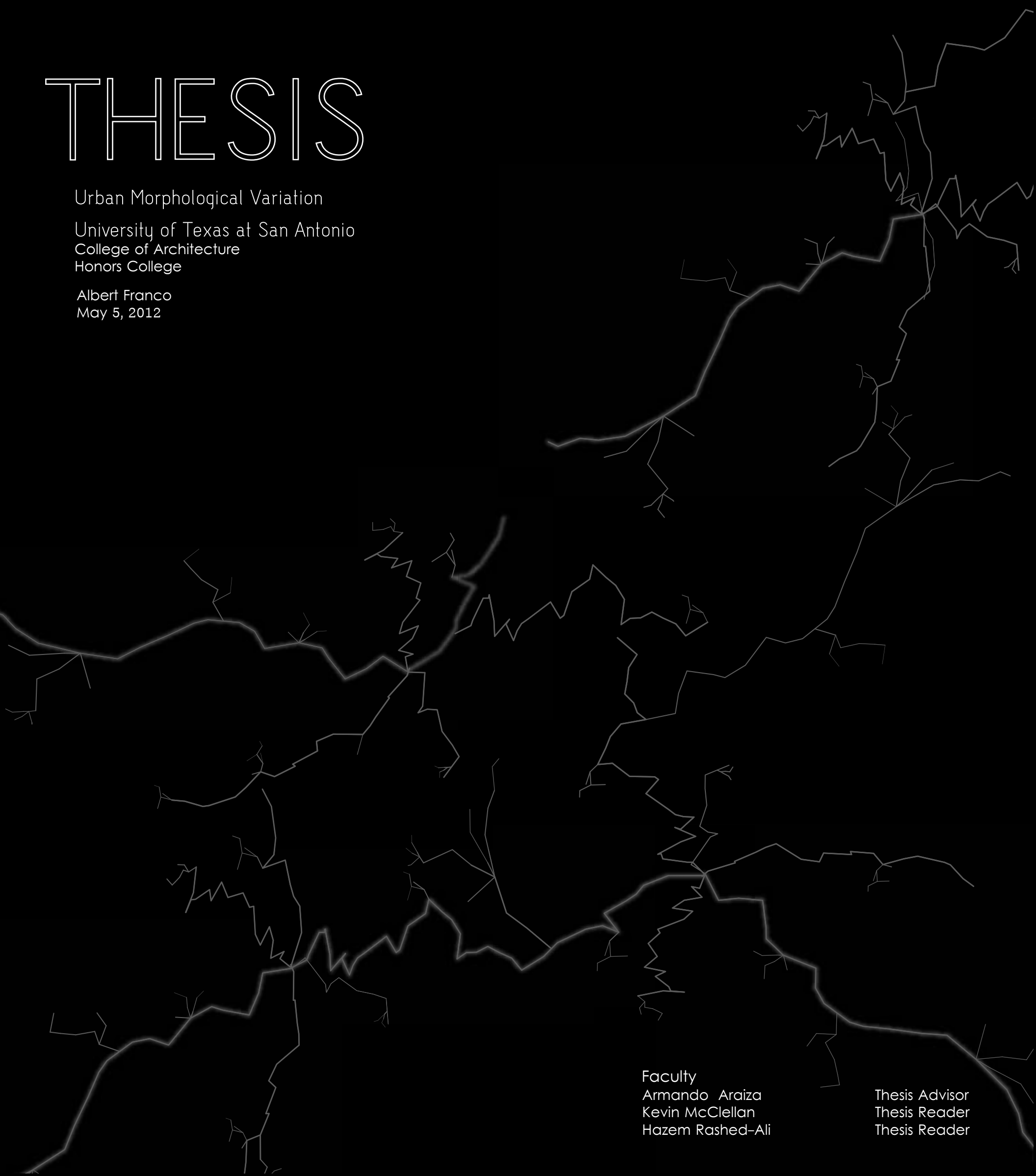
THESIS

Urban Morphological Variation

University of Texas at San Antonio
College of Architecture
Honors College

Albert Franco
May 5, 2012

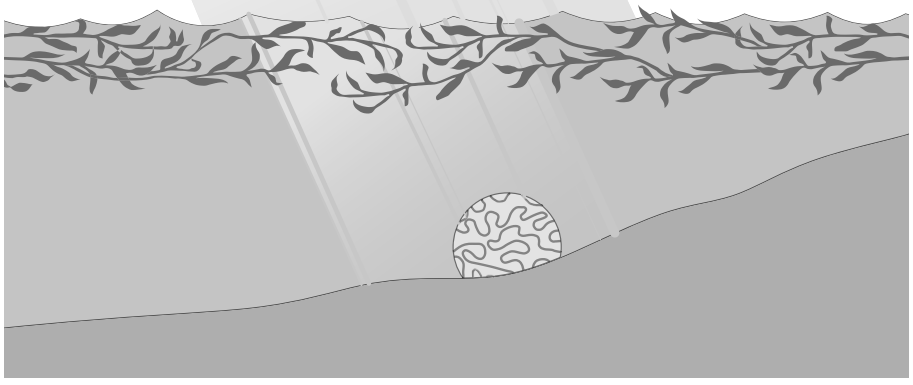


Faculty

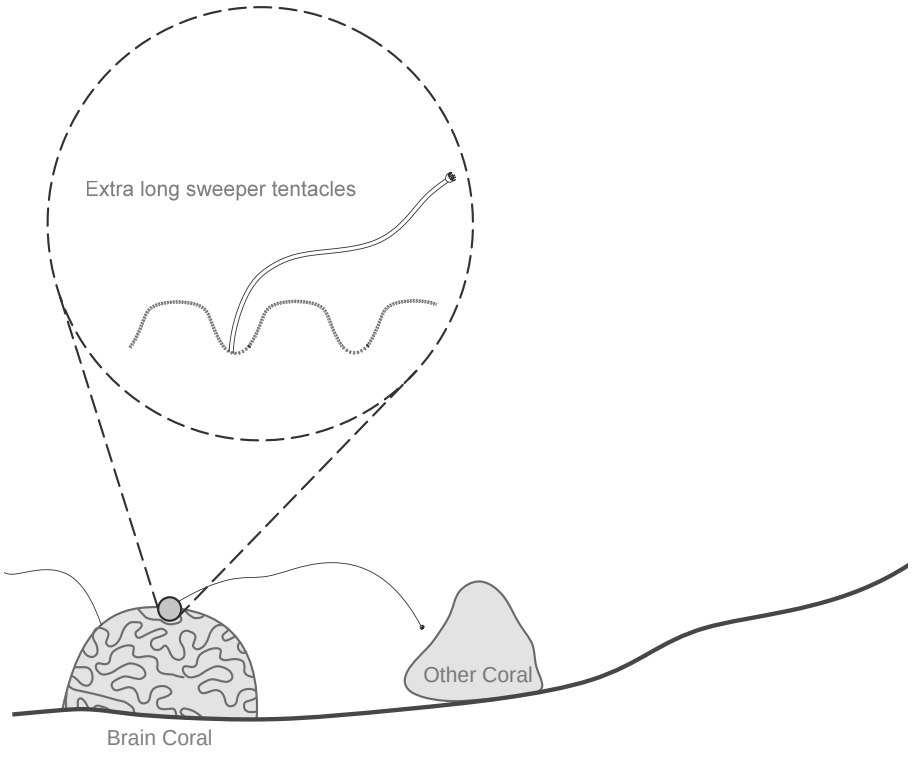
Armando Araiza	Thesis Advisor
Kevin McClellan	Thesis Reader
Hazem Rashed-Ali	Thesis Reader

Ecological Design

Marine organisms have proven to be very efficient in their environments. The Platygyra Genus is an interesting coral species because of its ability to adapt and grow in different environmental conditions. This rounded hard-bodied coral, more commonly known as 'Brain Coral', is the focus of this thesis. This colony of living organisms seems to be the quintessential example of compact morphology. By researching and understanding the Platygyra species I plan to use this as a point of departure for rethinking urban design issues. Exploration of its structural integrity, micro and macro growth patterns, and the corals symbiotic relationship to its environment are the key factors of focus for this thesis.



Natural light filtering through seaweed



Aggressive sweeper tentacles

Growth

The brain coral is a system of many smaller organisms called polyps that grow in one super structure. They are all interconnected into one open system. These polyps are the living portion of the coral. As polyps grow they secrete calcium carbonate that builds the hard exoskeleton. This exoskeleton is very important to the colonial organization and its survival against predators and other corals. Stringing together, multiple polyps, are stronger and less vulnerable. Although coral growth is not completely understood by science, there are many signs of great variation within the species. Each polyp goes through a morphological change from being one into two. This process is called Budding. Budding is when the polyp duplicates from its central orifice and grows until it becomes a separate living organism. This type of growth is meandering in any direction. Much of this budding is directional and dependent on the amount of space available for growth. Meandering forms begin to look very organized because of the skeletal structure that is secreted. The structure of this coral is not usually visible because polyps dwell on the surface to capture food. The calcified exoskeleton is also used as a defense mechanism. Polyps retract as predators swim by and try to consume them.

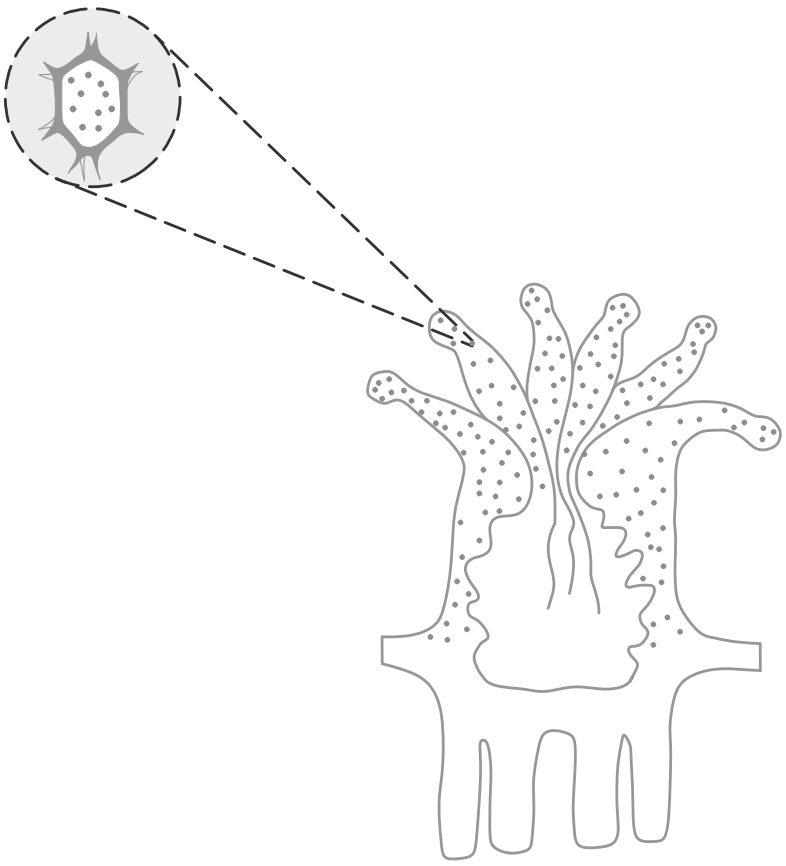
Brain corals also have a secondary growth system that begins a whole new colony. This method is called Spawning. Instead of splitting within the colony like budding, spawning involves the release of eggs into the water. These eggs surface on the surrounding ocean floor and begin to grow a whole new colony. At this point, many do not survive because the eggs are susceptible of being eaten by bottom dwellers and fish. The new colony that grows then becomes a competitor for food and space.



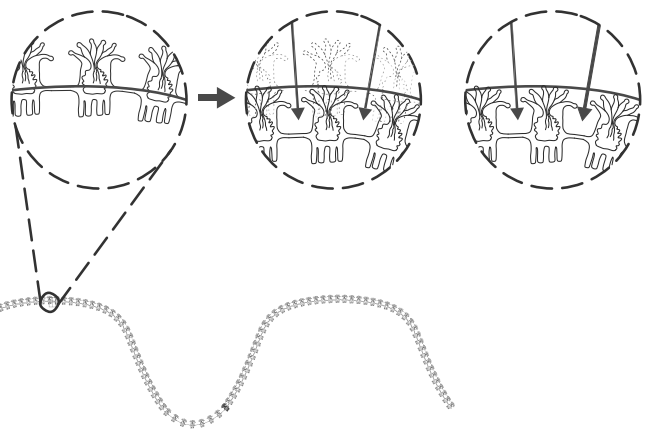
Coral in its environment



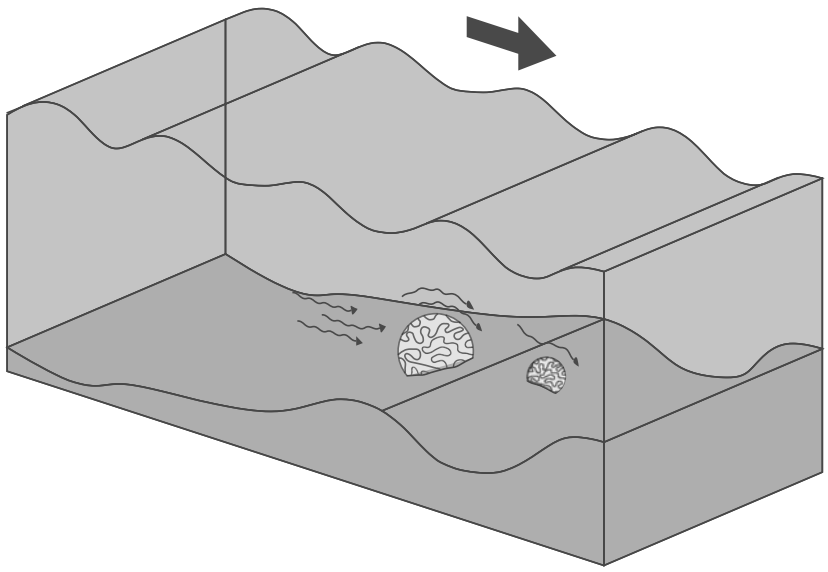
Image of Brian Coral



Symbiotic relationship between polyp and algae



Relationship between polyp and skeletal structure



Relationship between coral and water

Environmental condtions

The brain corals survival rate is much higher than other corals. Because of its circular shape the brain coral is not susceptible to cracking or breaking off of large parts. Brian corals life span can be up to 900 yeas of age. It's not only the circular shape that keeps this coral living so long, but this coral is also known to be very aggressive. Many corals have small tentacles that extend off of its surface to catch prey. The brain coral has extra long sweeper tentacles. Because of the length of theses tentacle the coral is able to reach out further for its prey and even take resources from its neighboring coral. Since this coral is so effective at gathering resources it usually doesn't have corals near its perimeter.

The corals location within its environment is very important for survival. Its growth depends on the amount of sunlight it receives and the condition of the water that it lives in. The brain coral will only thrive when exposed to a limited range of sunlight. If the coral is exposed to a large amount of sunlight, it will cause to decay. This usually happens when the coral is too close to sea level. The coral is also affected when it doesn't get enough light. The most common reason for the coral not receiving enough light is due to the amount of seaweed covering the surface of the water. The coral is so dependent on the sun because its polyps act as containers for photosynthetic algae called zooxanthellae. The algae and coral have a symbiotic relationship with each other.

Water temperature and flow are very important to the corals survival. The corals calcification rate varies between cold and warm water temperatures. The skeletal growth is similar to the growth rings of a tree. The rings grow faster during the warm weather and slower during the cold. Coral growth rings are a little bit more interesting because they are able to record history. By looking at the rings we are able to tell what the temperature of the water was for the life span of the coral, and for some massive corals that time span can measure by hundreds of years. The coral also depends on the water current to carry food into the valleys of the corals surface. This method is the most significant form of food source of the coral. For this reason, the coral may grow at a slower pace if it has less water flowing through it.





Design Ecologically

As designers we can learn a lot from natural systems. Biomimicry is the study of nature's designs and nature's process that are then applied to solve human problems. There are many ex–amples of biomimicry projects within ar–chitecture, the automobile industry and product design. Architects and designers have recently been looking at biomimicry to try to improve our way of living. They are looking at systems in which work in the most perfect form. The design world is adapting and finding was to include these new methods and processes. In these examples to the left there are two built projects and one theoretical design.

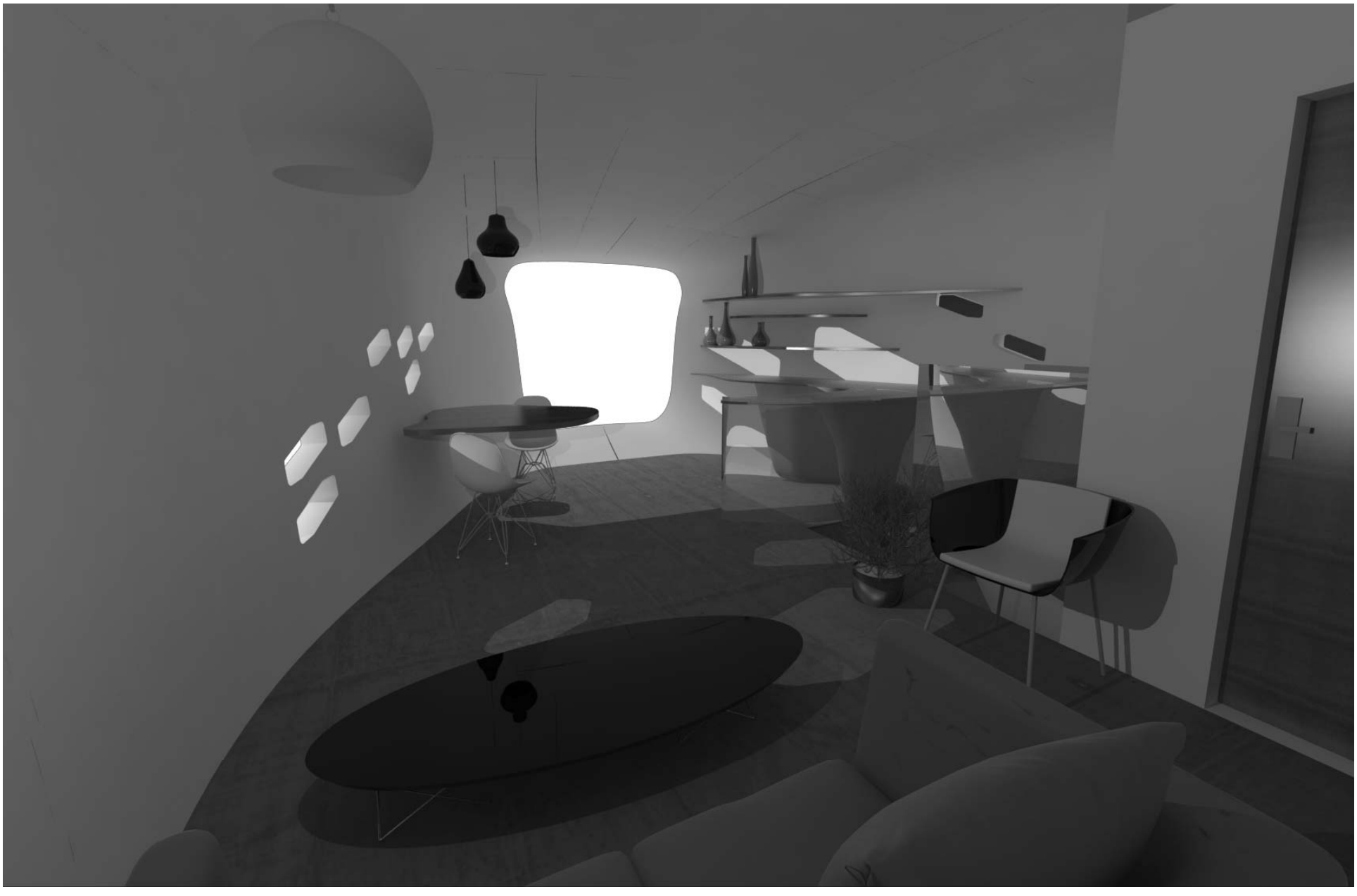
In this thesis I will explore the brain coral's structural components, growth patterns, and how the corals react to climate changes. The main focus of this thesis is to attempt to break down the systems in which the coral works within its environment and apply this re-search to densely populated urban cites.



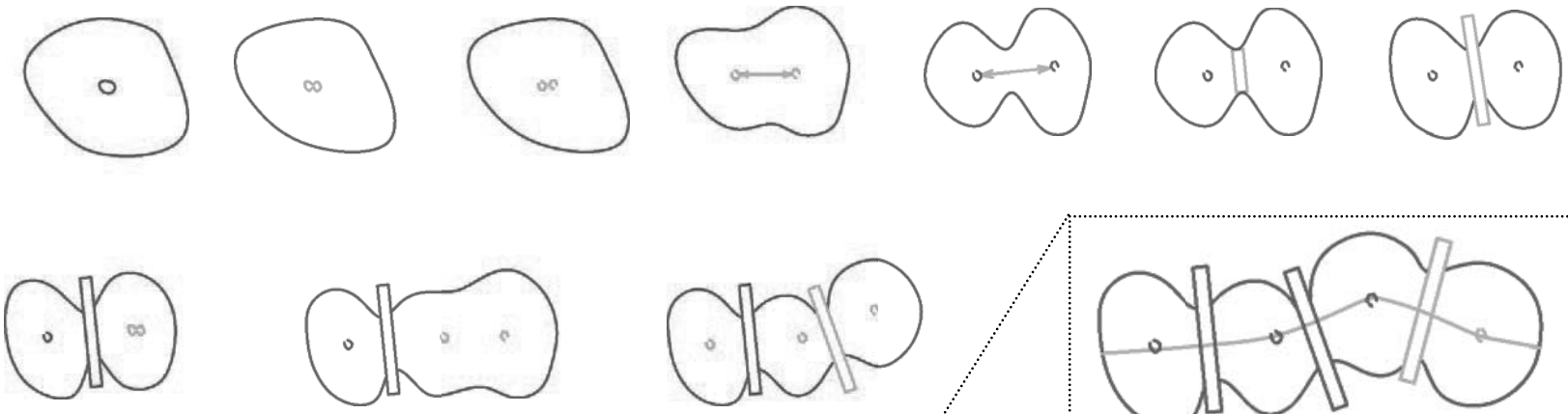
Coral condition	Variable	Design condition
Coral uses water to filter food through valleys and is dependant on water current.	Water	Valleys between living spaces with maintain the same function as the coral and provide food for the commu-nity of residence
Coral is dependent on light for its photosynthetic process.Light can be very harm full in large amounts or in insufficient amounts.	Natural light	Natural light is utilize to substitute the amount of artifi-cial light. Shading devices and solar panels are attached to the structural panels to offset heat and absorb energy.
Polyp secretion is a very important part of the coral survival. The structure acts as a second envelope and a natural defense mechanism. The coral also has sweeper tentacles that serve and aggressive arms that collect food from the surrounding areas.	Environmental conditions	The residence are built up of a panel system with a cus-tomizable openings and structural attachments. These attachments act as a second skin for the resdiences and are essential to the adaptability of the design.
Brian coral is round in shape to absorb the maxi-mum amount of sunlight on its surface. Its meander-ing forms are made up of clusters of polyps that share calcified walls. The forms grow multidirec-tional to maximize the number of living organism.	Function of Form	The organization of the residence grows in similar form to coral polyps, but its layout is dependent is topograph-ical conditions. These components are built across the landscape similarly to coral in form and also are con-nected



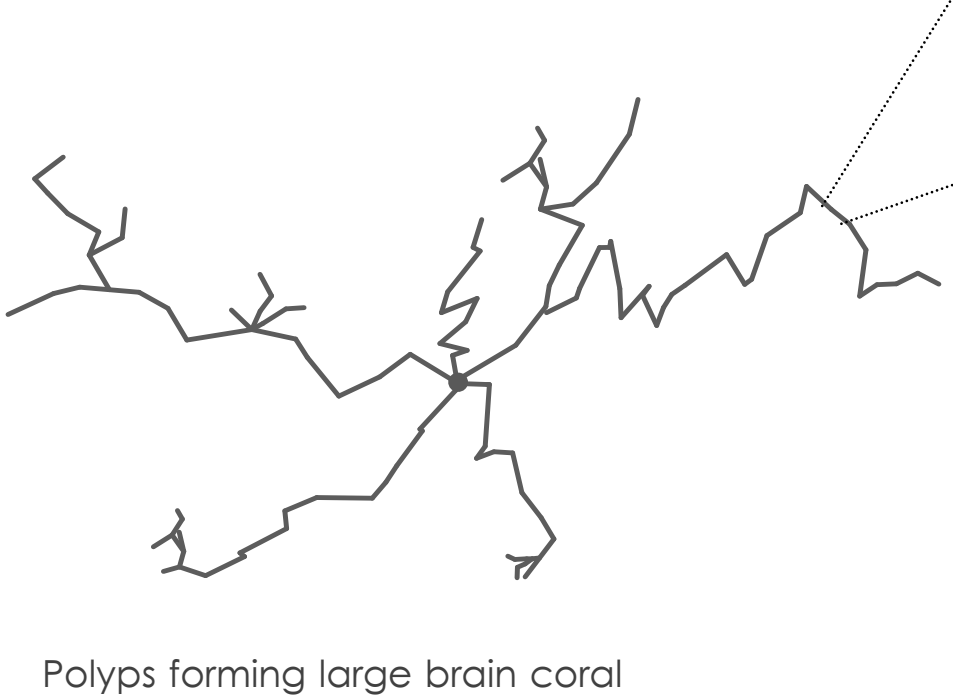
Window openings



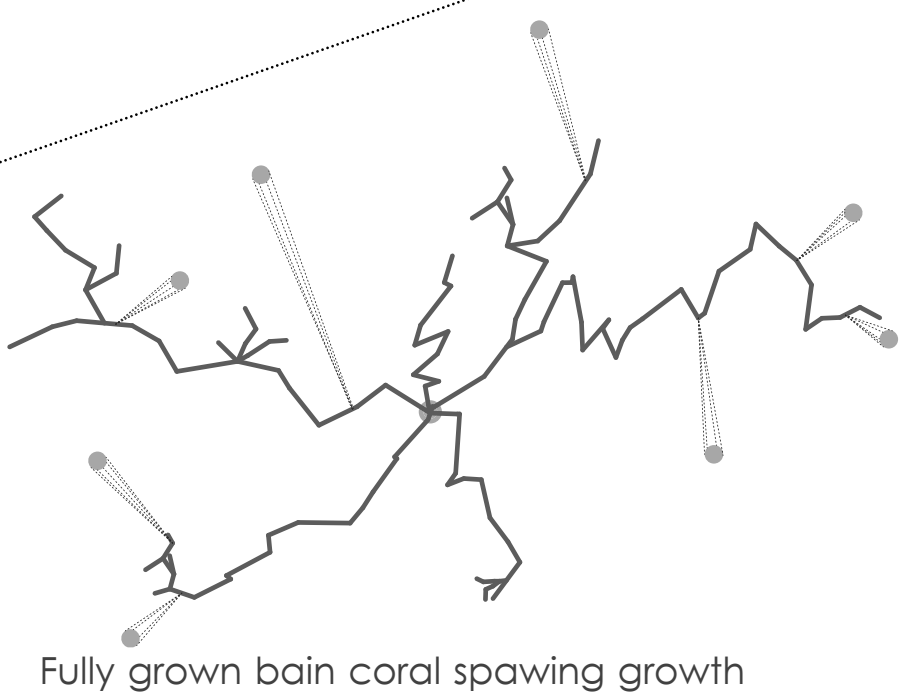
Interior living room and kitchen



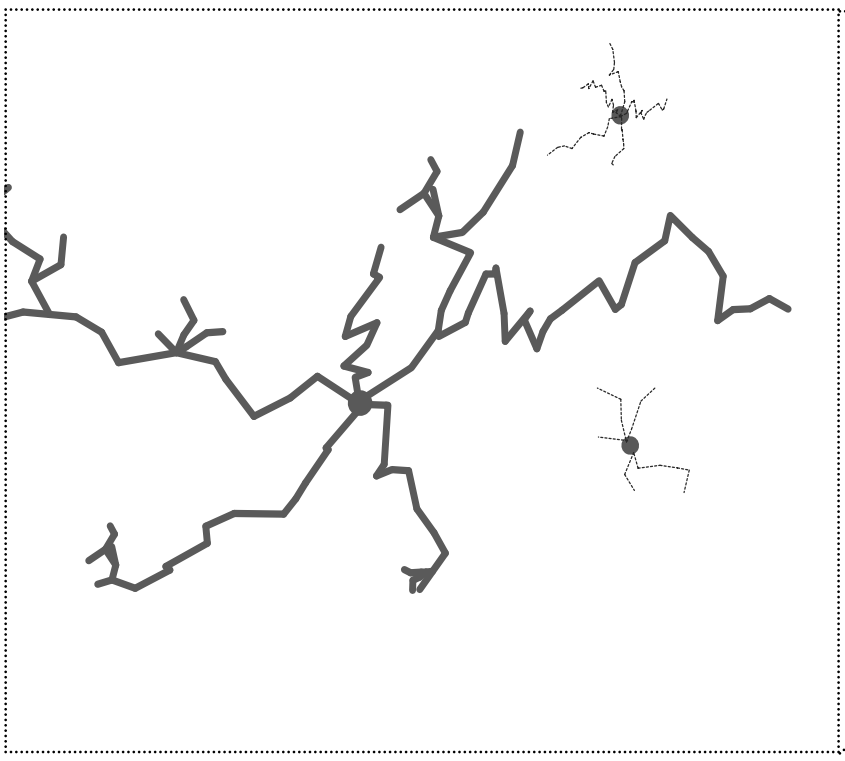
Polyp Budding at micro growth scale



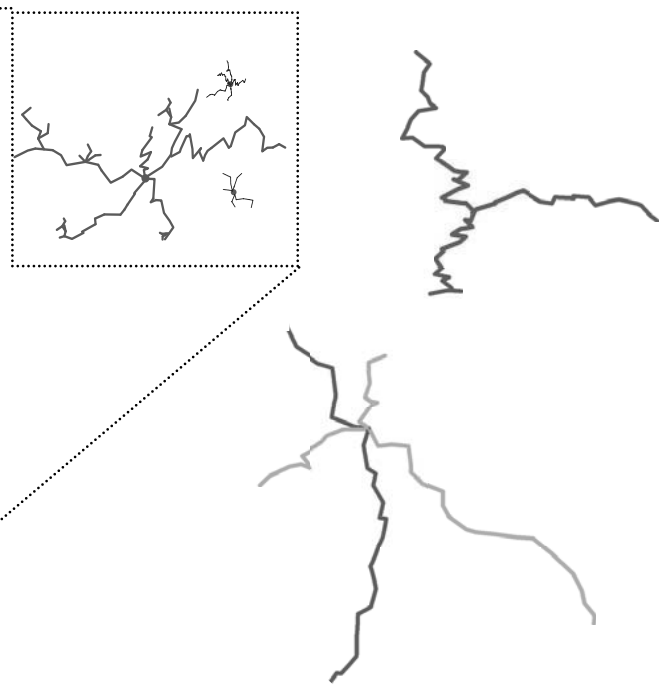
Polyps forming large brain coral



Fully grown bain coral spawing growth



Few coral survive spawning process and become full grown

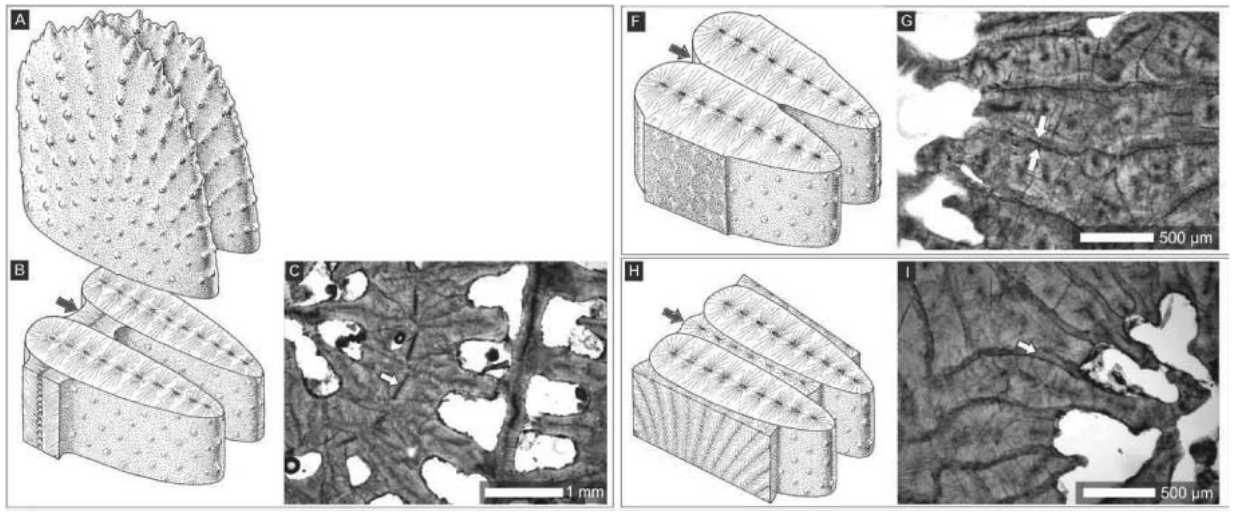


Full Grown Coral

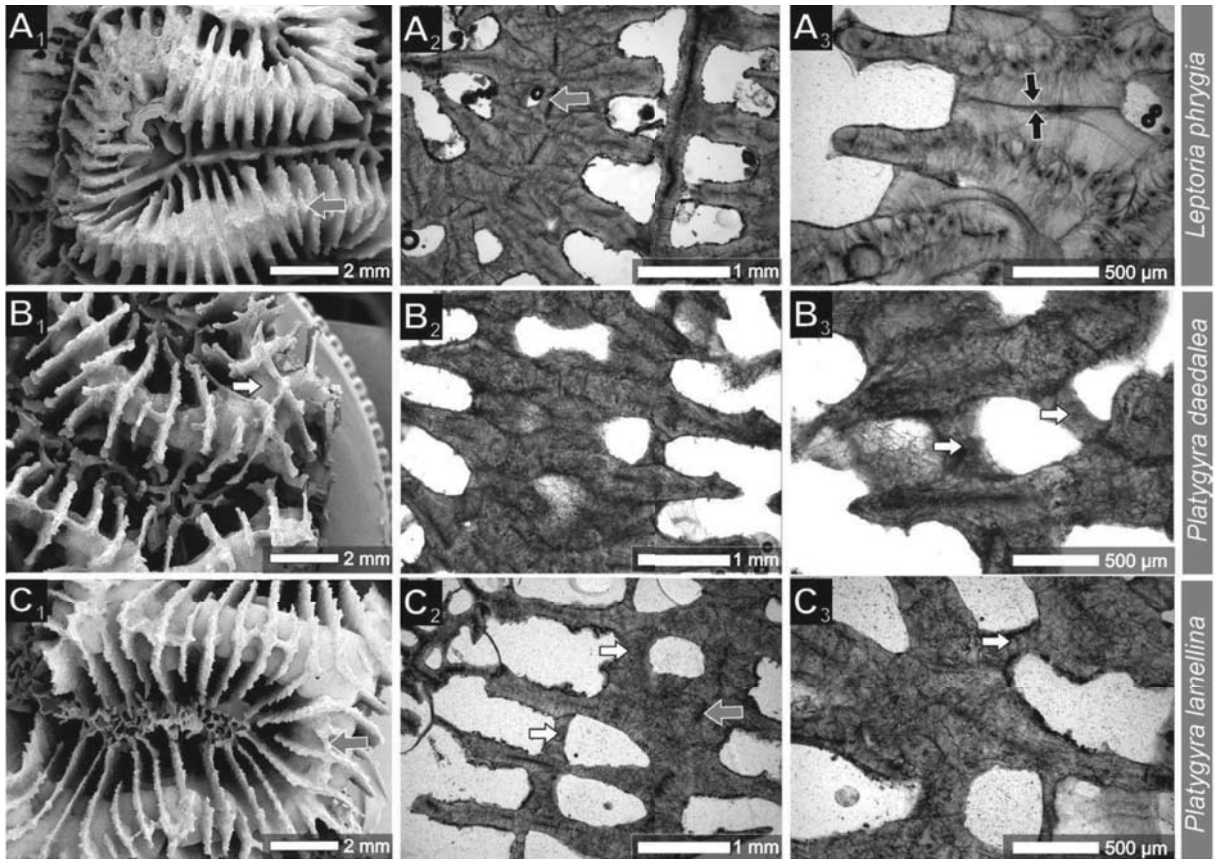
I applied the data discovered of coral growth variation to a densely populated environment. The mapping of the new design began from one point then grows, similar to the coral, on the site's topography. I imitated how the coral grows multi–directionally in a linear fashion and how it grows in specific directions based on the space that is available. This multi–directional growth was used to create an interconnected system of vectors on a landscape, which will eventually host residential units.

The residential units scatter throughout the landscape as clusters of living objects. Each resident rotates from other residencies to accommodate topographical changes. There are set rotation plates that are used to connect two residences. These plates vary incrementally from 15 to 35 degrees. The plates create an interstitial space between the two residences that is used as a main entrance. The units can also slightly change in height. It was important to accomplish a design that was able to fit within many circumstances that an urban slums may have.

The residence is made up of an adaptive panel system. The project was designed so that one–quarter of the residence can be mirrored to the other three–quarters of the design. All of the planar panels are interchangeable between structure attachments and windows, and in some cases have both windows and exterior attachment. The panels act as a double envelope system similar to that of the brain coral, how the brain coral protects it self against the harsh environment.



Two polyps with excreted calcium and x–rays



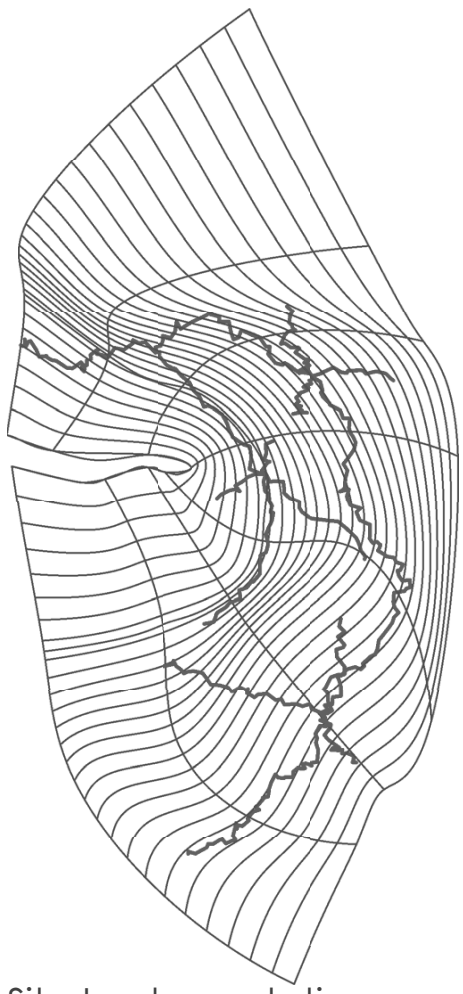
Coral skeleton close–up images and x–rays



Growth method applied to design bridging gaps between

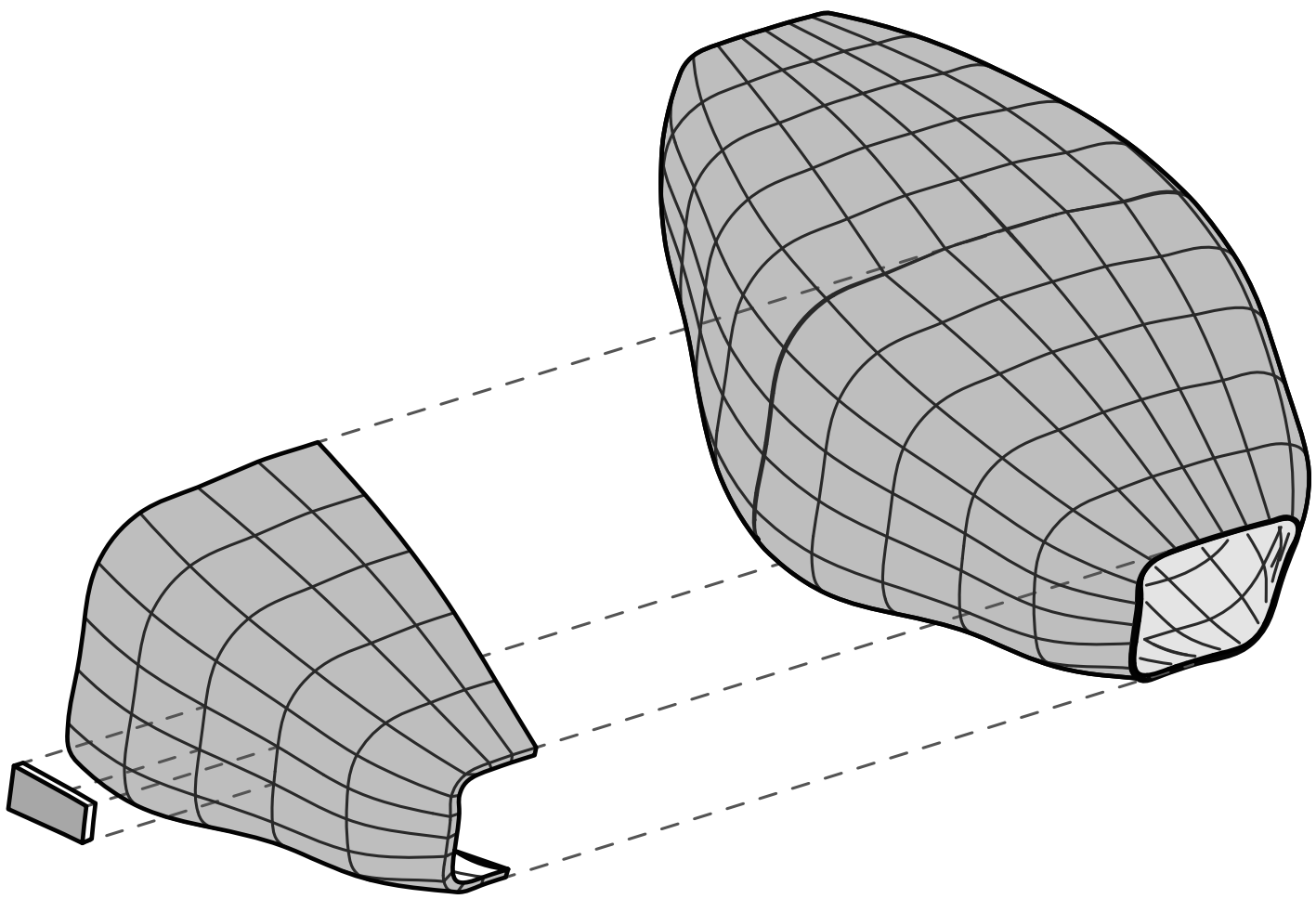


Interconnected system of growth

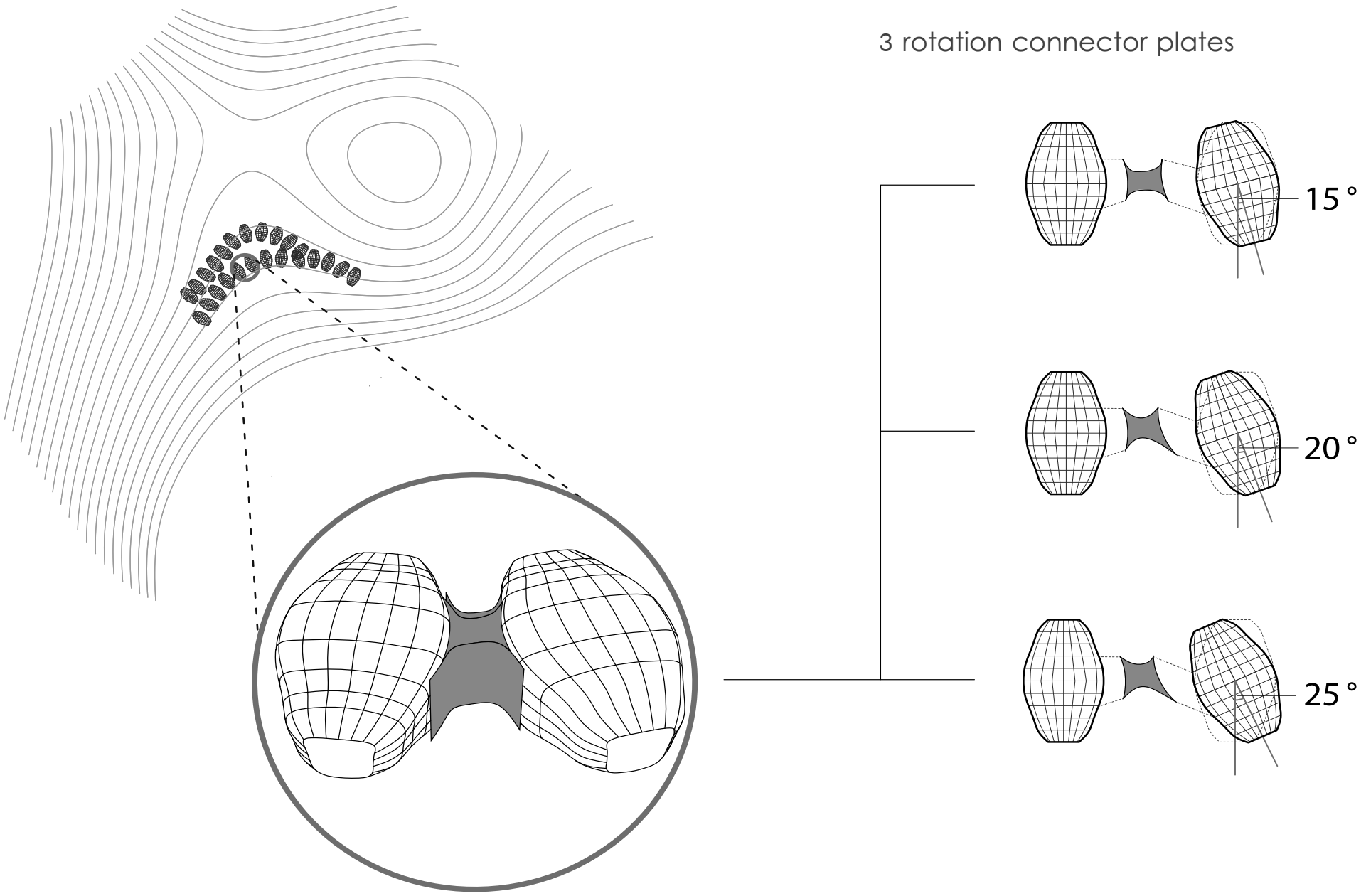


Site Implementation

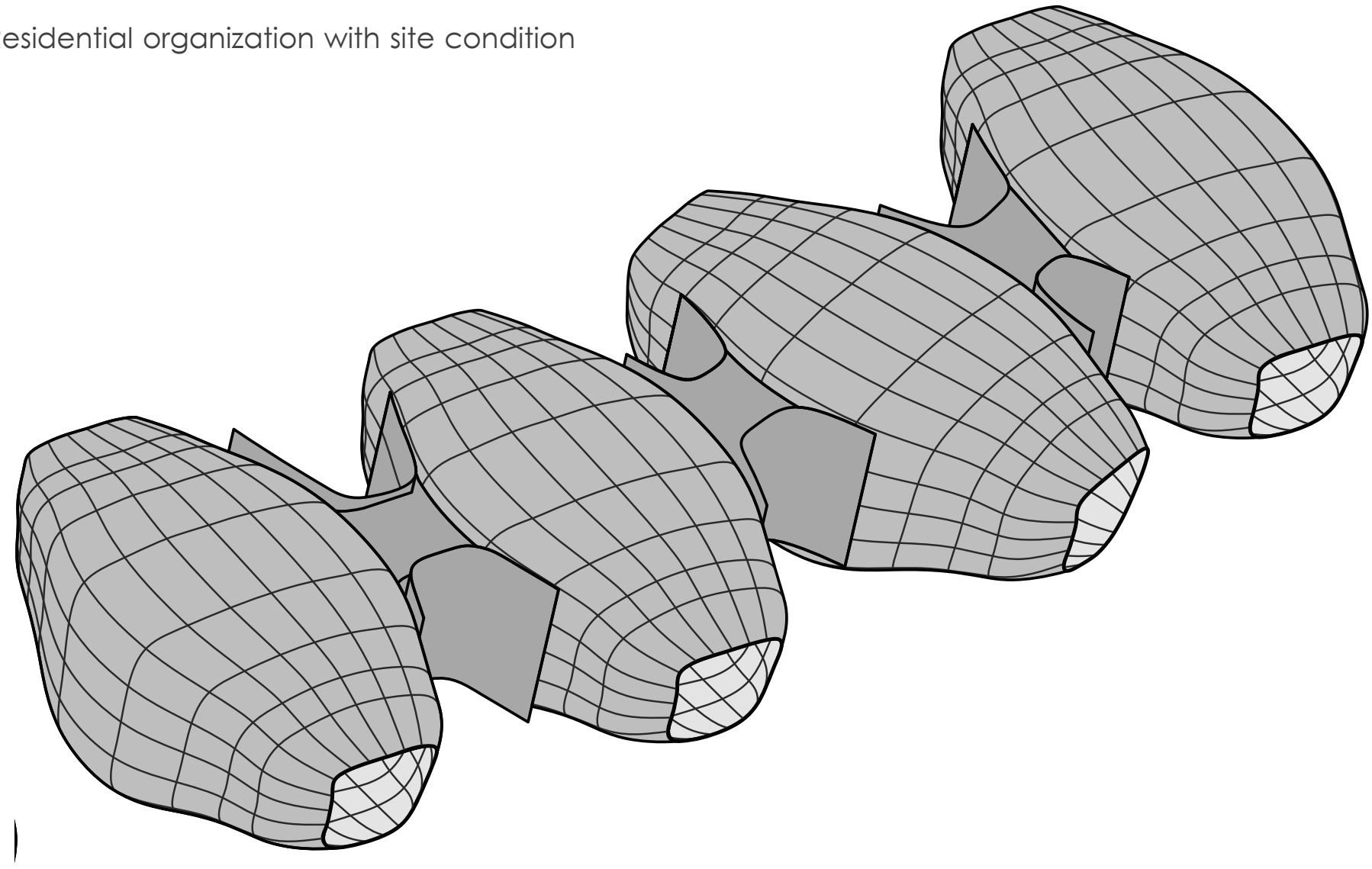
Caracas, Venezuela



Panel system breakdown

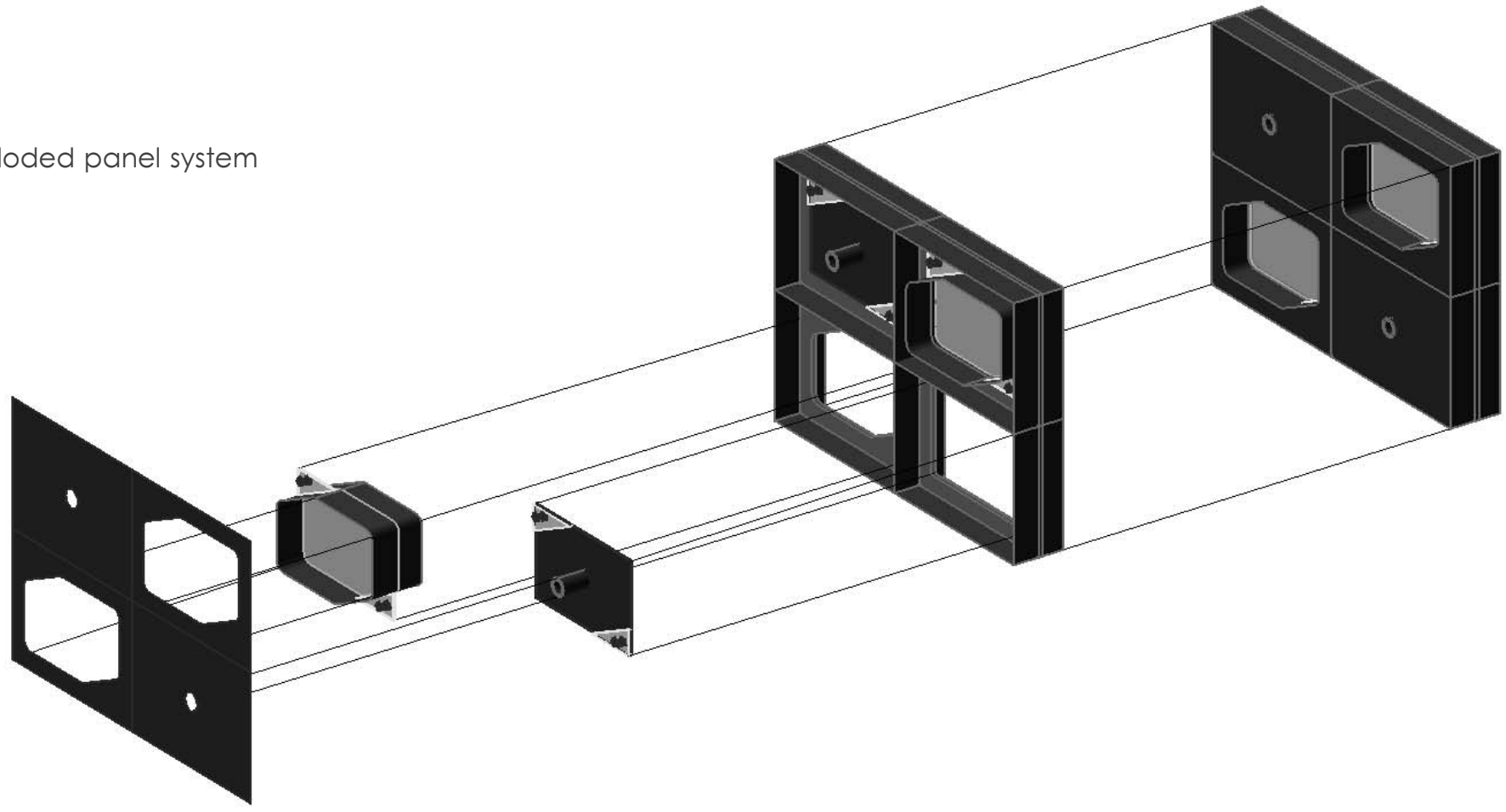


Residential organization with site condition



Residents connect at entrance points and rotate and shift according to the site

Exploded panel system

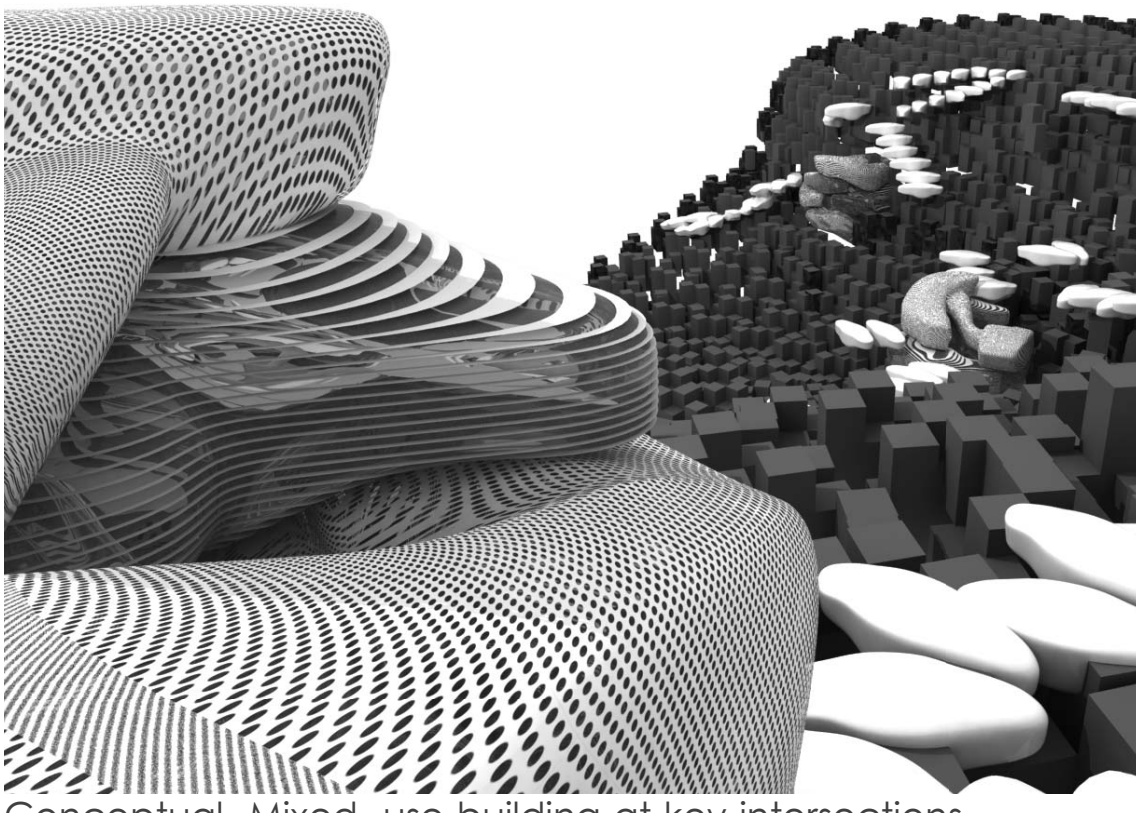


Site

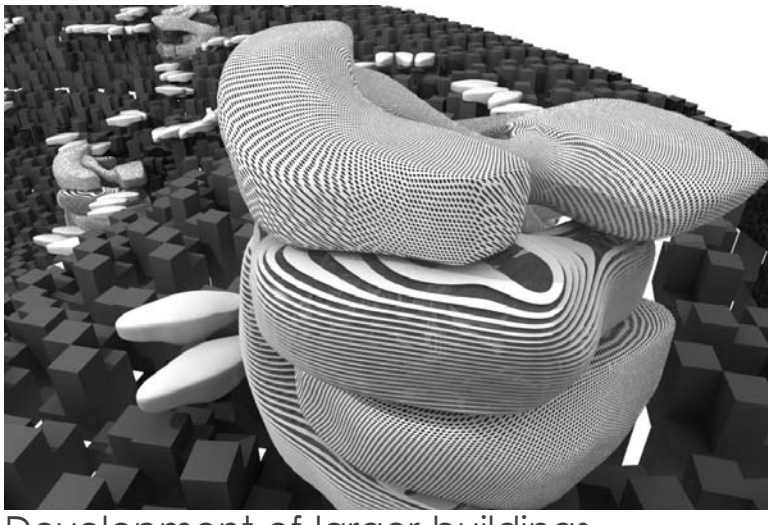
The development of a program is essential to the project as a whole. The intention was to look at urban slums as an opportunity to improve the quality of life. Applying a design with modularity, adjustability, and variation was my intention to address urban slum site issues. This design can be applied to many different urban slums around the world but I decided to focus on Caracas, Venezuela. Caracas has one of the highest rates of squatter settlements at 52%.

Structural component

The structural panel has four open connection locations. They are designed in this way so that one could decide whether to connect a window, or a structural piece, or both in one panel. The structural connections are used to attach additional components such as a louver system, roof decking, green roof and trellises.



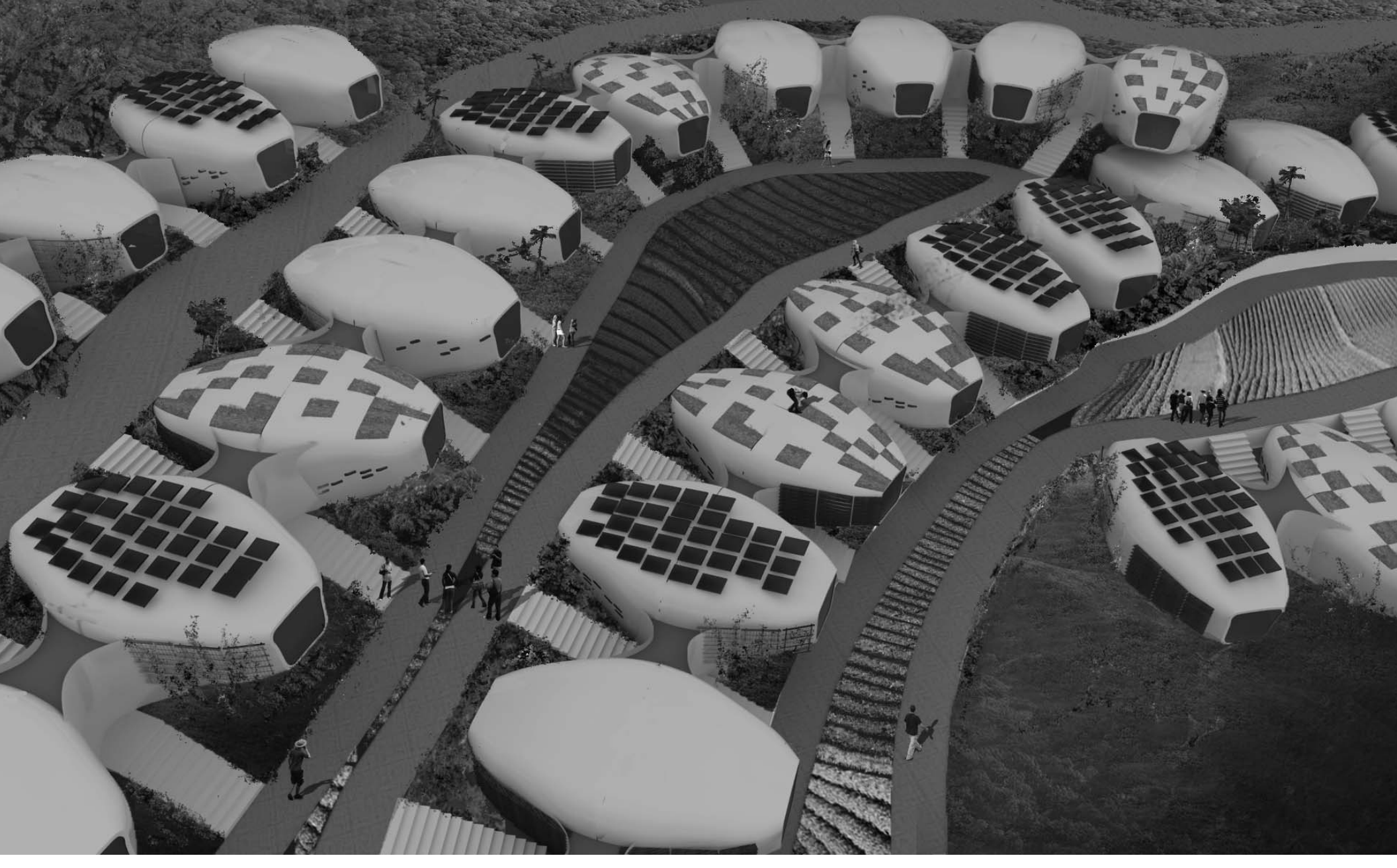
Conceptual Mixed use building at key intersections

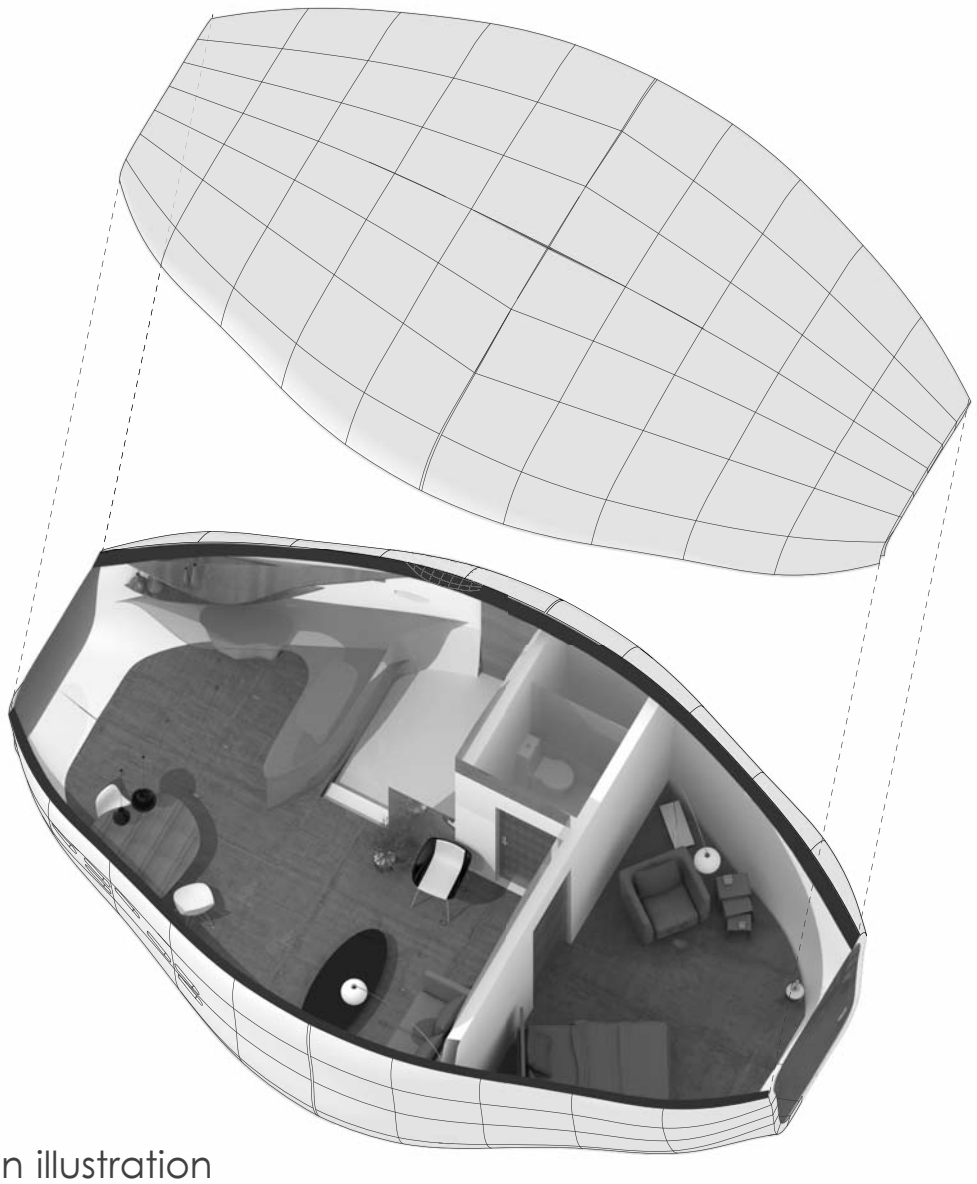


Development of larger buildings



Interior of resident





3–D plan illustration

This image is a representation of how these residential units may be inhabit–ed. The focus of this representation is to show that he flexibility within in the site and the attachment possibilities. The attachments shown on the residences are Wooden shading louvers, Photo–voltaic panels, metal trellises, and green roof panels. In addition to the structure the sense of community it at play and the current residents are sharing a very large communal garden that is used for growing their current food so they are able to sustain the current environment.