad in such media suit are the tarzans in the media forest” (designboom).

While looking to incorporate the same relationship with the environment as did Toyo Ito in his desing on the Sendai Mediateque, I looked to deconstruct the design, and adapt its central elements to the site in Jaffa. While many components are inspired by Toyo Ito, after research and analysis on the site in Jaffa, many elements where changed to deepen the intended intervention specific to the site of Florentin. In this project I will break down different approaches to how Toyo Ito looked at architecture in the design of the Mediateque and reveal differences in how I incorporated the concepts.

conceptual scheme

The design is composed of three elements, plate, tube, and skin. The plates are the six steel-ribed slabs, appearing to float as they are only suppored by the vertical tube elements, that being the structural column lattices, giving it is characteristic image of a forrest. The columns are organized in a free form plan, independent of the facade, as they fluctuate in diameter stretching from floor to floor, independently supporting the strucutre of the building. The third element skin is the double-skinned glass facade wrapping around the building. The simple concept allows for an impactful visual while also functioning to incorporate complex information systems inside the building.



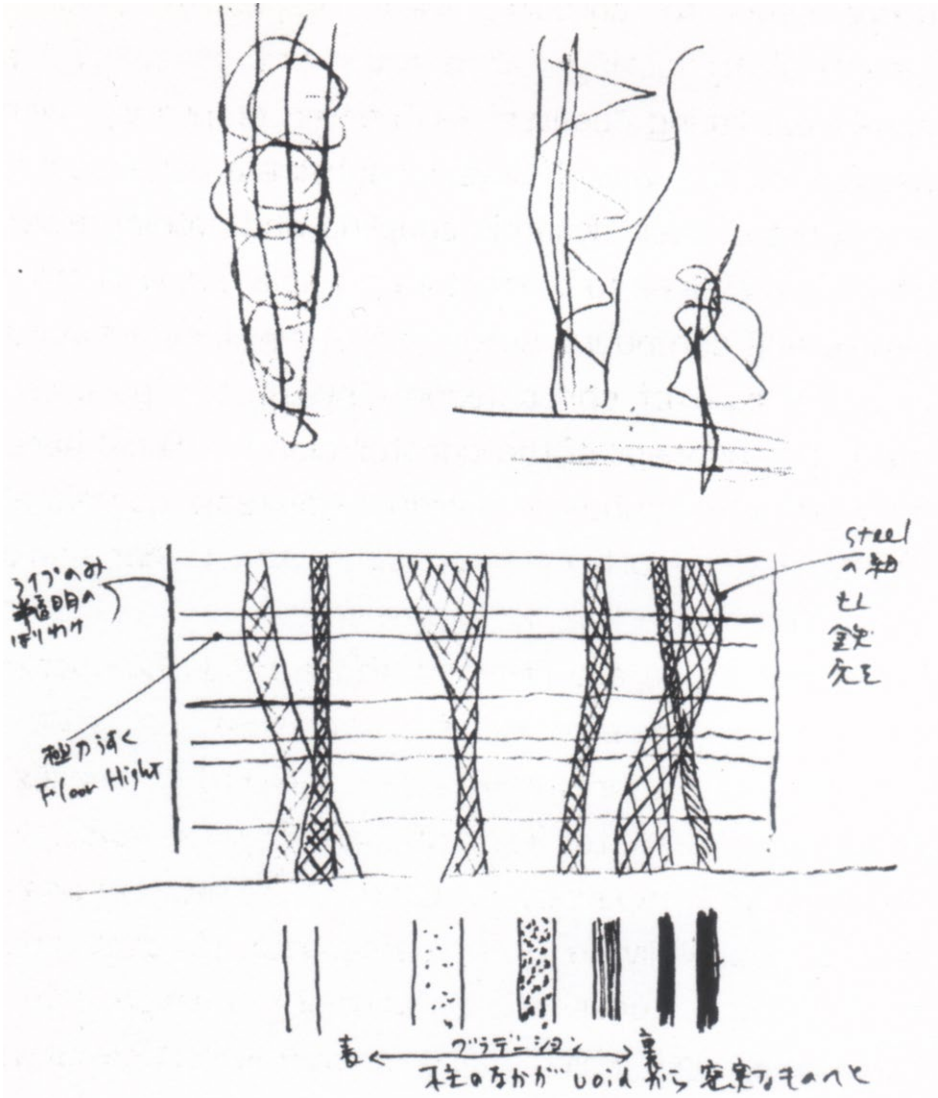


Figure 76, 77 | building scheme. source: https://www.archdaily.com/118627/ad-classics-sendai-mediatheque-toyo-ito. building diagrams. source: https://www.designboom.com/architecture/toyo-ito-designboom-interview/

technical scheme

These columns not only function as the stucture, but also work as light shafts, storage, circulation, and technical systems. The systems may be compared to the biological activities of a tree. Machine spaces for air-conditioning systems are located on the rooftop and the bottom floor and are communicated with each other by the tubes penetrating the plates. Just as various elements produced by photo-synthesis and the nuturients absorbed by the roots from the soil flow inside the trunk of a plant. Various forms of energy produced in the machine spaces at the top and the bottom flow inside the tubes. Air flowing is released into the spaces by air inlet duct near the floor surface. The column trees of the building also serve to transport people, by means of vertical circulation. Several elevators and stair shafts are used as shafts between the open floor plans. Mechanical technologies are combined and integrated at different levels to make the building as a whole an organic and functional structure.

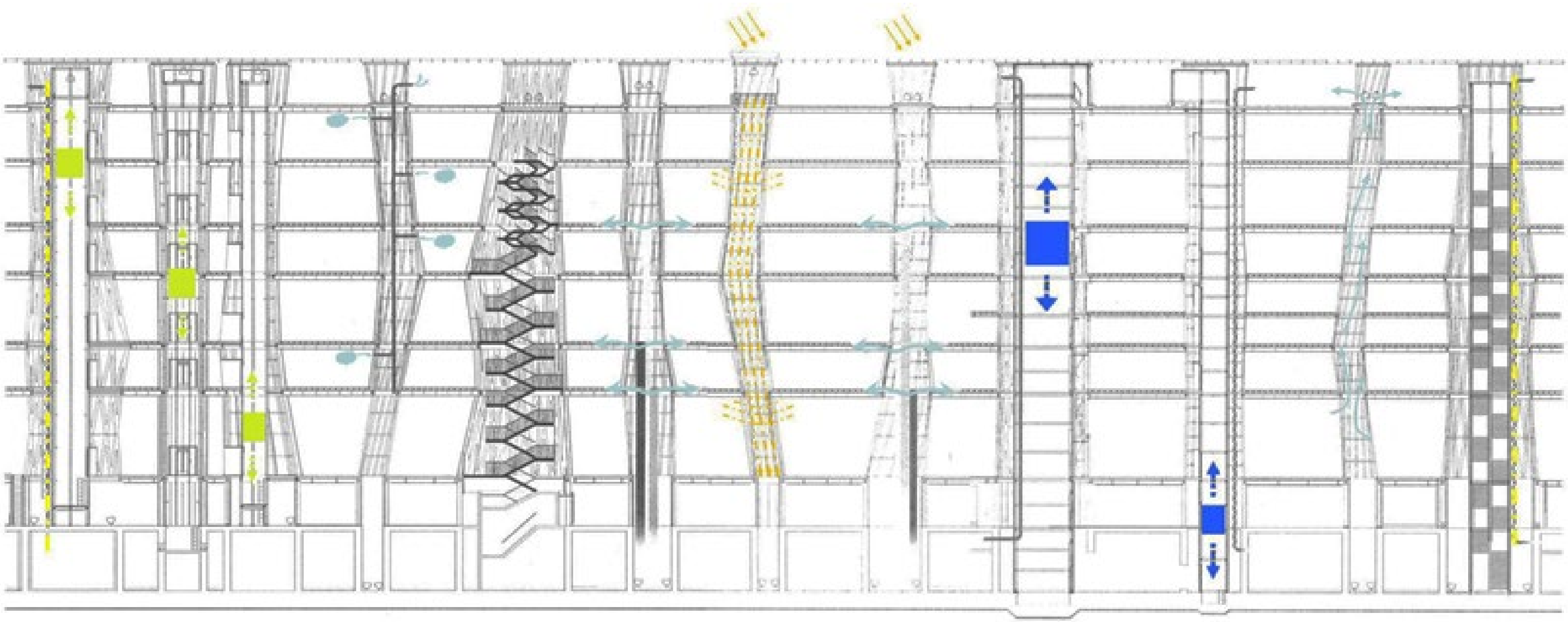


Figure 78 | technical scheme. source: https://en.wikiarquitectura.com/building/sendai-mediatheque/

lighting scheme

The tube also acts as an effective device to introduce natural light into the building. Natural light is effectively taken into the building by means of an optical mechanism provided on the rooftop, transmitted downward by a reflection sheet inside the tube, and diffused into the inside spaces on each of the floors through prisms and lenses. Artificial lighting means are also arranged inside the tube. The color temperatures of natural and artificial lights are mixed to adjust the brightness. During the day, an environment is created where the abundant natural light and man-made light coexist. These devices are promising as the first step toward positive utilization of natural light.

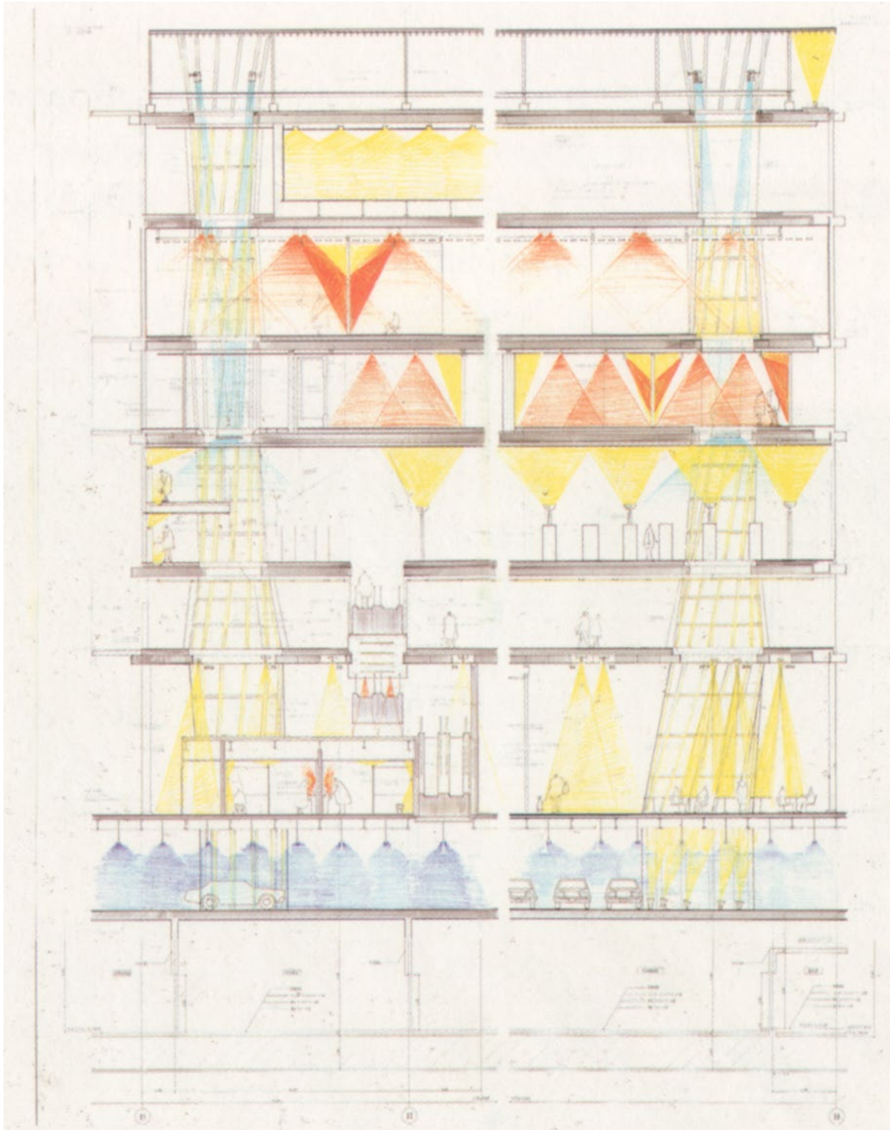
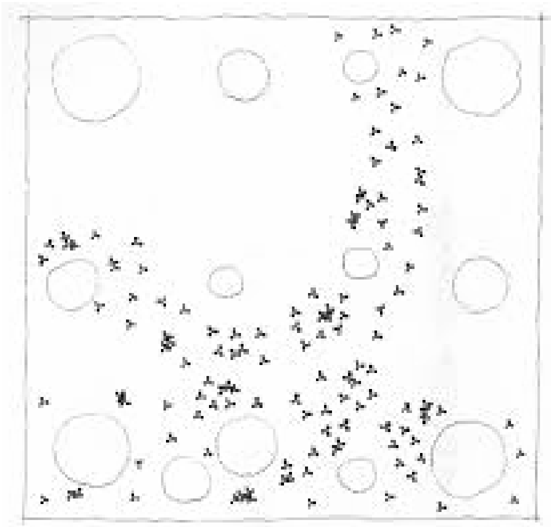


Figure 79 | lighting scheme. drawing by Kaoru Mende. source: https://kmckitrick.wordpress.com/sendai-mediatheque-toyo-ito-kevin-mckitrick/

circulation scheme

The circulation mimics nature in its free open floor plan scheme. As the columns are like trees of a forrest, the layout is on a proportioned grid, but doesn't stick to rigid alignment. Surrounding the circular lattice colums is free open space without wall divides. This allows for flexibility in movement of people, while accomidating for a multitude of different programatic functions.



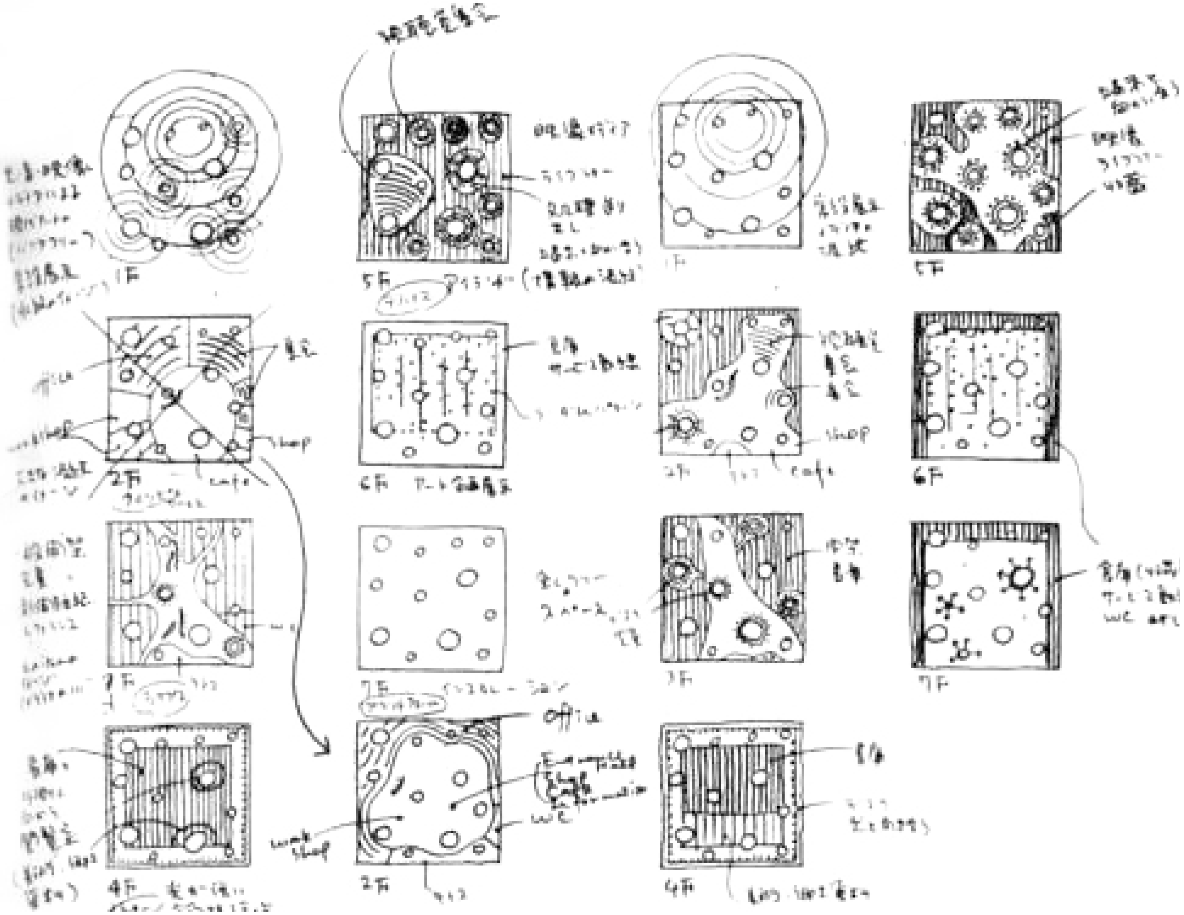


Figure 80, 81 | circulaiton scheme. drawing by Toyo Ito. source: https://www.designboom.com/architecture/toyo-ito-designboom-interview/ circulation sketches. drawing by Toyo Ito. source: https://www.pinterest.com/pin/413627547000675895/

barrier scheme

The double-skinned facade on the south facing the main street breathes like the human skin. During summer, the upper and lower opening mechanisms are released to generate ascending air current inside the double-skinned wall to cool the wall surface temperature to thereby reduce the need for forced air conditioning. During winter, the opening mechanisms are closed so that the double-skinned wall can function as a highly insulating layer of air. This skin is not only a barrier for thermoregulation purposes, but it becomes a separation from the external city of Sendai to inside the mediatheque. This barrier performs a kind of commincation and translation process from the outside environment, to the people of the building. Various types of barrier in today's society define the form of architecture. A barrier exists between the administrator of a building and its users, Between private and public spaces, between archetypes in different genres such as library and museum, between foreign languages , and between different media such as visual images and printings.

Figure 82 | Sendai Mediateque. photo by Rasmus Hjortshøj - COAST source : https://divisare.com/projects/322293-toyo-ito-associates-rasmus-hjortshoj-sendai-mediatheque

programatic scheme

A new era of the digital age has produced new medium, of mixed electronia media. Mueseums and libraries should reflect the changing medium of our time. The following mediatheque establishes and archetypal presence showing off media such as CDs, CD-ROMs, and video tapes. Media types of previous generations such as books and paintings will also be displyed, and ranked with no hierarchy. Museums will be turned out of date, as new ways of enjoing images will take over existing, via the mediatheque. It will be a convenience store of media showing cultural phenomena. This new form of convenience store should not be placed like a monument in the city, but rather a trainstaion, accessable for the whole public to consume.

Figure 83 | Sendai Mediateque. photo by Rasmus Hjortshøj - COAST source : https://divisare.com/projects/322293-toyo-ito-associates-rasmus-hjortshoj-sendai-mediatheque

scheme with nature

The mediatheque's central theme is that architecture plays a pivotal role in re-connecting nature and humans so they can live resiliently and sustainably. In order to connect the relationship to sustainability, we must spacially connect architecture with the environment, in terms of indoor and outdoor relationships. When dealing with inside and outside in architecture, there are usually only two options: divide or connect… Japanese traditional architecture connects inside and outside, and European architecture divides inside from outside, but Ito actually reverses inside and outside. This reversal is uncharted territory in architecture. In Ito's architecture, inside can be outside, and outside can be inside.

Figure 84 | Sendai Mediateque. photo by Rasmus Hjortshøj - COAST source : https://divisare.com/projects/322293-toyo-ito-associates-rasmus-hjortshoj-sendai-mediatheque

design

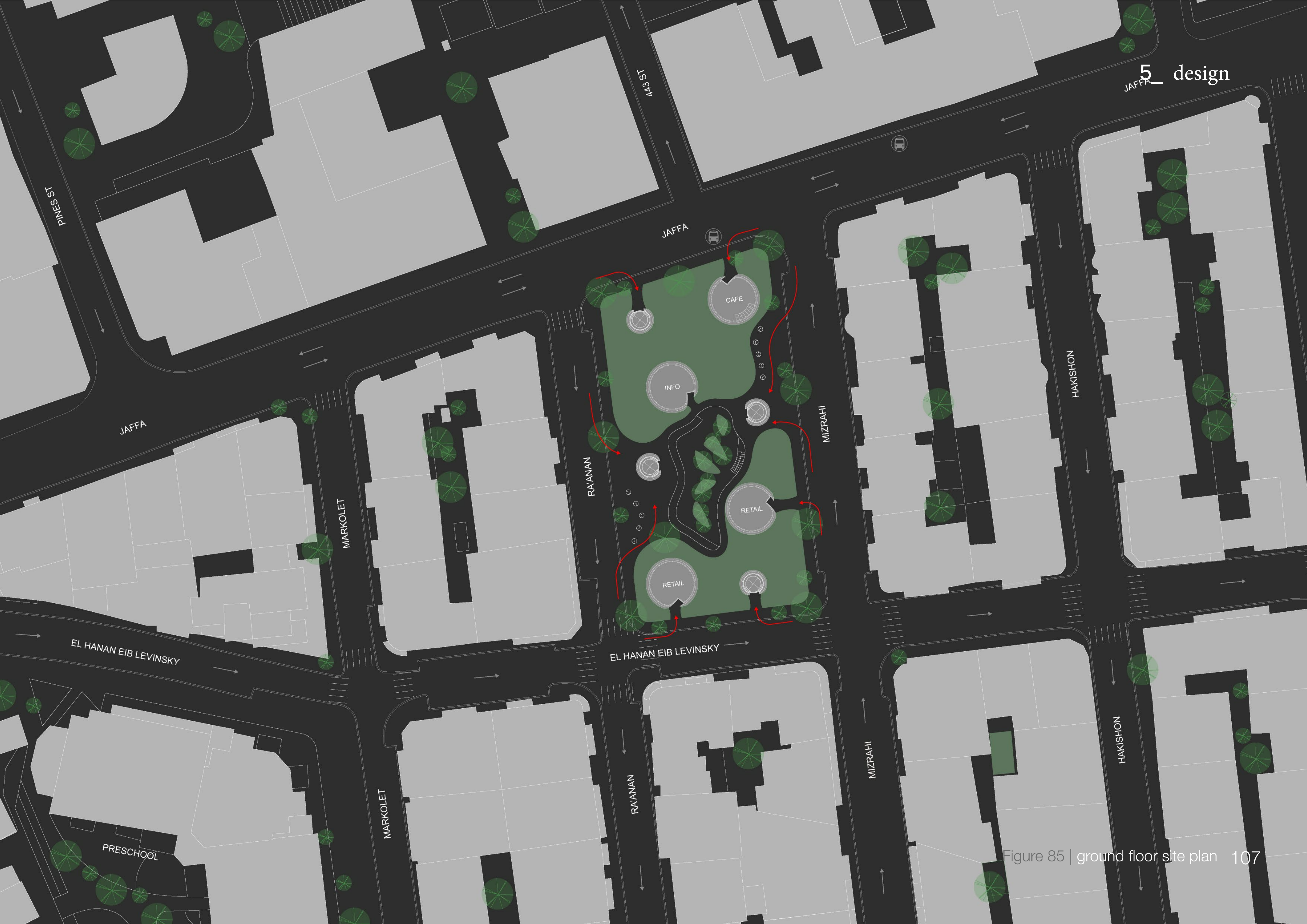


Figure 85 | ground floor site plan

Figure 86 | site elevation

Program

- tropical rainforest biome
- mediterranean biome
- temperate forest biome
- arid desert biome
- retail
- information
- cafe
- meeting/working
- event space
- library
- art gallery
- bathroom
- rainwater recycling
- trash/recycling system

The program is designed as an environmental center for Florentin. It is a park space, that inclues indoor and outdoor climates, ranging form Tropical rainforest, mediterranean, temperate forest, and arid desert biomes. The circulation occurs vertically through these totem strucutres, with interior stairs, along with vertical shafts for elevators. The groundfloor functions like many of the blocks in Florentin do, serving as retail and cafe, along with an information center for the building. Librarys, event spaces, and galleries are used to project information on the environment of the time though discussions and events. It is also a point of trash collection with the underground pneumatic system, and a community spot for people to gather in central spaces.

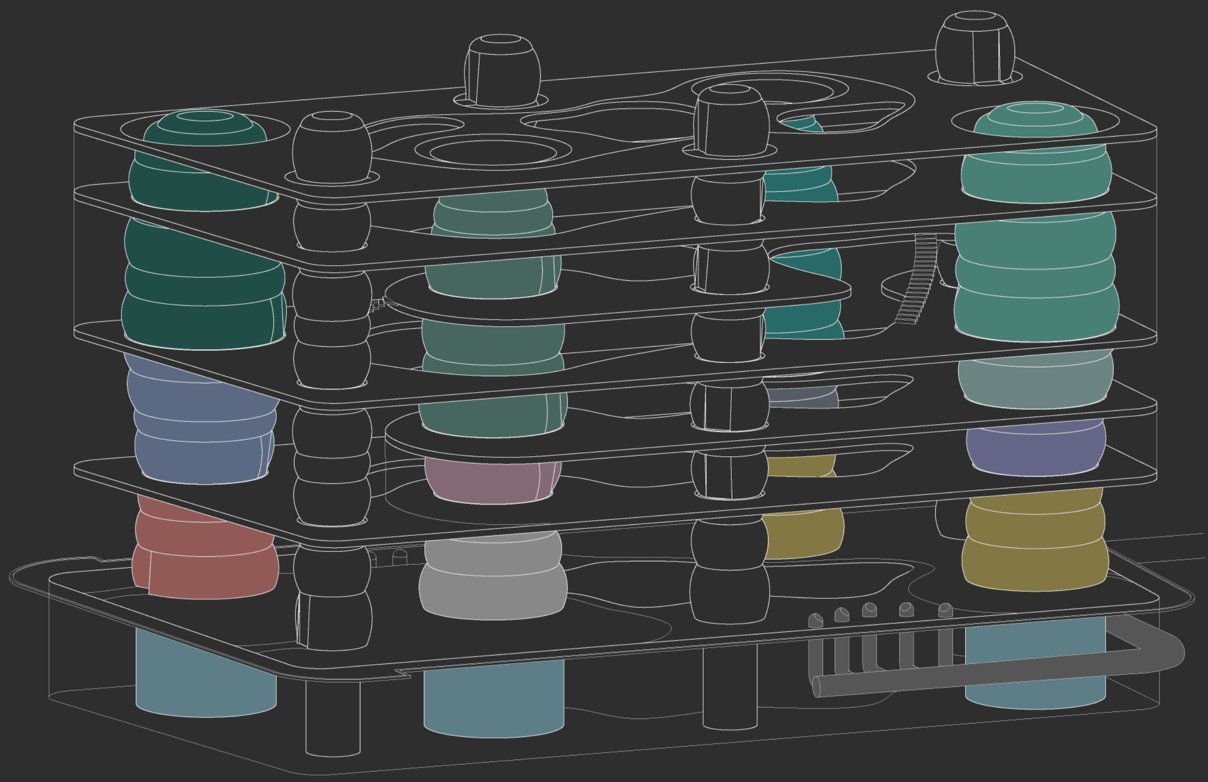
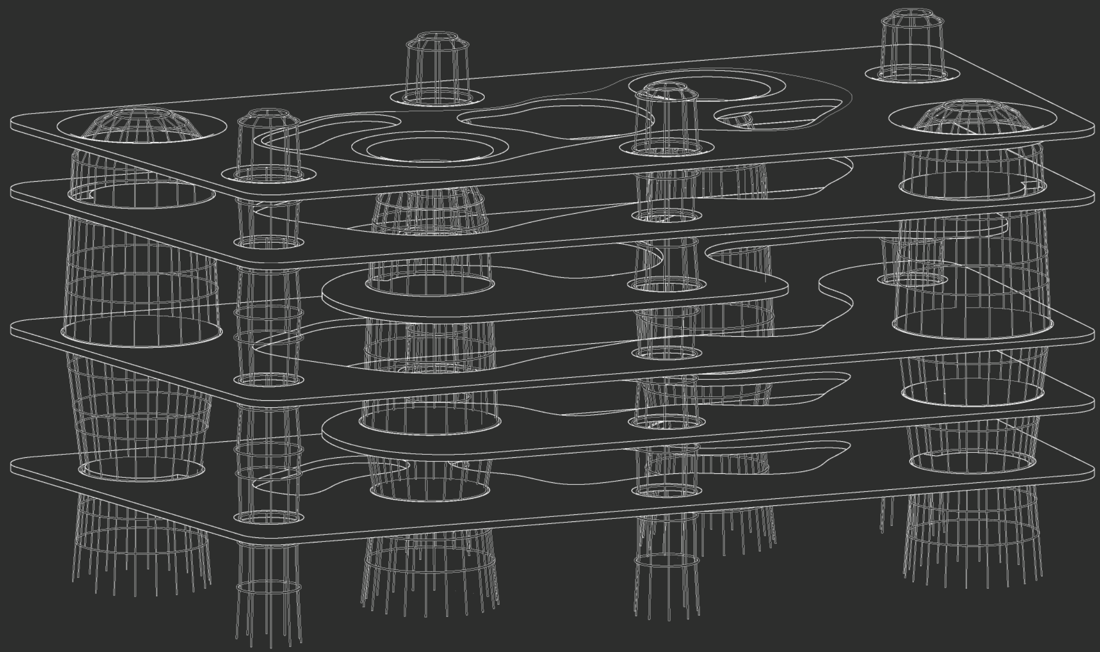


Figure 87 | building program

Structure

steel pipe column lattice system

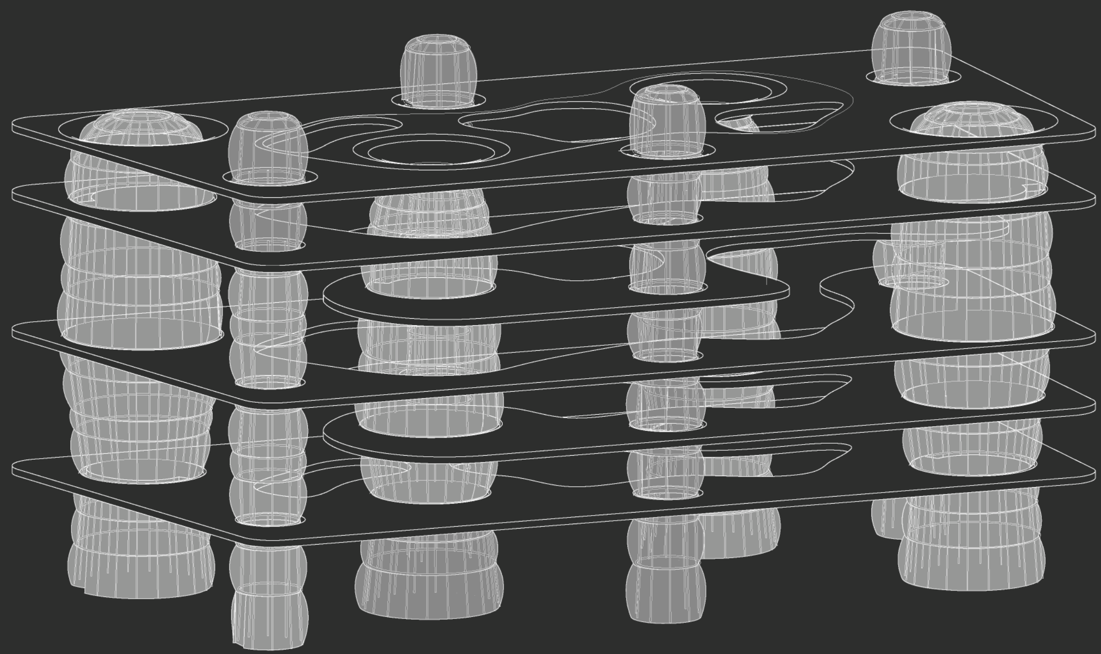


The structural scheme is inspired by Toyo Ito's Sendai Medateque, in its use of steel piped lattice columns as the main strucutral element, supporting the continous steel ribed slabs. While the columns are used as support, they are also used as rooms themselves, able to be occupied.

Figure 88 | toem steel column strucute, steel ribed slabs

Building Skin

ETFE pillow skin



The totem columns are covered in a building skin made of ETFE pillows, that inflate and deflate operating to control interior conditions optimal for the specific climate, in response to the outdoor environmental conditions. The pillows clip on to the rings of the steel ribbed columns, acting as a cover to the space.

Figure 89 | responsive ETFE pillow skin

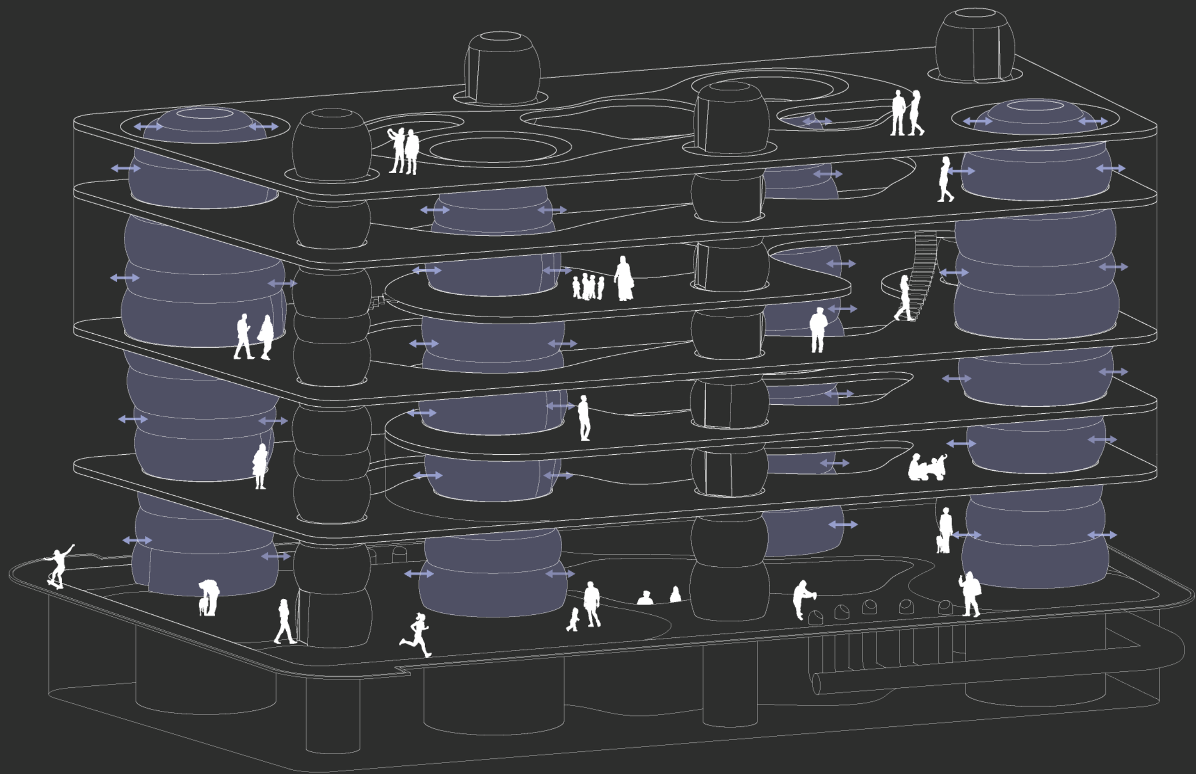


Figure 90 | ETFE skin inflation & deflation

Indoor & Outdoor Green Spaces

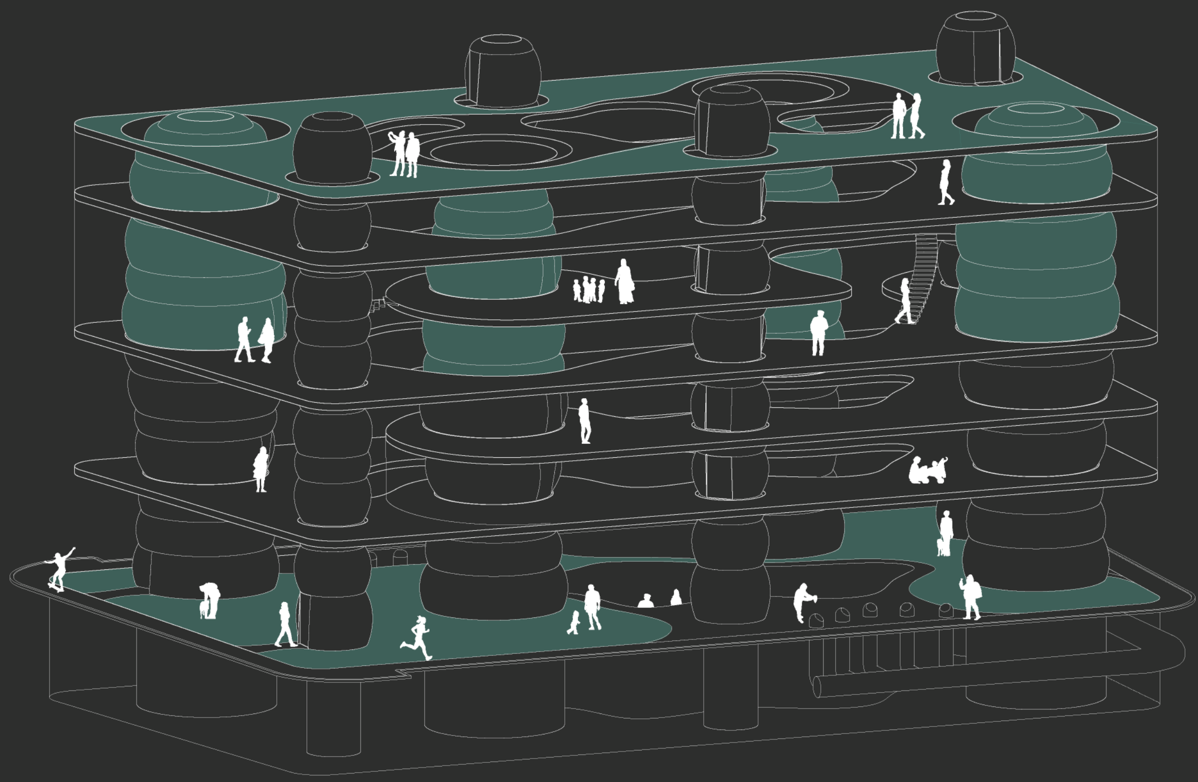


Figure 91 | indoor & outdoor green spaces

Vertical Shafts - Circulaiton & Technical Systems

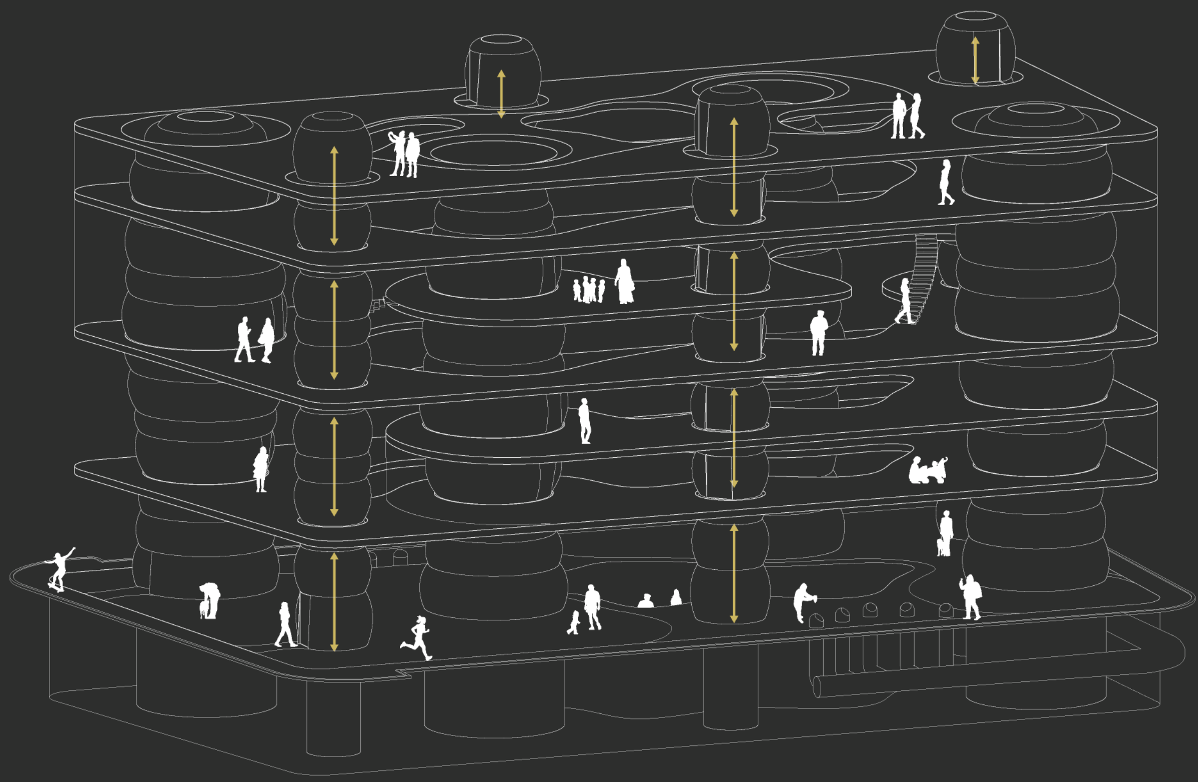


Figure 92 | vertical shaft system

Circulation

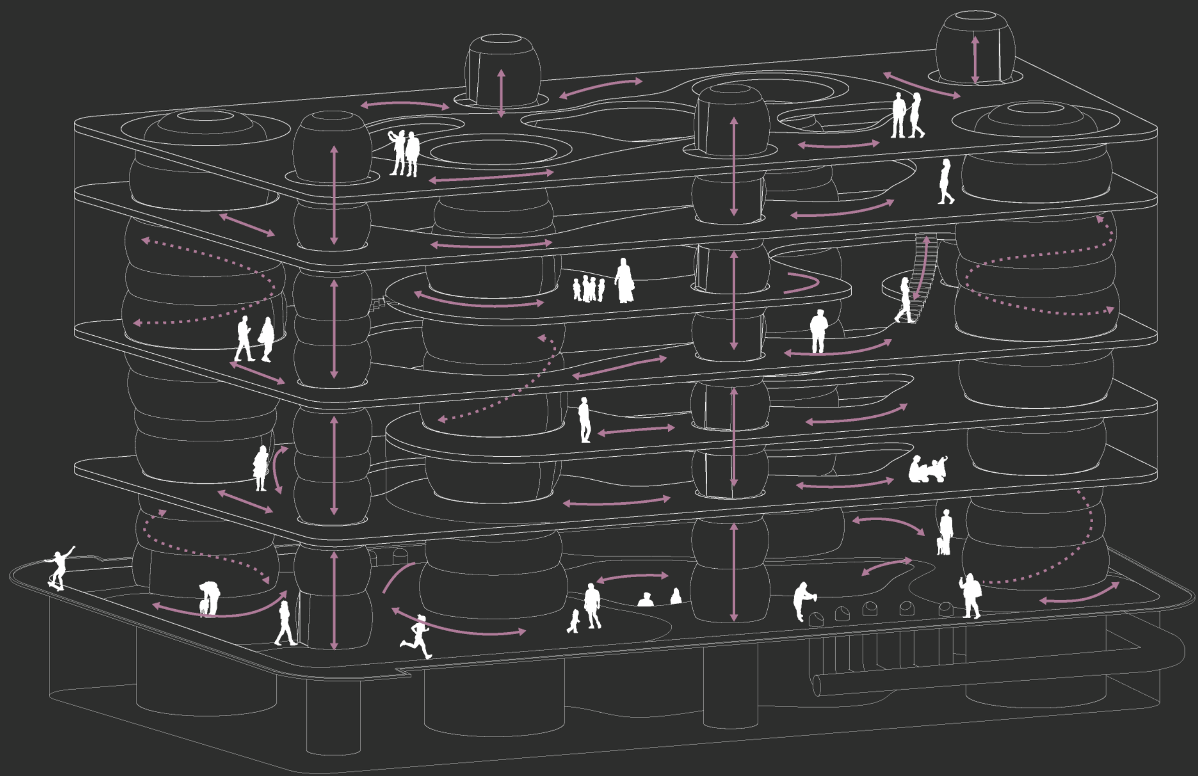


Figure 93 | open floor plan circulation

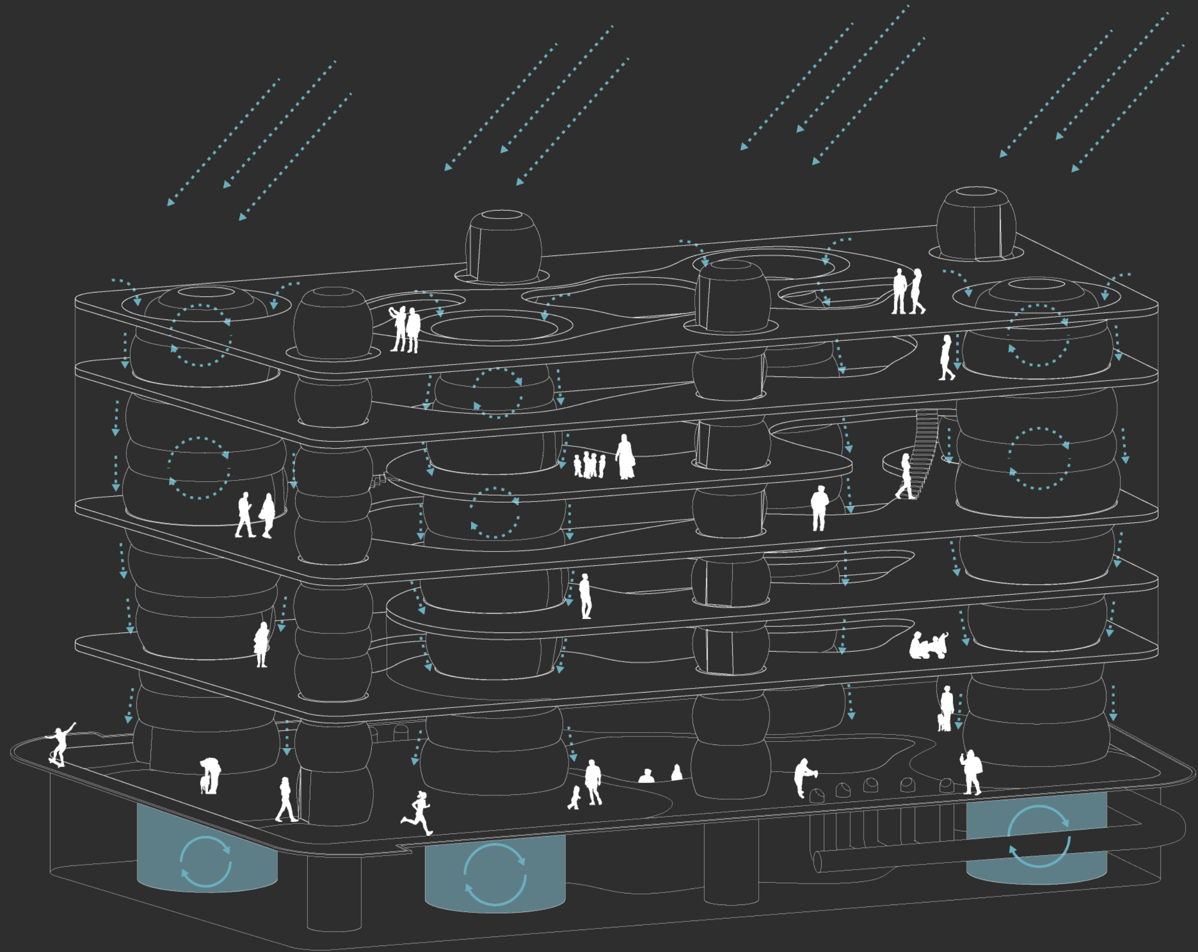


Figure 94 | rainwater circulation in retention system

Figure 95 | underground pnematic trash disposal

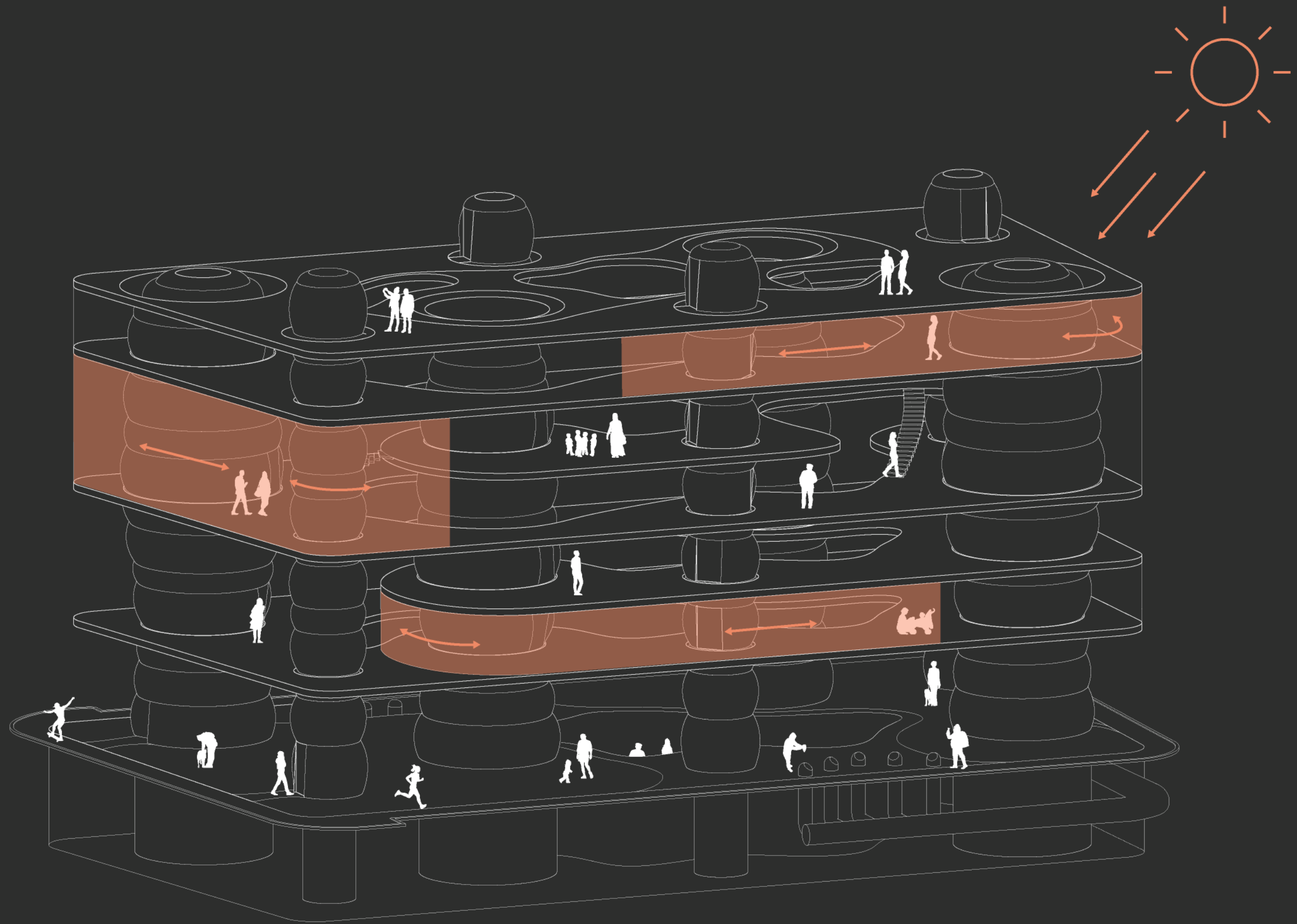
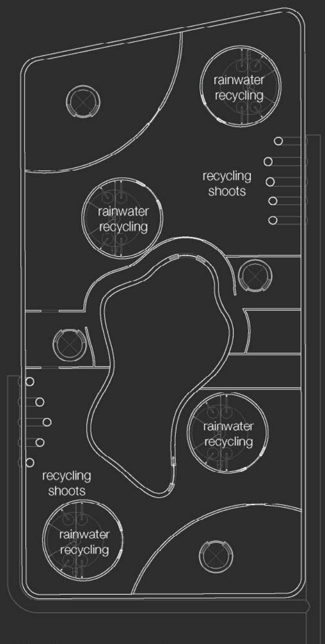
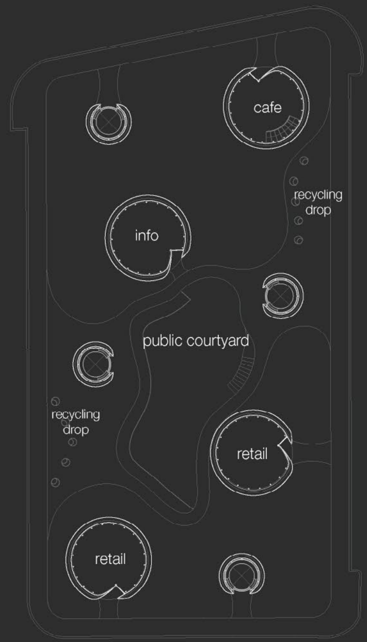


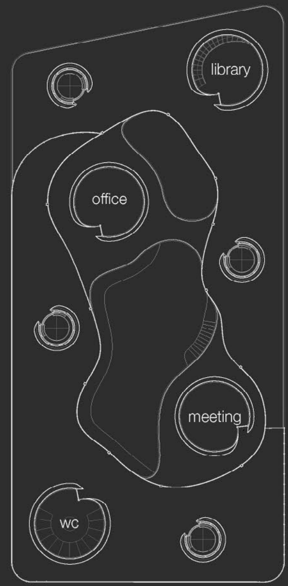
Figure 96 | movement of daylight operated rotating curtains



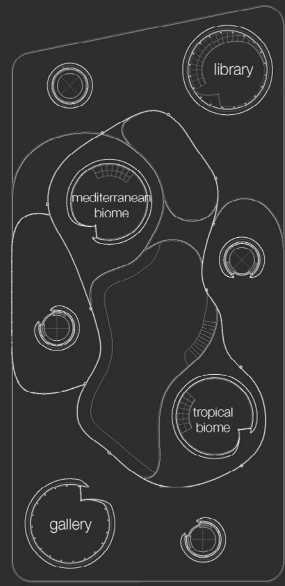
Underground Floor



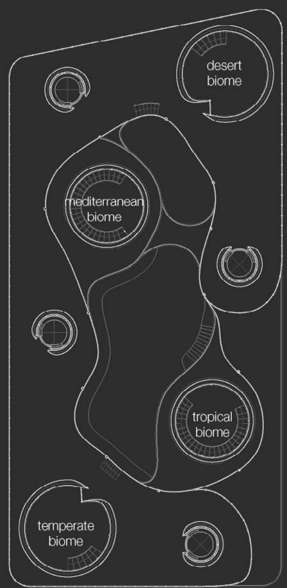
Groundfloor



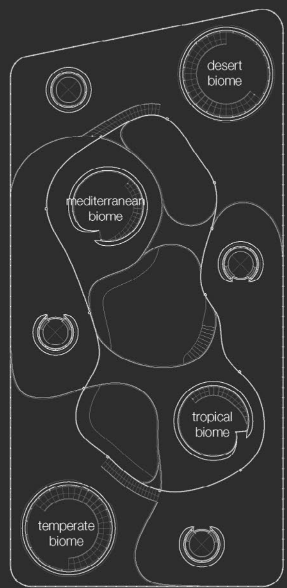
First Floor



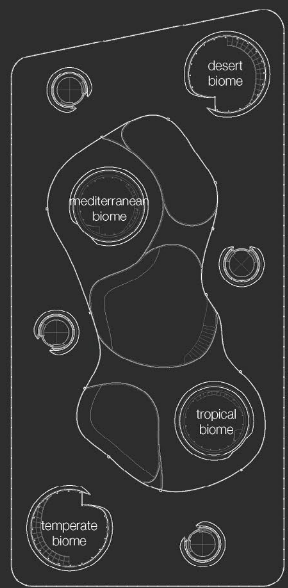
Second Floor



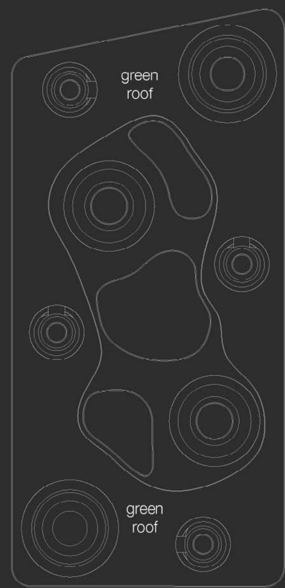
Third Floor



Fourth Floor



Fifth Floor



Rooftop

Figure 97 | plan diagrams

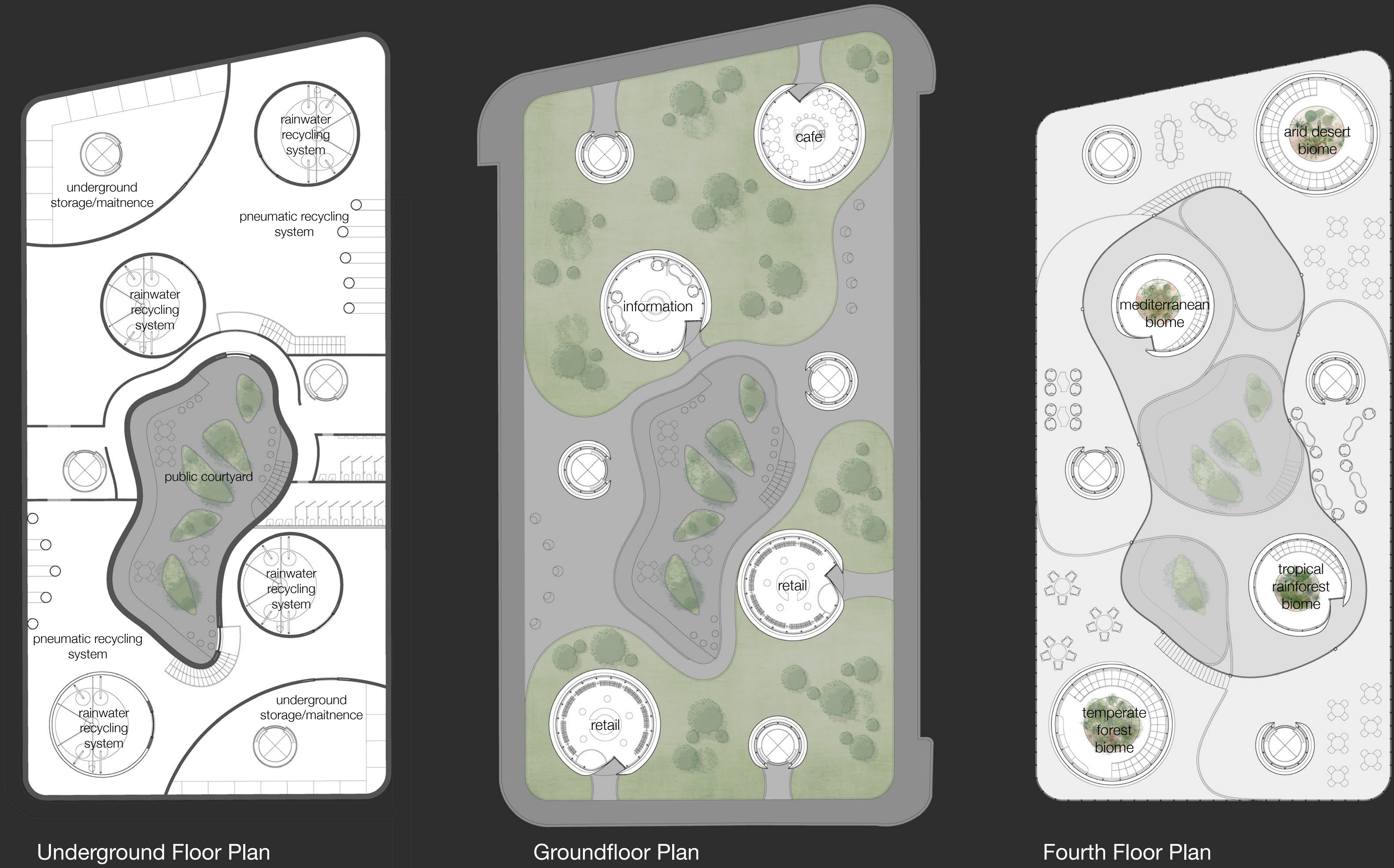


Figure 98, 99, 100 | building plans

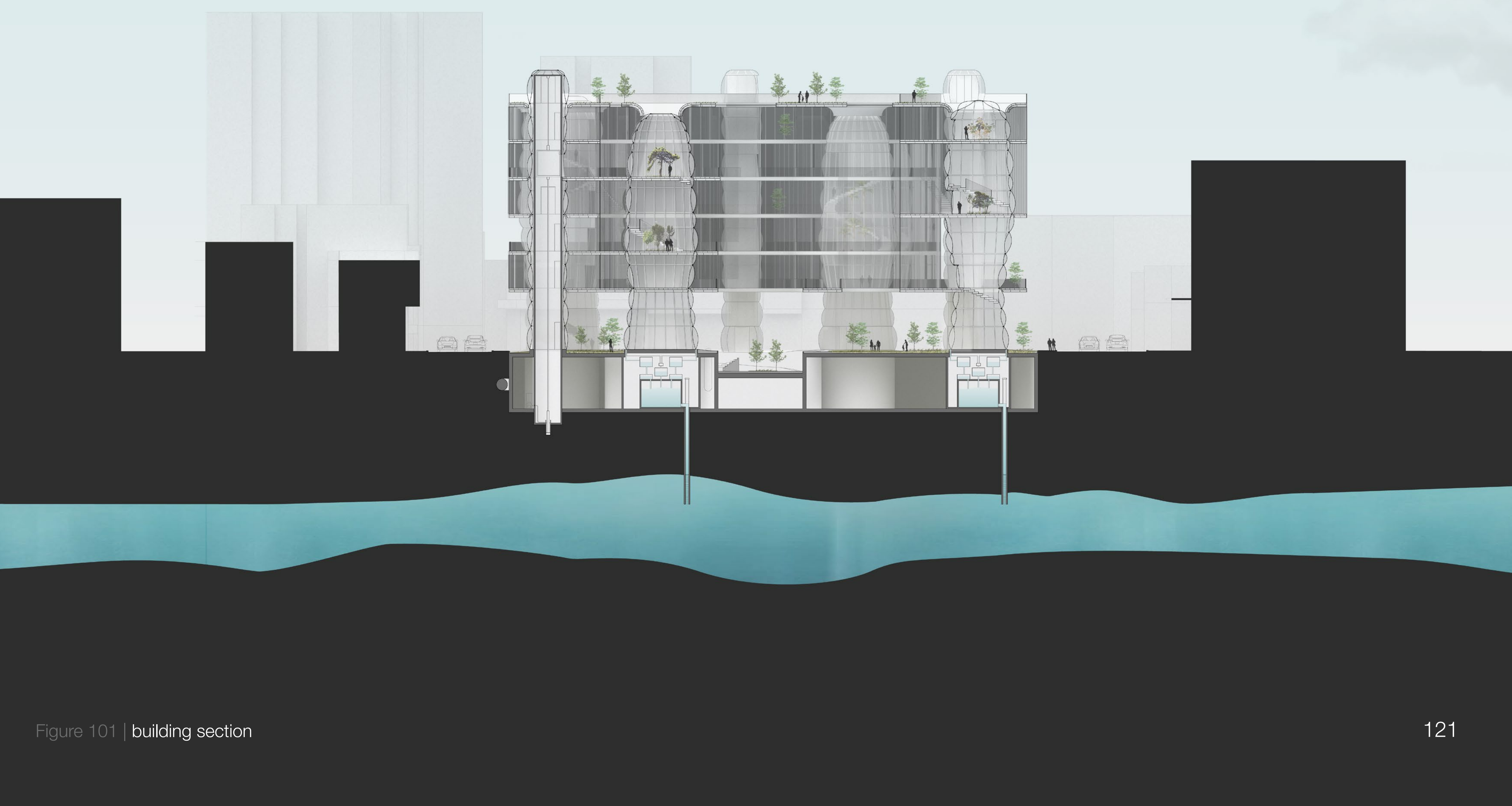


Figure 101 | building section

ETFE Pillow Air Inflation

The ETFE pillows defate and inflate through nitrogen pumped air chambers, causing a change in indoor air temperature. In the summer, the pillows inflate to allow for thermal protection and reduced solar gain. In the winter, the pillows deflate to absorb the solar rays, and increase solar gain. The pillows also fluctuate to chaning conditiions during the day.

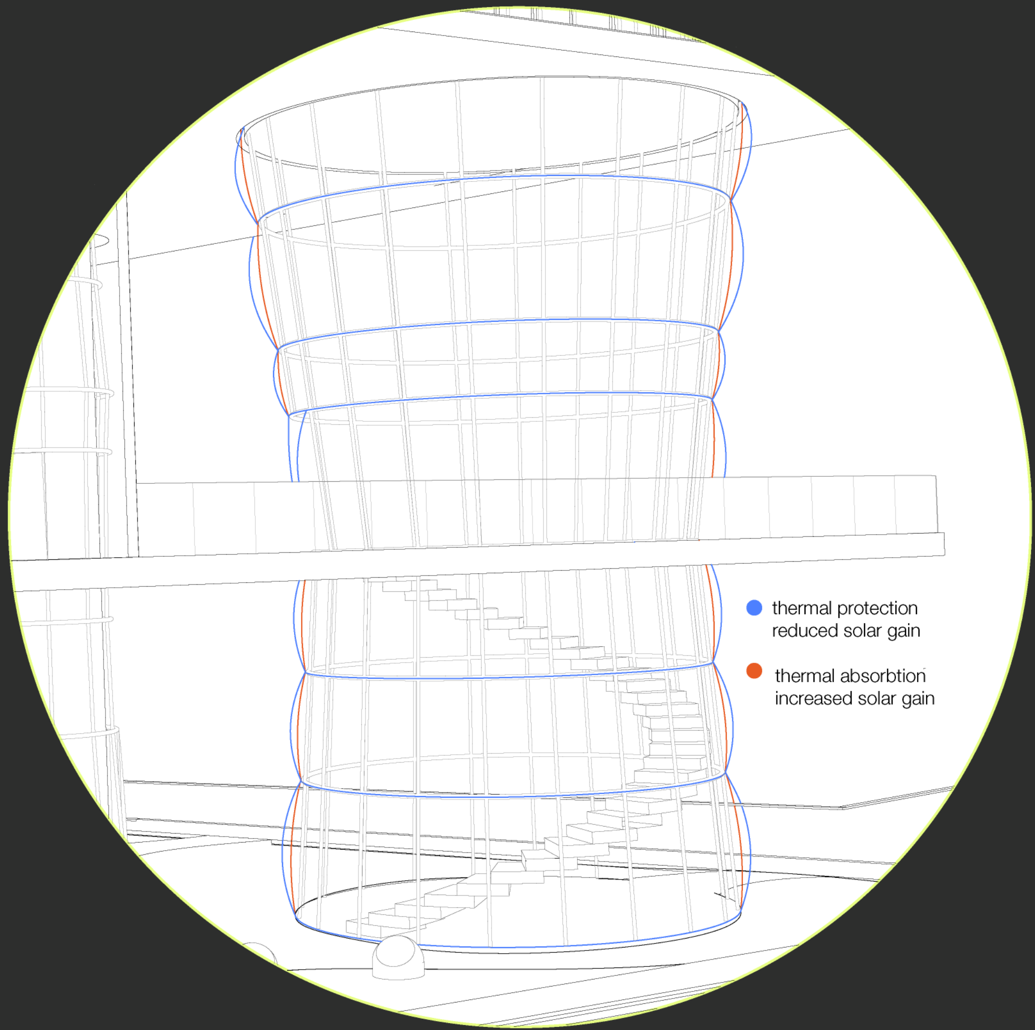


Figure 102 | responsive skin conditions

ETFE Pillow Sustainability Performance

As ETFE pillows inflate and deflate, both long-wave and shortwave radiation either reflected back into the atmosphere or transmitted into the building absorbed as thermal energy in the form of heat and light. The inflated pillow reflects more radiation, preventing solar transmission, while the deflated pillow is able to absorb more rays, transfering heat indoors. Convection is also occuring through the direct heat transfer of the material. Condensation builds along the outside of the pillow, and is collected as water to be recycled along with the rainwater collection system.

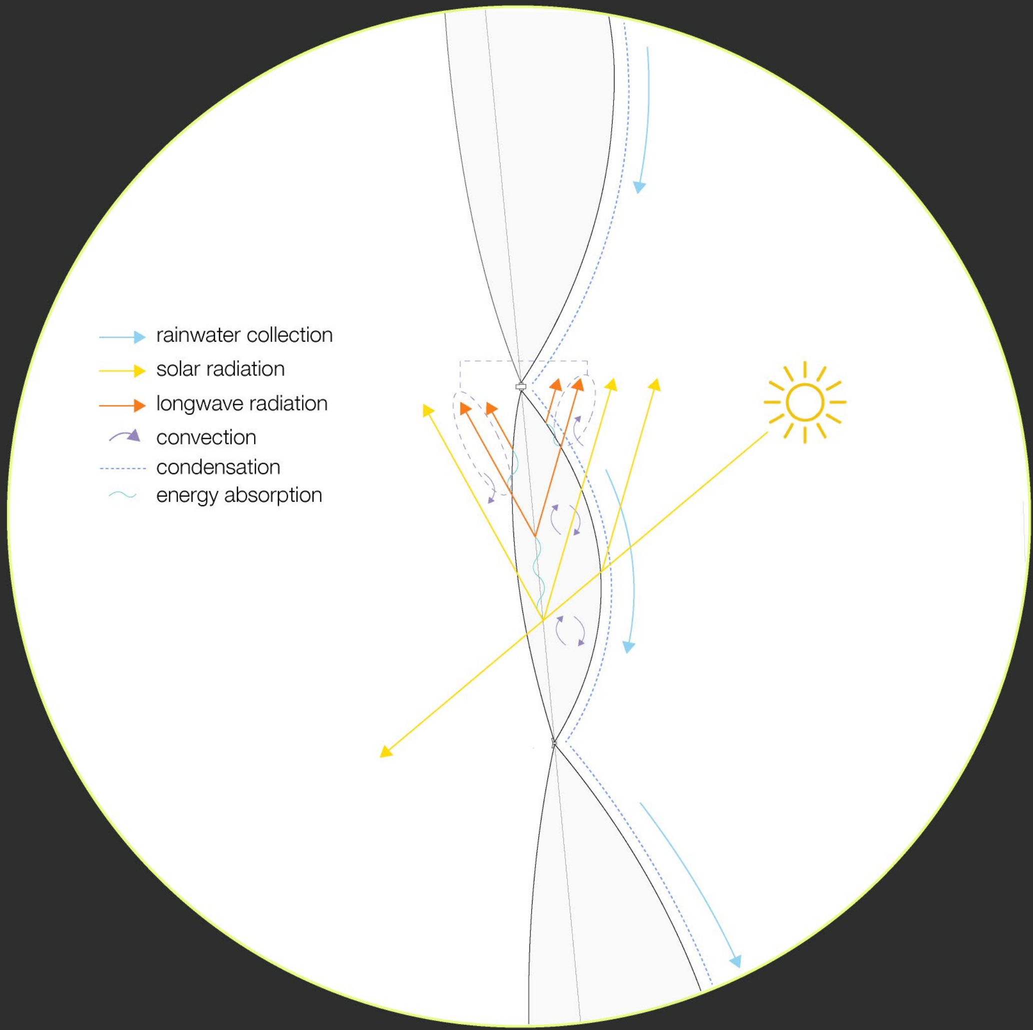


Figure 103 | ETFE pillow performance

Totem Strucutre

The floor slabs are created from a honey comb steel ribed slab, cabable of large spans. The slab is suppored by the column structures that are the ‘totem’ spaces themselves. These totems are constructed by a steel latice system with circular steel rings, supported through connecting steel columns. The pillows are atached on the outside anchored thorough a pin system to the connecting steel latice. Water pipes and air chambers are connecting along the vertical steel columns on the inside, serving as veins of the totem, breathing air and water back into the bioclimate.

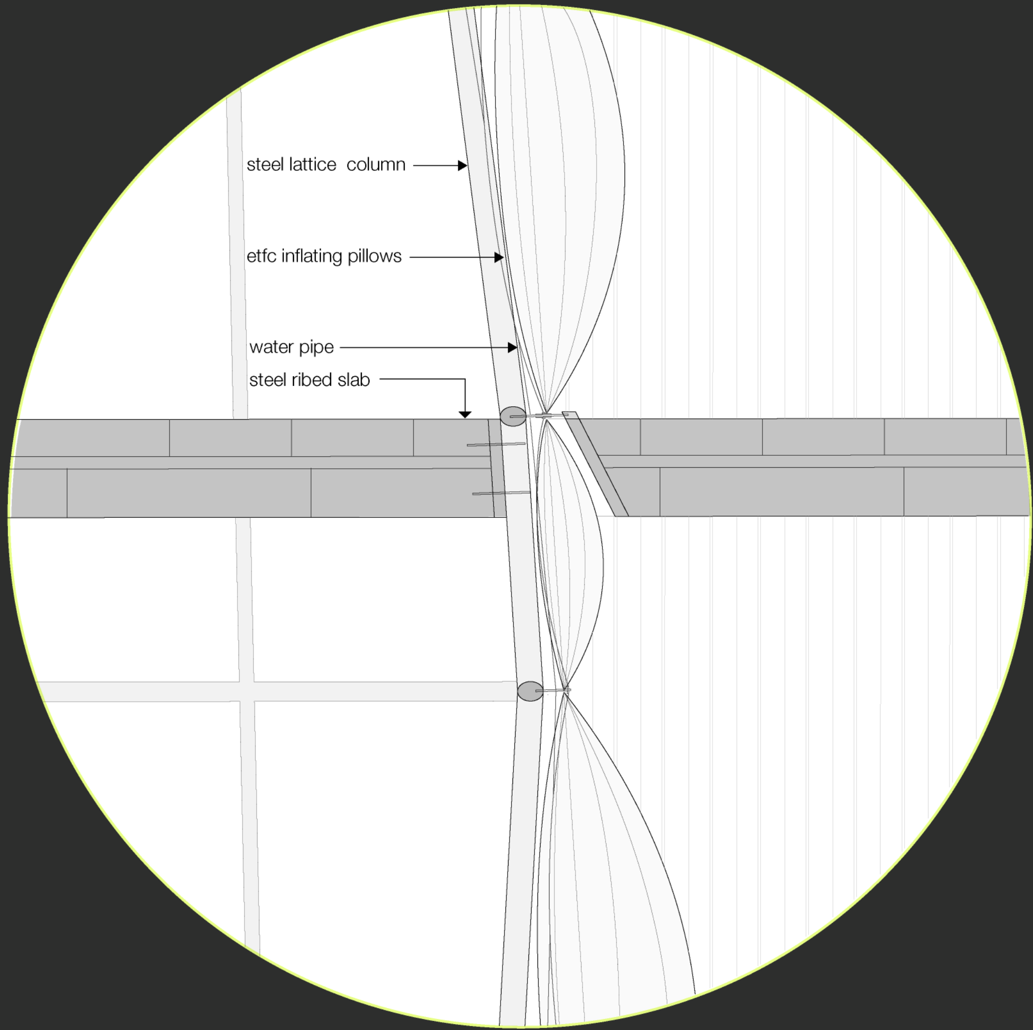


Figure 104 | lattice steel column and pillow skin connection

Rainwater Collection

The greenroof on top of the building serves many functions, providing habitat to plants and wildlife, serving as insulation for the building, and collecting rainwater. The runoff of rainwater is filtered down the totem structure with regular occuring rainwater. The catch has a filter system at the bridge of where the roof meets the totem. The water then flows down the ETFE pillows like a fountain, reused and recycled to other parts of the building.

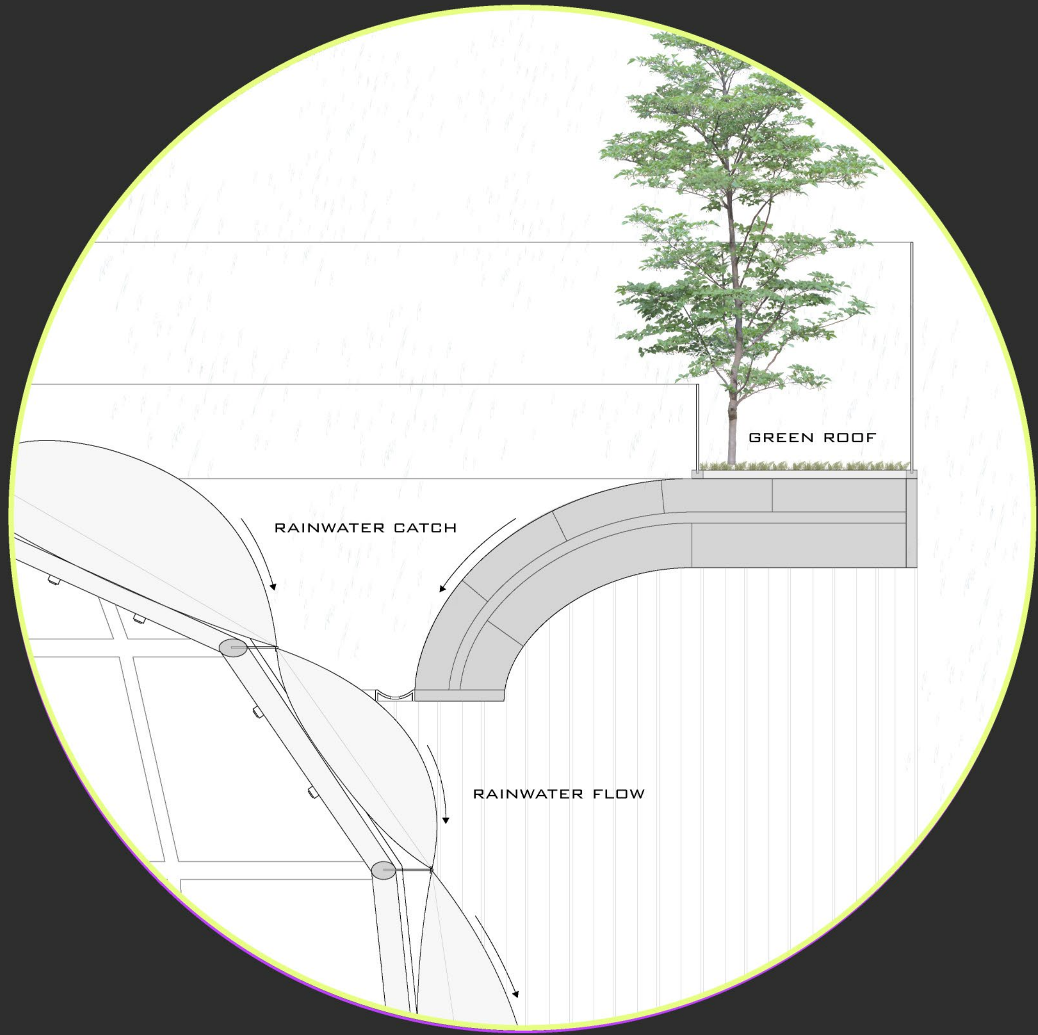


Figure 105 | green roof rainwater catch

Rainwater Recycling System

The rainwater collected from the collection system is filtered down the totems to reach the underground recycling system. The rainwater is funneled through a series of water tanks for storage, and then through a large pump and filters, to be sent back out as clean water for the irrigation system in the bioclimates. The main tank has connection to the underground city water, connecting to the well system to pull water from when there is seasons of little rainfall.

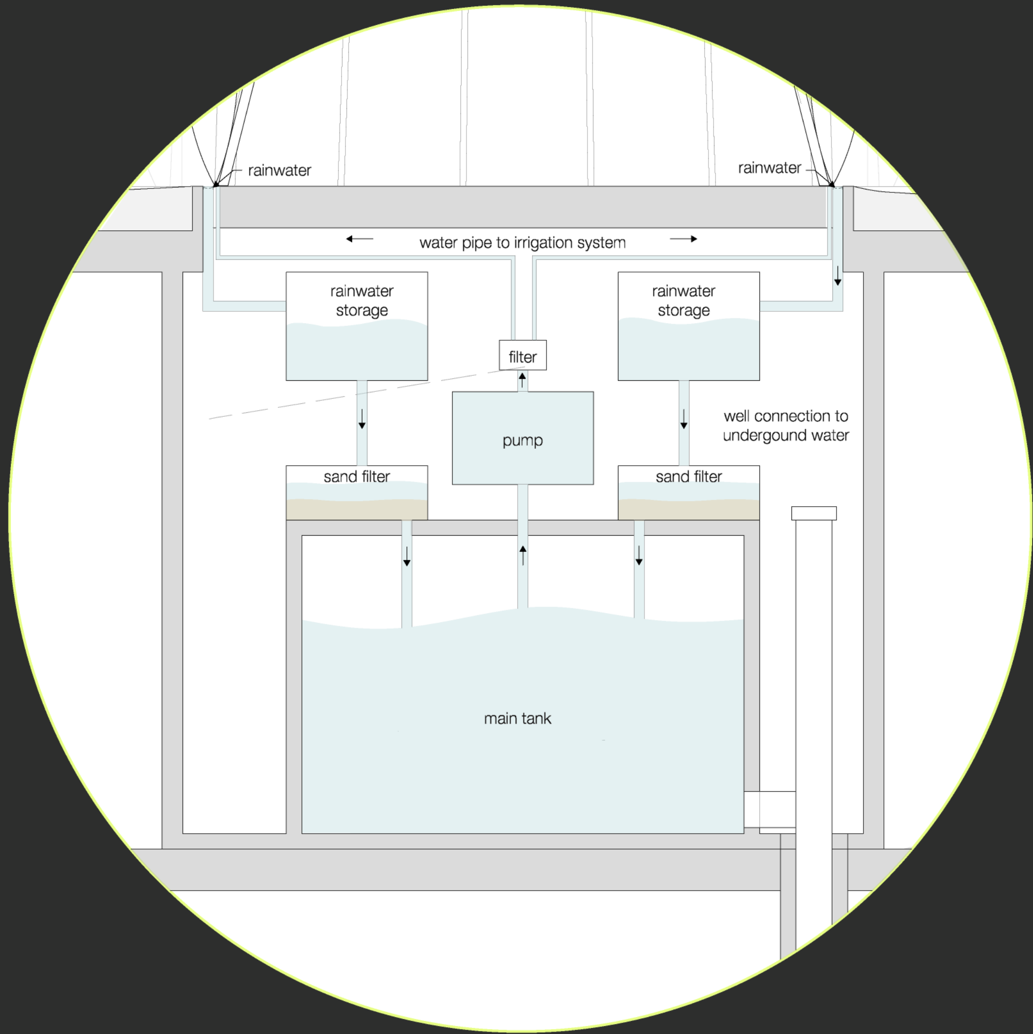


Figure 106 | underground rainwater recycling, connection to city water

Daylight Operated Curtain System

As the ETFE pillows effect the light control in the bioclimates, the daylight operated curtain system controls the light intake in the other parts of the building. The curtain system contains daylight sensors on the track, in which the curtains will rotate around the building regarding to how much direct sun the different parts of the facade is reciving at different times of the day. This helps to keep thermal and visual comfort as the direct sun in Israel is strong. This also operates as an effective cooling method, saving on energy used in HVAC systems.

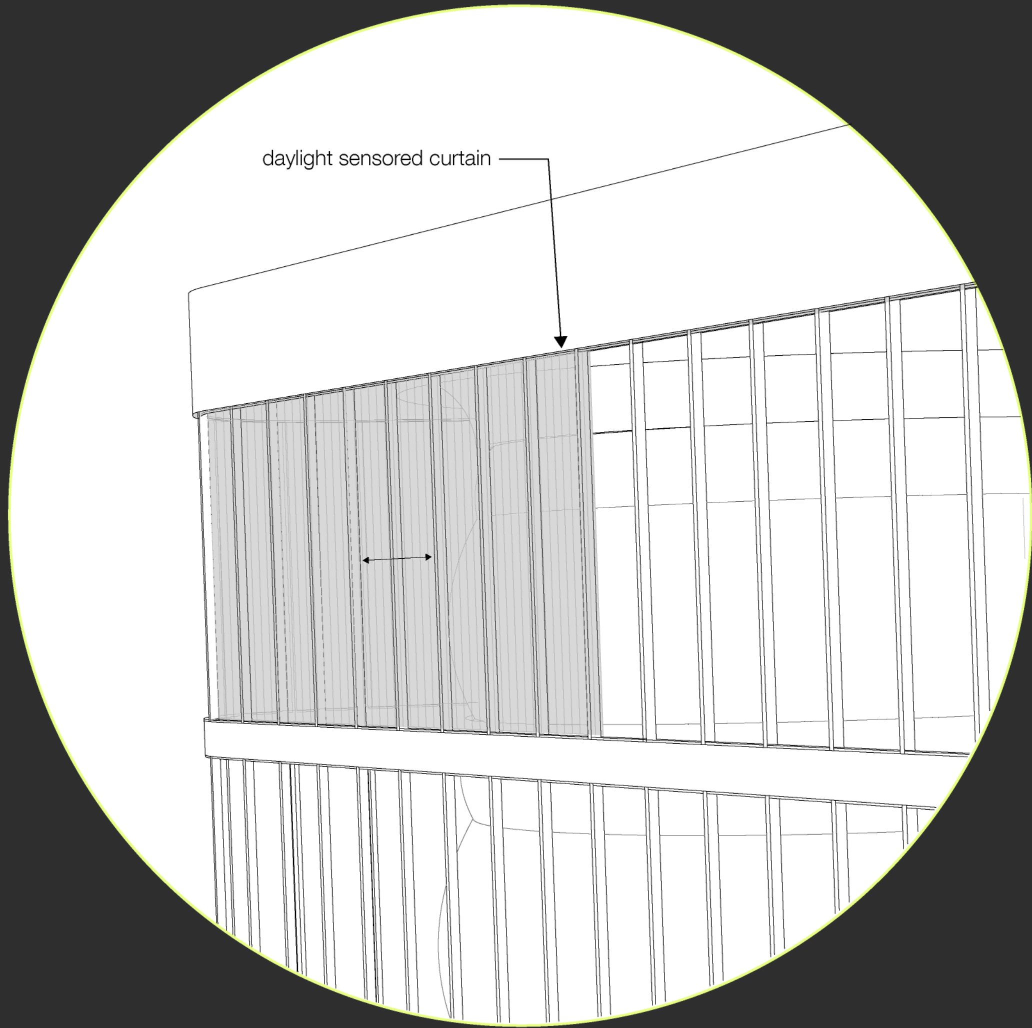


Figure 107 | daylight responsive curtain system

Pneumatic Trash/ Recycling System

A pneumatic trash/recycling sytem uses vacum powerd tubes to send waste to its respective sorting plants. This helps the environment saved from the energy used in driving around recycing bins, and emitting carbon dioxide in the environment. The underground system frees public space above ground. The drop off bins are separed in different funnels depending on its recycled material. The vacum will be time operated, acting as the sorting mechanism for the large tube.

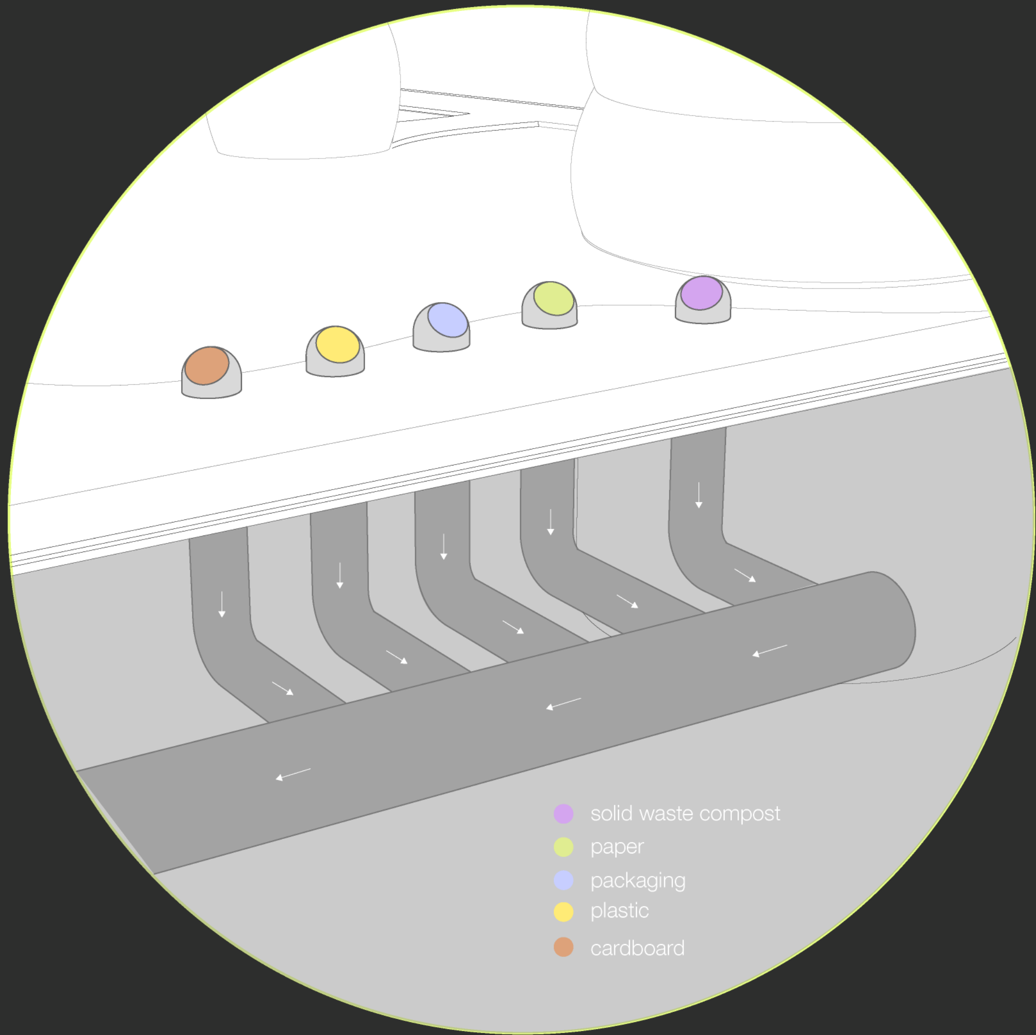


Figure 108 | underground pneumatic trash system

Figure 109 | a community connection point

Figure 110 | a multi-climate park space

Figure 111 | a new type of 'green' in the city

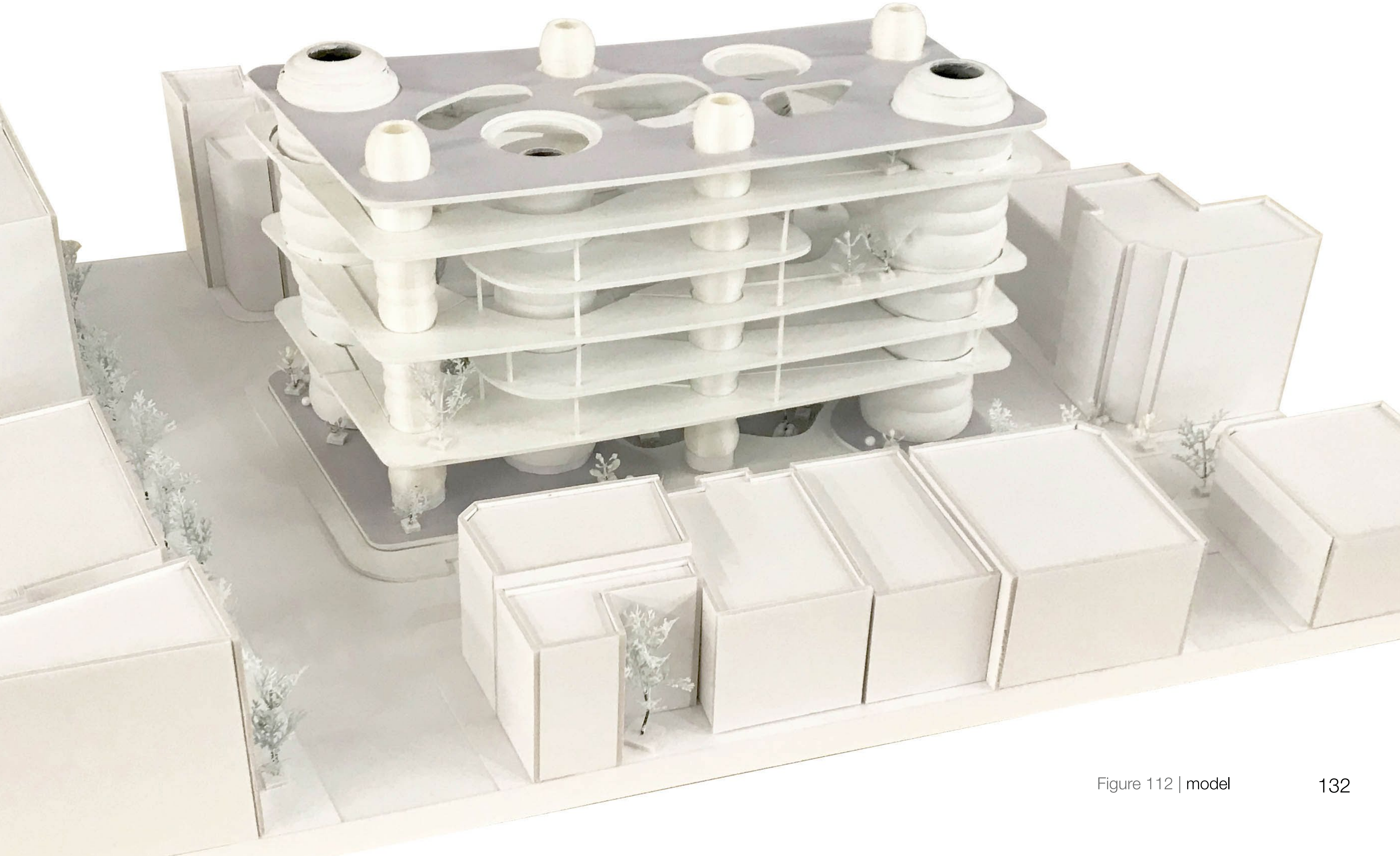


Figure 112 | model

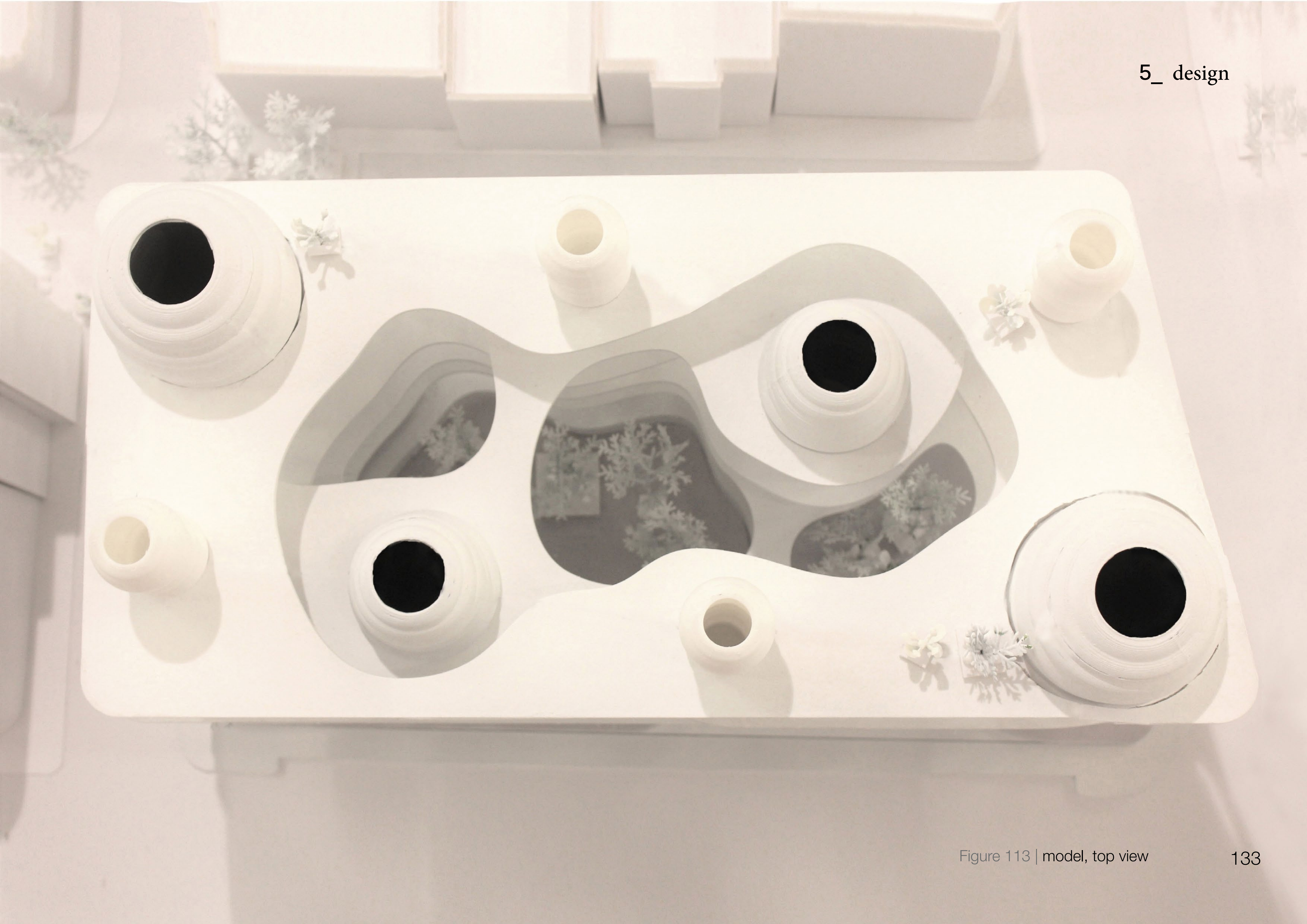


Figure 113 | model, top view

conclusion

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The environmental community center in Jaffa is designed in mind the many dimensions of sustainability. This includes the choice of site intervention, use of real time site analysis, emerging technological advancements, responsive parameters, visual aesthetics, and programmatic uses as a both a park, a waste drop off site, water recycling point, and environmental education center. The outdoor becomes the indoor as this new type of park is simply marveling in the beauty and sensations of nature, through its many different varieties in climate and vegetation. Beyond marveling in the sensations of nature, the building is designed to be an act of performative architecture, responding to the environment as a tool for environmental education.

As architects and designers, we have a large responsibility to facilitate and encourage people to relate to their communities and the environment. Not only do we have the power to design buildings that are meant to nurture our planet, we have the power to design methods of inspiring and changing behaviors of inhabitants. Environmental research should be at the forefront of every decision, looking to nature to help us provide solutions. In this digital age, we must turn to technologies to simulate and optimize these decisions, as we now have plentiful environmental data at our fingertips. These technologies are not only digital, but also physical and practical systems that can be used in the architectural form itself. The forms we are working with today are open to a wider range of functions, as they can perform in responsive ways, that adapt and adjust to given climate conditions. With the current unpredictability in the state of our climate, it is important to be able to react to changes in our ecosystem, through climate control in architecture.

Architecture can serve as a point of community, for people to unite around a common purpose. With the current climate crises, we need buildings that bring people together to discuss policies and actions, along with educating members of the community. Just as research and design are huge factors in sustainability, education is just as important, as people need to address how their own behavior can play a vital role. Creating a network to discuss these topics helps strengthen the outreach potential exponentially. This network should not only extend to residents, but to industries, educational centers, businesses and governmental offices as they all have a voice. As information is passed, we hope to achieve the goal of transparency in our systems. Transparency can educate, enlighten, and inspire, revealing processes in an impactful performative way as light gets shed on mysterious areas of darkness. The whole process is a performance, one which is experienced through the architecture itself, as space can perform for impact.

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