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SPLIT HOUSE Co-Housing



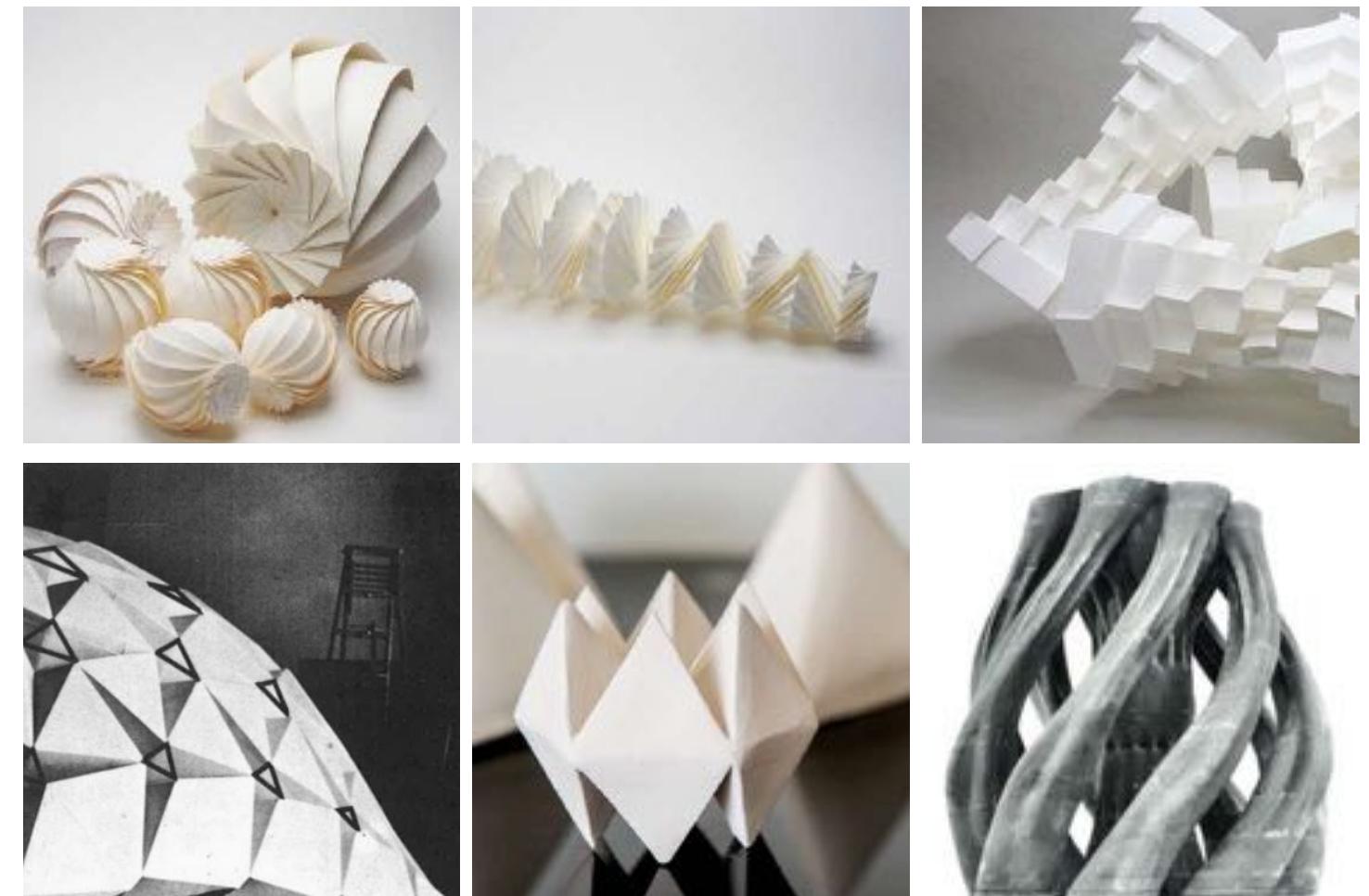
Hazelwood, PA
Lithopic NOW Studio
Dana Cupkova
Spring 2020

Embedded in an ecological hillside, the co-house focuses on taking advantage of landslides that occur in Pittsburgh due to heavy rain and the central greenhouse and co-housing rooftops collect mud and water and redirects it over, through, and around the architecture to allow for direct interaction from the occupants

CONCEPT

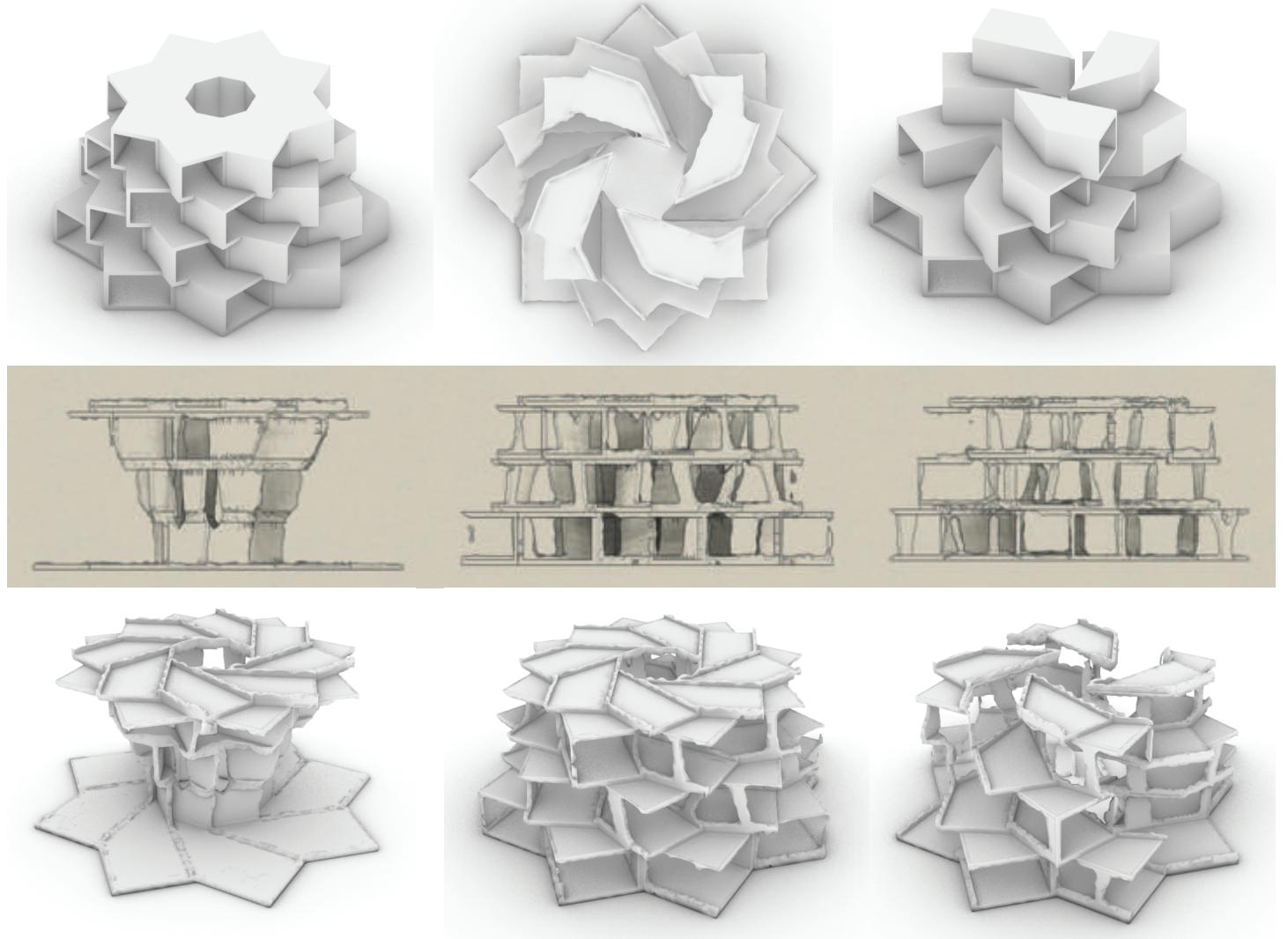
The project began with trying to understand the concept of form and structure together in the form of a component piece that would become integrated into the final project later. When beginning this project, I was interested in creating interwoven spaces between homes that would have shared public spaces weaved with private spaces. This led to me to research origami-like forms that could become structural components for homes to be placed into it, like a structural core to the building.

ORIGAMI



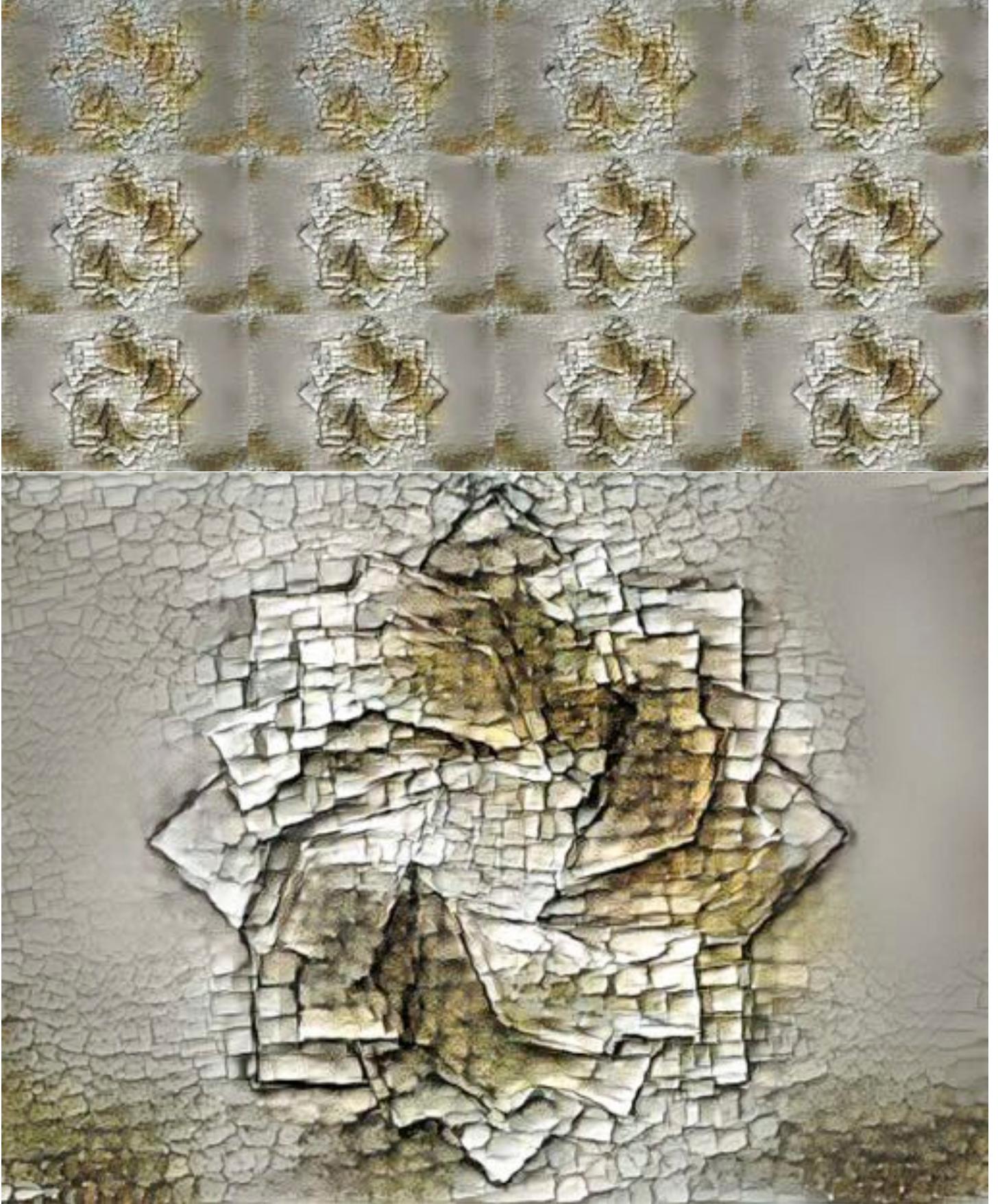
The first image to the left on the top row focused on understanding how spaces overlap with one another to create openings. The second and third images looked more at the idea of creating a large structural column that could be used to hold homes of multiple families and have a spiraling circulation from the bottom to the top. The two images to the left in the second row were more of facade components that could be fitted together, like a puzzle, that would then create an unified form at the end. The final image was a concrete column that was more interested in the formal qualities of how the exterior pieces were spiraling around this central column and creating these openings between each piece.

Through these studies I became more interested in creating a structural core of a building that could then have modular pieces that could connect with one another to create an architectural form for housing.

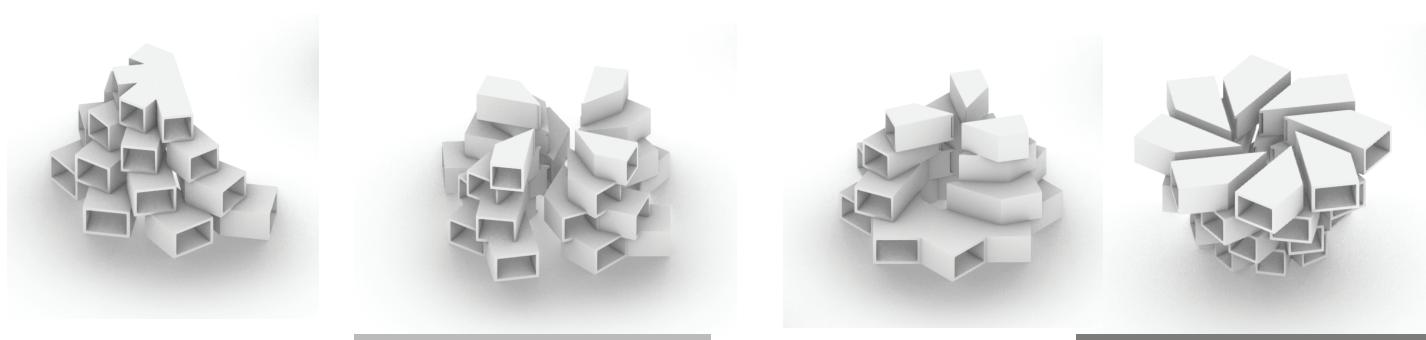
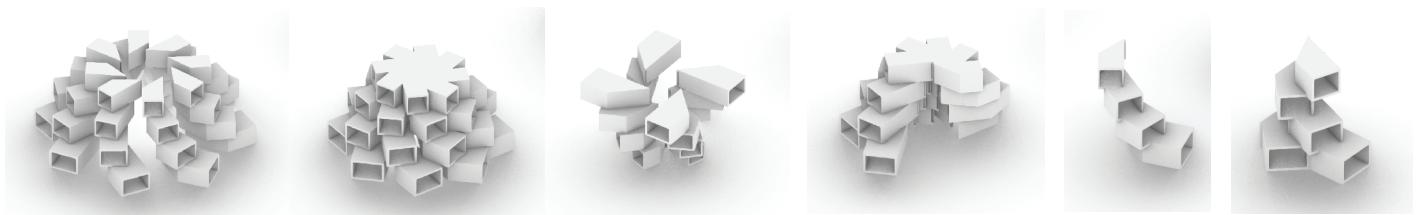
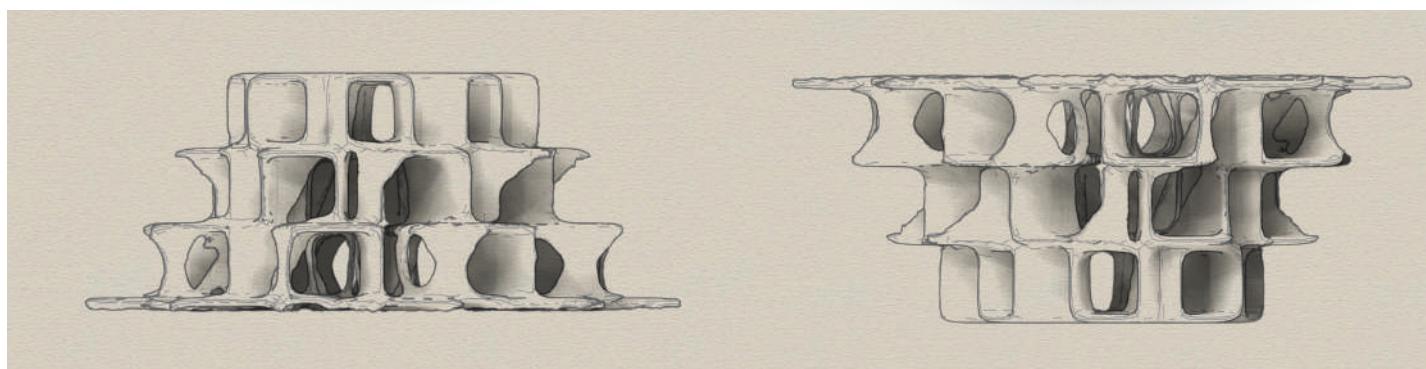
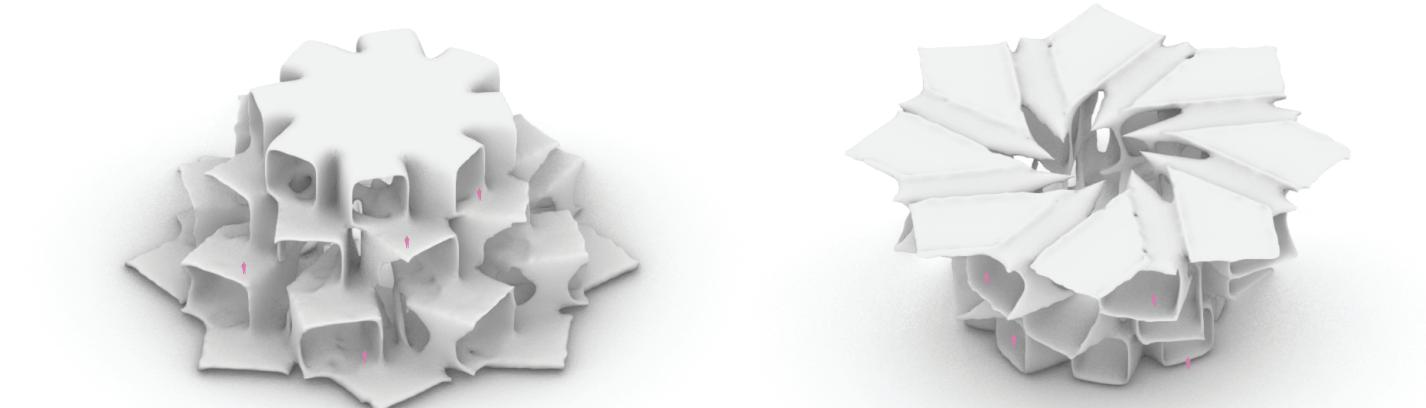
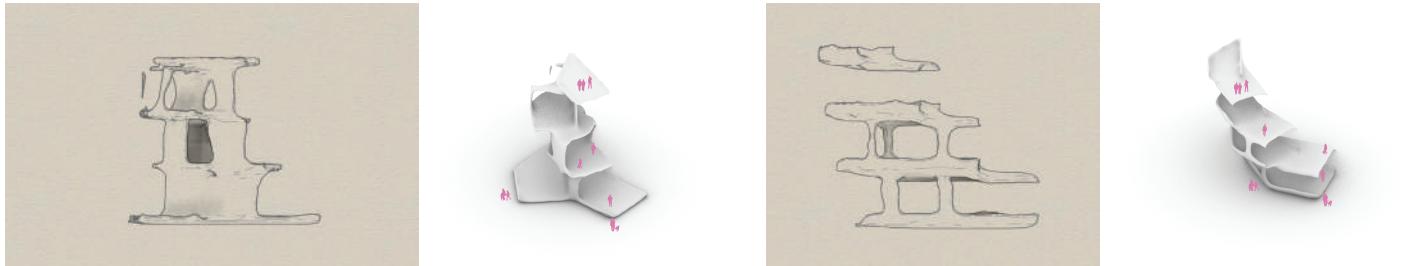
CONCEPT**FORM**

Continuing with the idea of creating interweaved spaces using this structural core to create housing for families that integrated both private and public spaces created the forms shown in the image above. These were studies of form and how load could be distributed to different parts of the structure to allow for material to be optimized in the overall structure and create openings amongst the spaces to allow for access to public and private spaces amongst different families. Then, I began to grow interested in the idea of creating these homes that stacked on top of one another that would provide a distinct difference between public and private spaces that could potentially later be puzzle pieced together to create a series of homes for multiple families.

The images on the next page used this form and integrated an ecological textural pattern onto the form to see how the form would alter the texture. The texture I was interested in looking at was a combination of concrete floors and moss/grass that sprouted in between these concrete tiles.

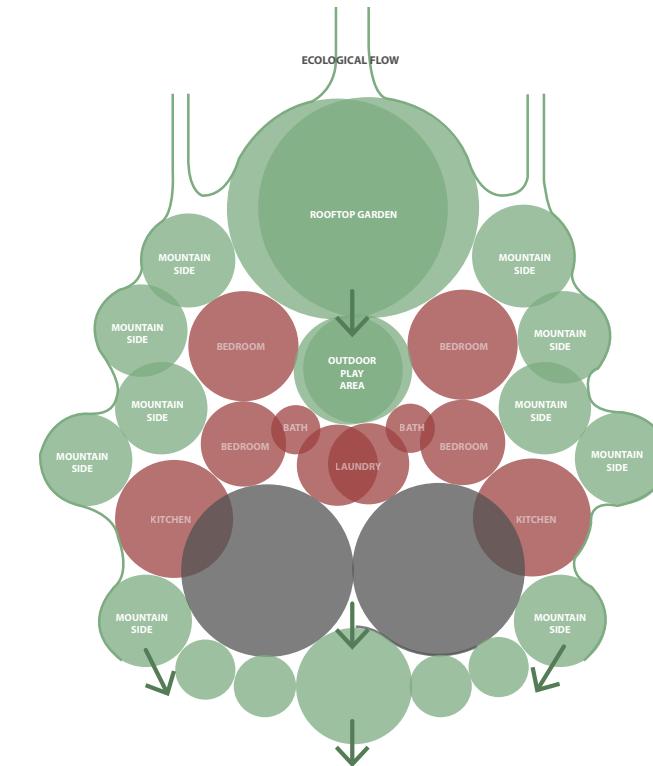
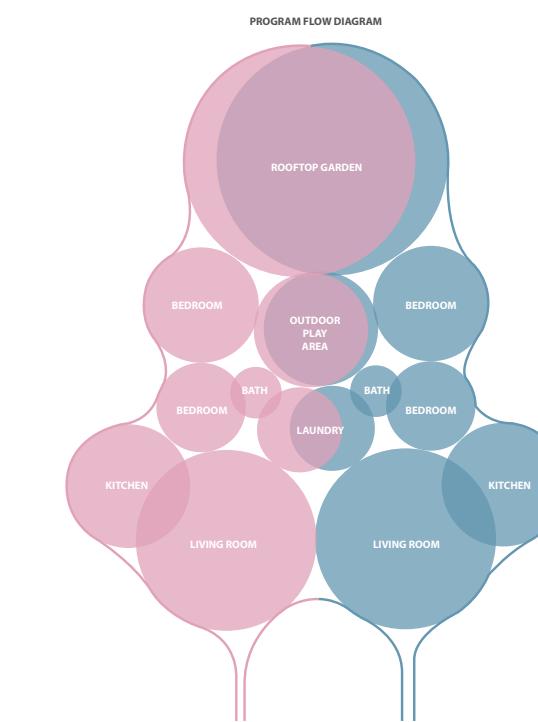
CONCEPT**TEXTURE**

CONCEPT CO-HOUSING



CONCEPT CO-HOUSING & ECOLOGICAL FLOW

The goal of this co-housing environment is to allow for lower-class families to have an option of more affordable homes in a neighborhood with a good schooling system. It also allows the opportunity of co-parenting amongst families through these public spaces in between these homes to allow for closer relations to form between both the parents and the children that live in this area. These initial flow diagrams helped understand how human circulation and activity would occur in the architectural form and how that would be affected by the potential ecological flow that ran across the form. I later began to try to understand how the ecological flow and human circulatory flow could interweave with one another. This would allow for the ecological flow to surround the homes and allow for people to always be surrounded and in contact with the environment around them.



HILLSIDE CONDITION

I was looking into sitting this building on a hillside steep that was approximately 37 degrees sloped in Hazelwood. Since Pittsburgh, Pennsylvania is an area that is very susceptible to extreme landslides because of the large amounts of rain in the area, I wanted to focus on creating a form that would be able to take on these flows of mud and water onto the site and allow for human interaction with it and to prevent this house from sliding down.



FLOW & GAN STUDIES

Flow scripts were run onto existing concrete tiles that were provided by our professor to understand how ecological flow, like rainwater, would be collected onto the site in places with low elevation and high elevations. The different colored lines represented different zones of water that were collected based on different elevations on the site, so different groups of flowlines would come together depending on where the source of water on a hill came from. The circles represent the elevation on the site where the larger circles are where the elevation is at its highest and the smaller circles represent where the elevation is at its lowest.



FLOW & GAN STUDIES

TEXTURE AND LANDSCAPE



Rather than looking at directly how ecological flow would affect a site, these studies tried to understand the textural integration onto a landscape from these image studies. GAN stands for Generative Adversarial Networks which are algorithmic architectures that uses two neural networks (in this case an ecological texture pattern and a landscape pattern) and pitting one against the other in order to generate new, synthetic instances of data that can pass for real data. In this case it is used for image generation. In the images above and below the first image is the ecological texture patterns that I was interested in, including the one that I generated from the flow studies. The second image is the landscape tile that was provided. The third image is the GAN image that was generated from combining the first two images to understand how the ecological texture would affect the landscape.

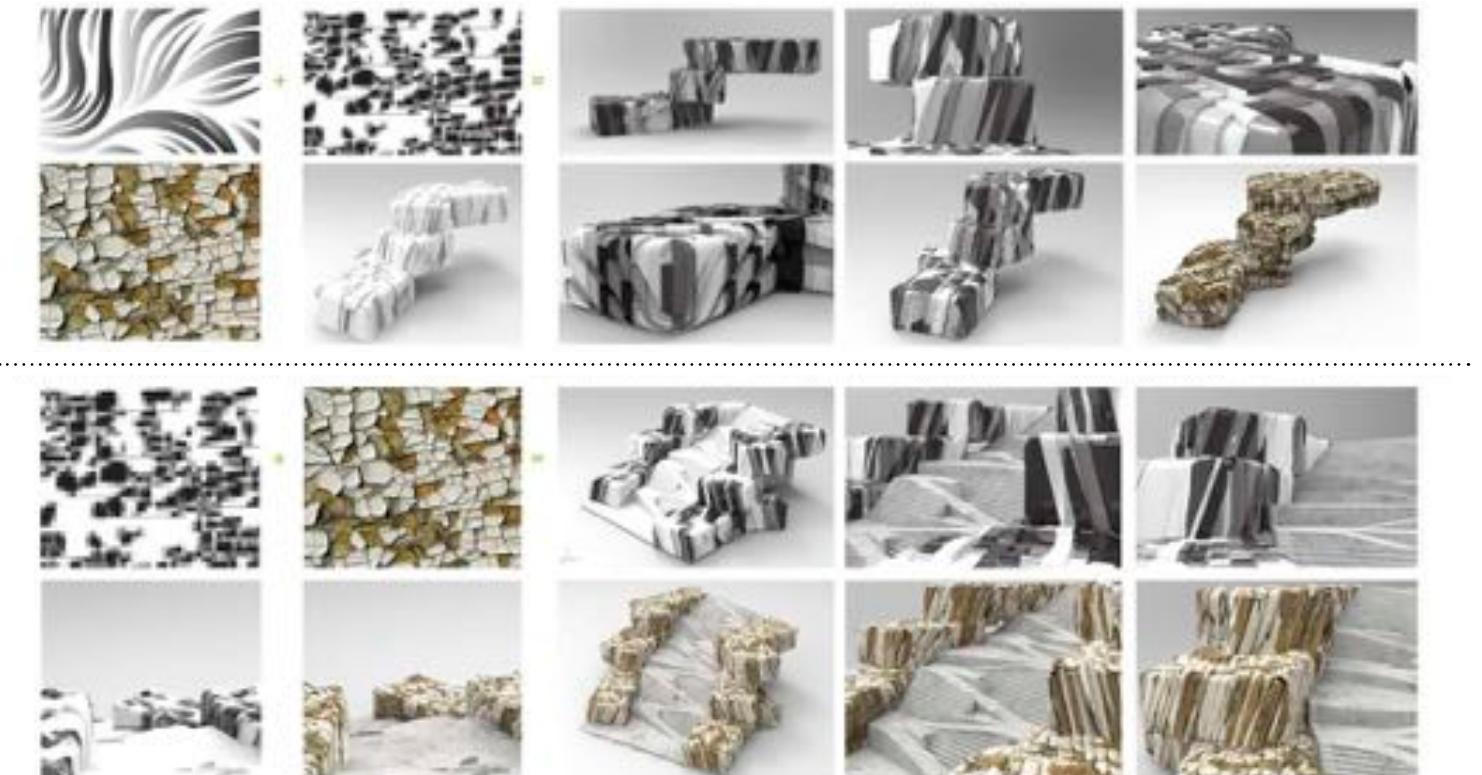


TEXTURE STUDIES

These are initial studies of architectural form on an initial massing of multiple buildings and understanding different ecological patterns integrated on these forms through Keyshot.



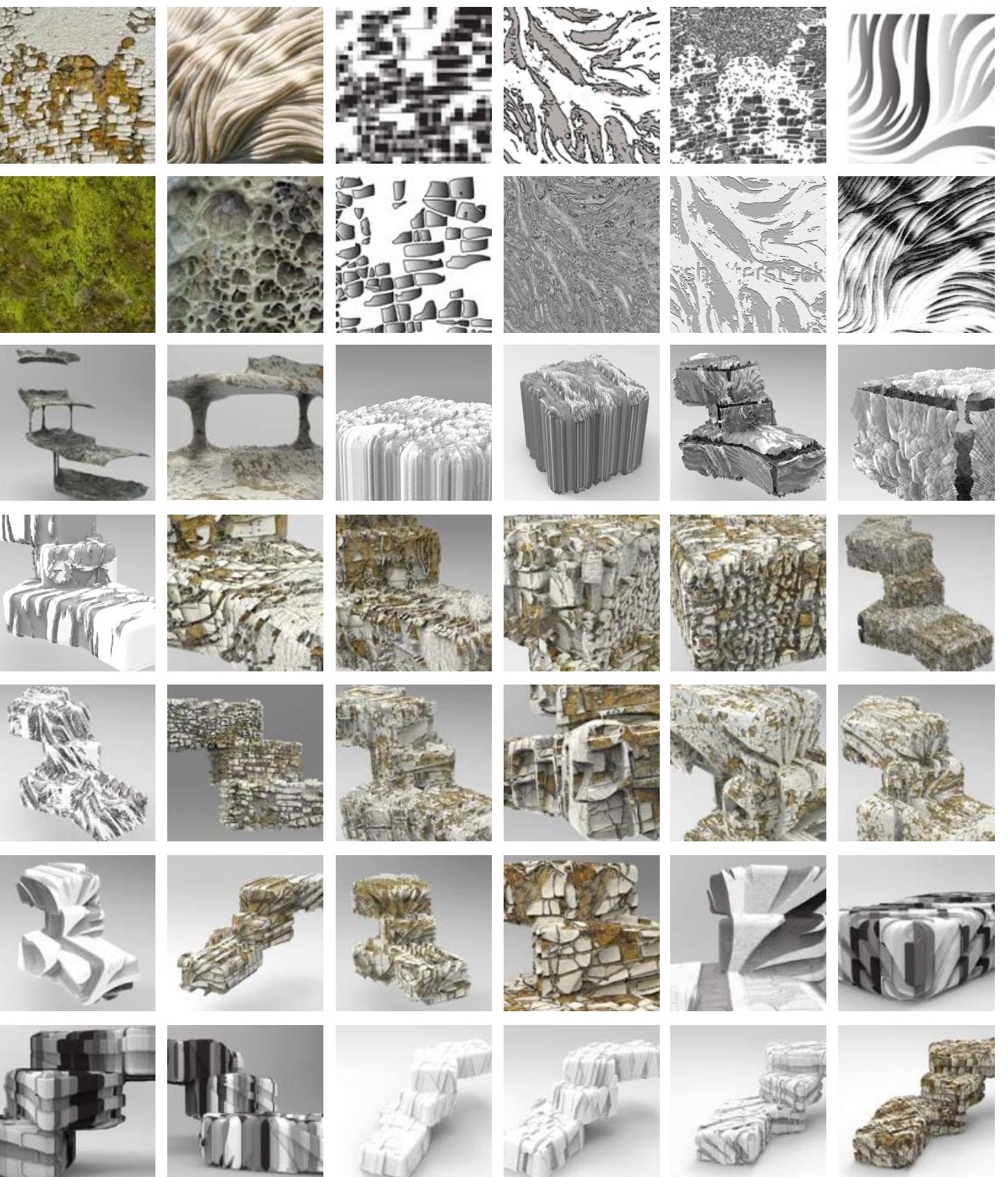
Then, I began to do more in-depth studies going more into the focus of the architectural facade form and material texturing that I was interested in looking into.



CONCEPT

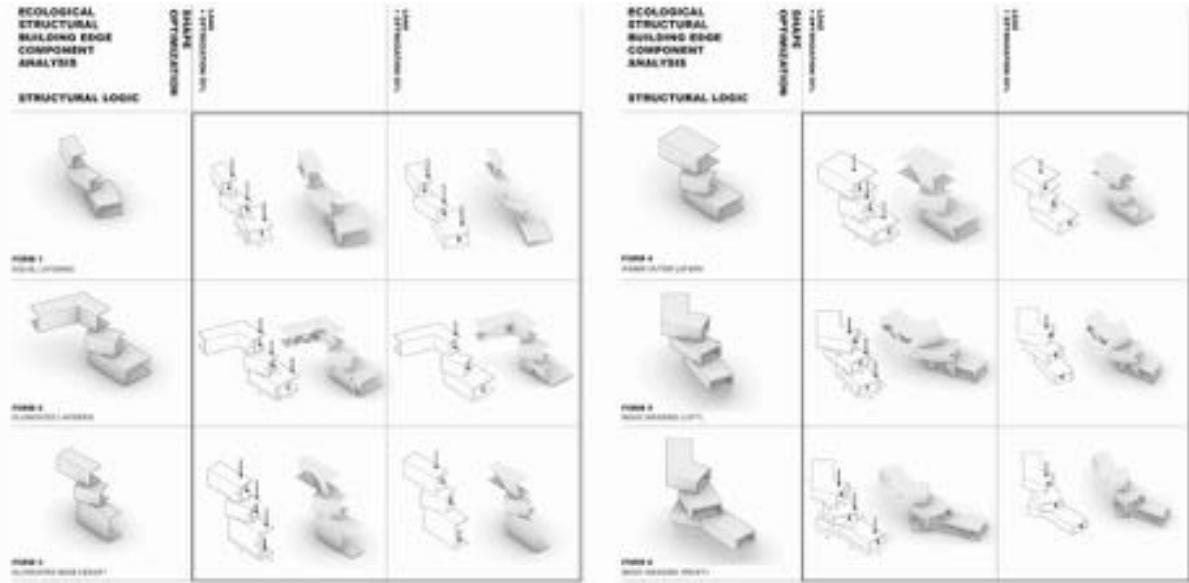
INITIAL STUDIES CATALOG

This is a catalog of the ecological texture patterns that I was interested in and the black and white patterns that I developed from them to use for form studying through Keyshot. This is also a catalog of the studies I did from the start to the end before I reached the final form that I was interested in developing more.



VOLUME REDUCTION

These studies below focused on trying to understand how these stacked massings could be formed in a more structural way through different amounts of spatial overlap, different heighted spaces, different lengths of spaces, etc. This helped create a more structural understanding of which sets of forms placed on top of one another could be the most structurally sound. Then, I ran studies on how the material of these forms could be optimized depending on where the loads were placed on the overall structure.

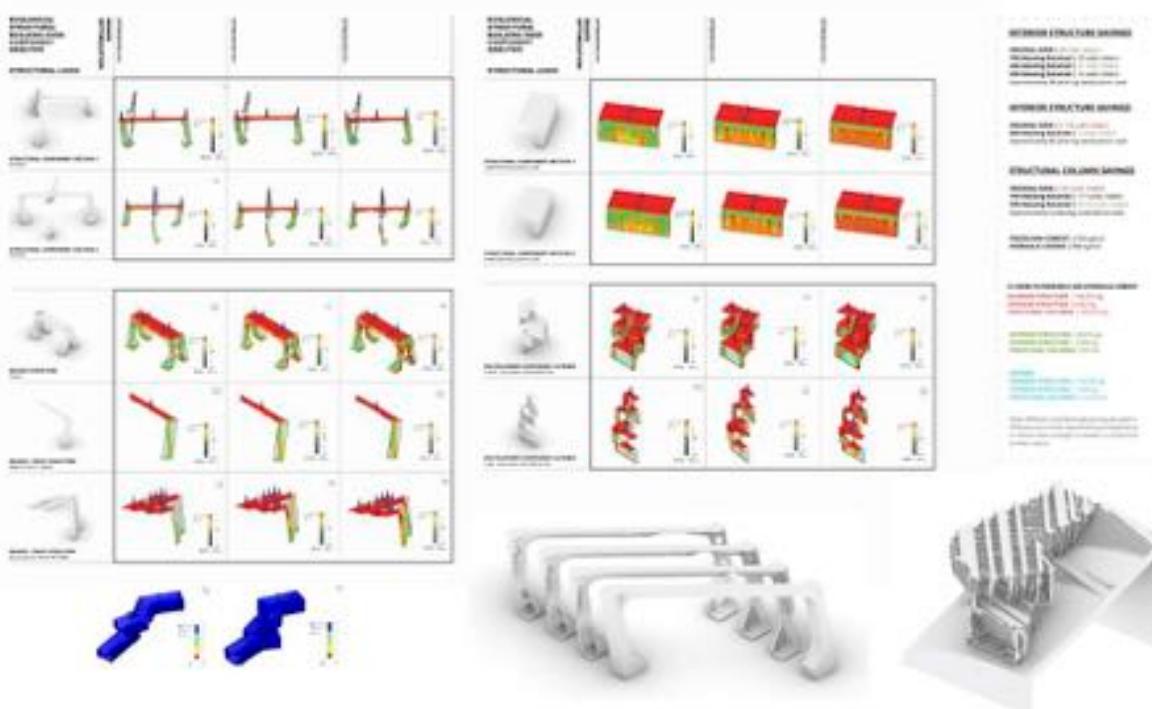


The studies below began to understand how different structural components are integrated from the initial Keyshot form studies and understanding how much material could be taken away from these forms to reduce the weight of the overall mass. From this I concluded that there were three main structural pieces to the building:

[An Exterior Structural Piece](#), where I reduced 40% of the massing and saved about 86.5% of material,

[An Interior Structural Piece](#), where I reduced 20% of massing and saved about 33% of material,

[A Structural Column](#) for the floor plates not being held up by the overall mass, where I reduced 50% of massing and saved about 46.8% of material. I also did an analysis to understand where the architectural form would potentially need more structural load and where it would need less to use different levels of optimized structural pieces in different parts of the building.

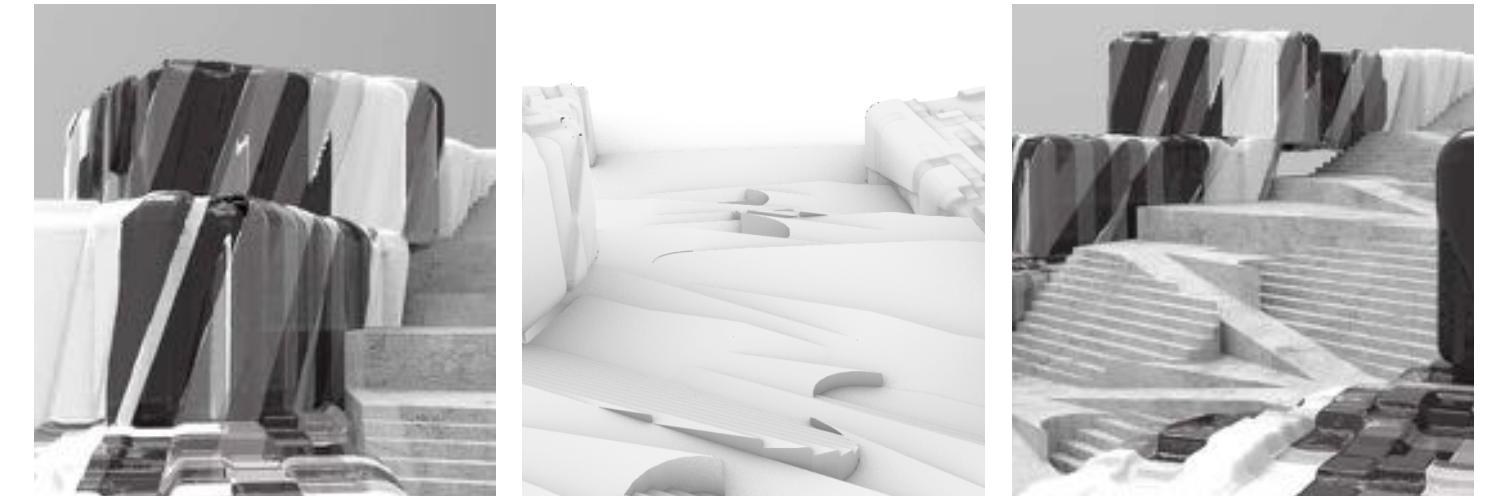


DESIGN INTEGRATION

I started to understand how architectural form could integrate the idea of interweaving between different homes to allow for shared spaces and private spaces to coexist with one another

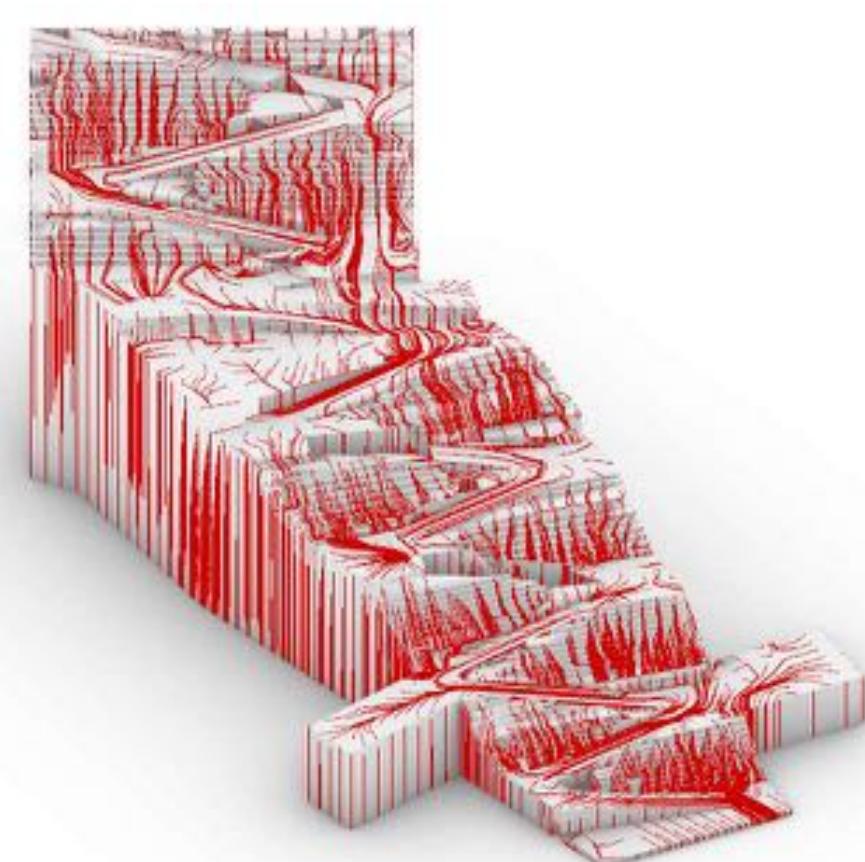
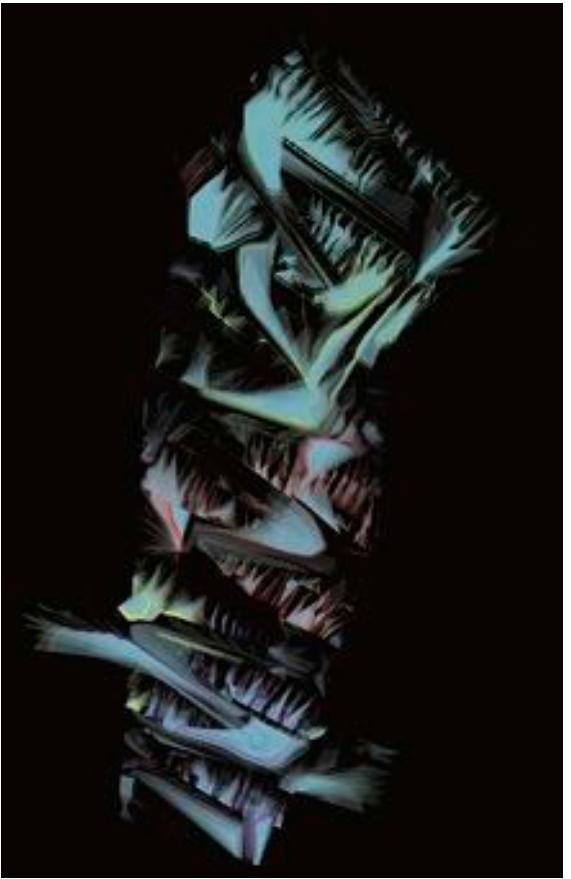
MASSING COMPONENT

The form follows the idea of splitting through the hillside to embed a central greenhouse into the hill that would allow for the architectural masses to come out, ground itself into this structure, and surround the space. This central greenhouse also acts as a circulatory system through the building using a series of stairs and ramps. This system also allows for ecological flow to pass through the entire structure to continue along down the hillside and prevent the building from sliding down in the case of a major landslide.



DESIGN INTEGRATION

ECOLOGICAL FLOW ACROSS CENTRAL SITE



The central circulation acts as a greenhouse in between the homes that carves into the hillside to plant itself onto this steep slope. It provides direct flow from the top of the hillside to collect the water and mud runoff to prevent the architecture from falling when a landslide occurs. It also acts as a public space for both the families that live here and for the community to interact with the environment and one another while also providing a sense of privacy by only allowing specific entrance points.



These are studies beginning to understand how ecological flow would pass across the rooftop and where water would potentially collect.

DESIGN INTEGRATION

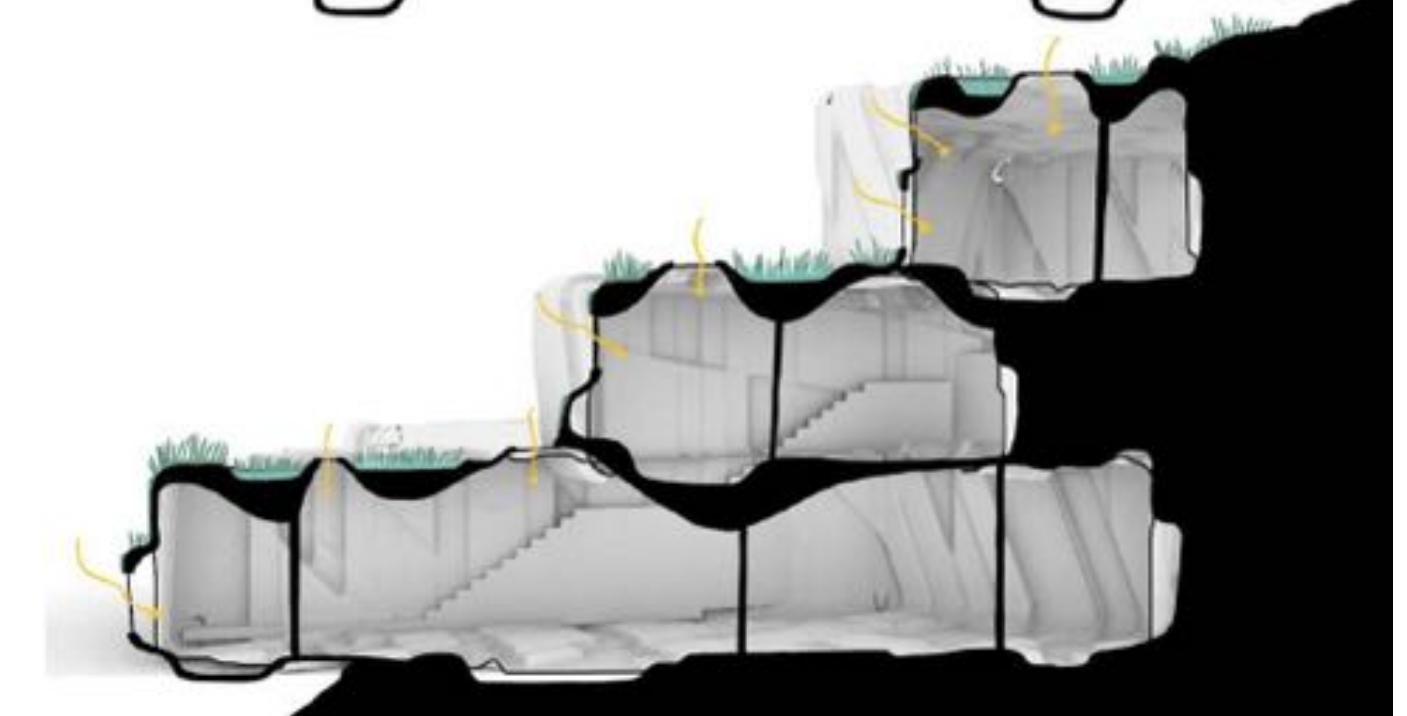
ARCHITECTURAL PLAN

The building is entered from the top of the hill and circulates downward through this central system in between the two pairs of homes. As you can see in the images on the previous page, the roofs are beginning to take in the idea of integrating a wetlands to allow for runoff to flow through these crevices and overflow onto one another until it reaches the very end of the system.

To follow with the idea of creating a co-housing system that would allow for certain spaces to be accessible to the public and other spaces to be private for residents that live here, the building is only accessible through the middle building from the stair-ramp greenhouse. This space would act as a lobby space that anyone visiting the site can go into or for shared amenities like the laundry room. From there there will be private staircases that would lead to the apartments above and below this room for the different families that live here.

SECTIONAL ECOLOGICAL FLOW ACROSS THE BUILDING

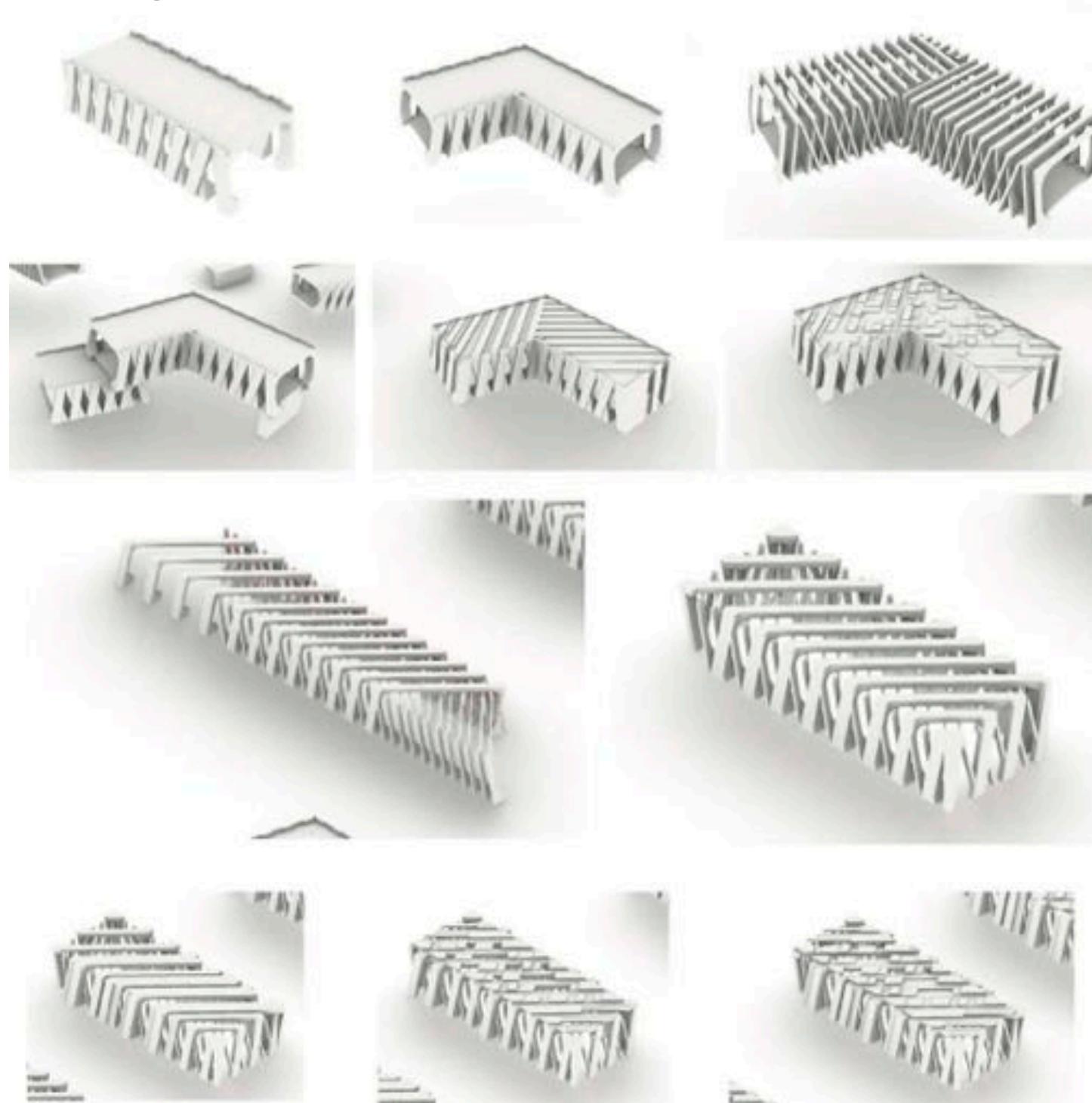
The first image begins to show how two to three buildings sit on top of one another and surround this central circulation space. The second image shows the pathway that the ecological flow would take on top of the roof of the building from the beginning to the end of the site. These studies began to show how the rooftop condition would have green spaces and dips in the roof that would collect water to channel it through the site. It also began to understand how the form could start to create apertures to allow for light to come in.



DESIGN INTEGRATION

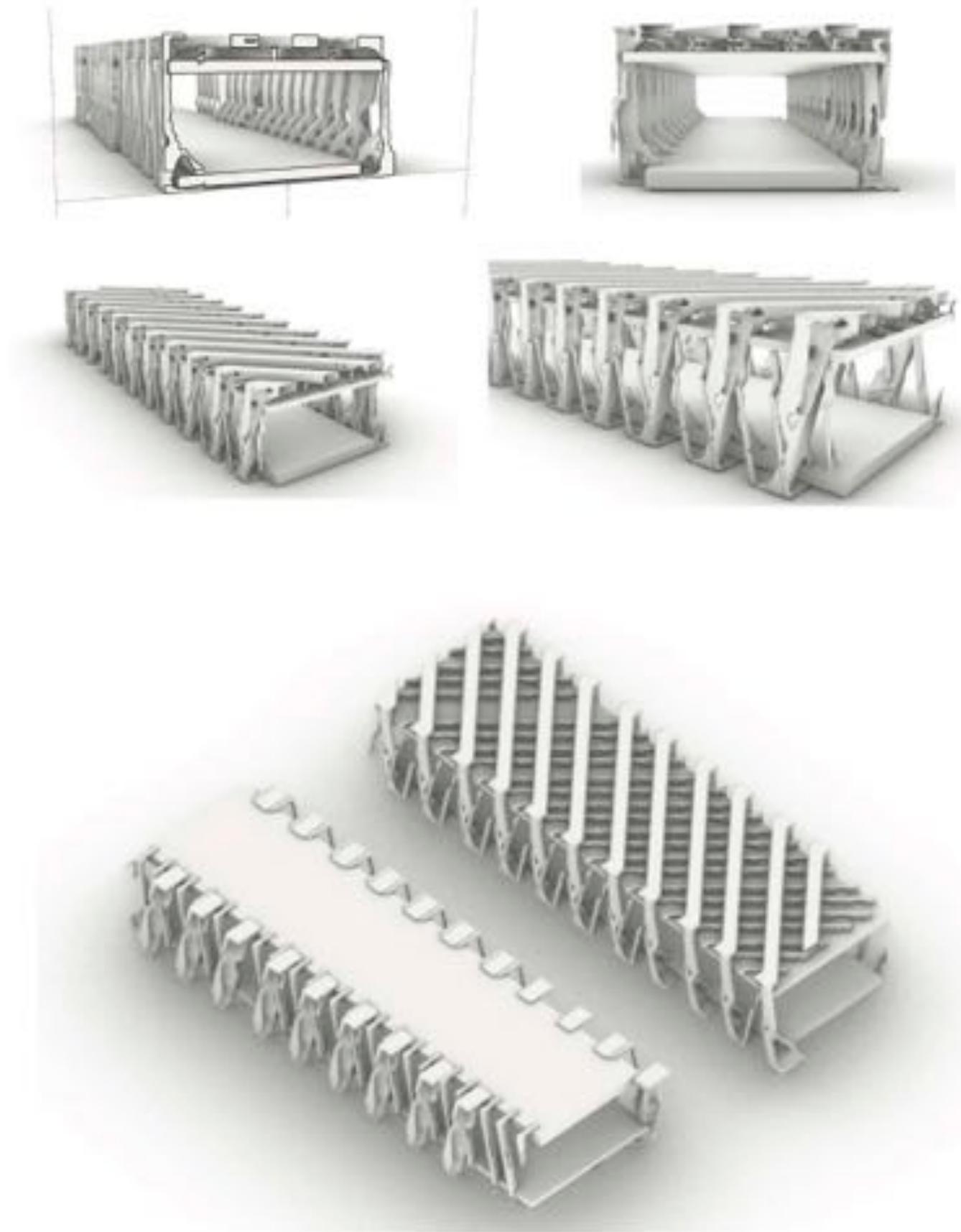
THE SKELETAL STRUCTURE

Using the form-building studies from Keyshot, I began to gain a wholistic understanding of the structural form of the architecture using the three components I mentioned before: An Exterior Structural Piece, An Interior Structural Piece, and A Structural Column. The structural pieces would create these diagonals across the facade and rooftop in response to the ecological flows that would run across them. The Exterior Structural Piece would be thicker and incorporated more into creating openings for apertures and show how the facade would look. The Interior Structural Piece would be used more commonly and focuses on holding up the concrete rooftop pieces and the exterior facade panels. The Structural Column would hold up the floorplates that are not imbedded into the hillside or held up by another building mass.



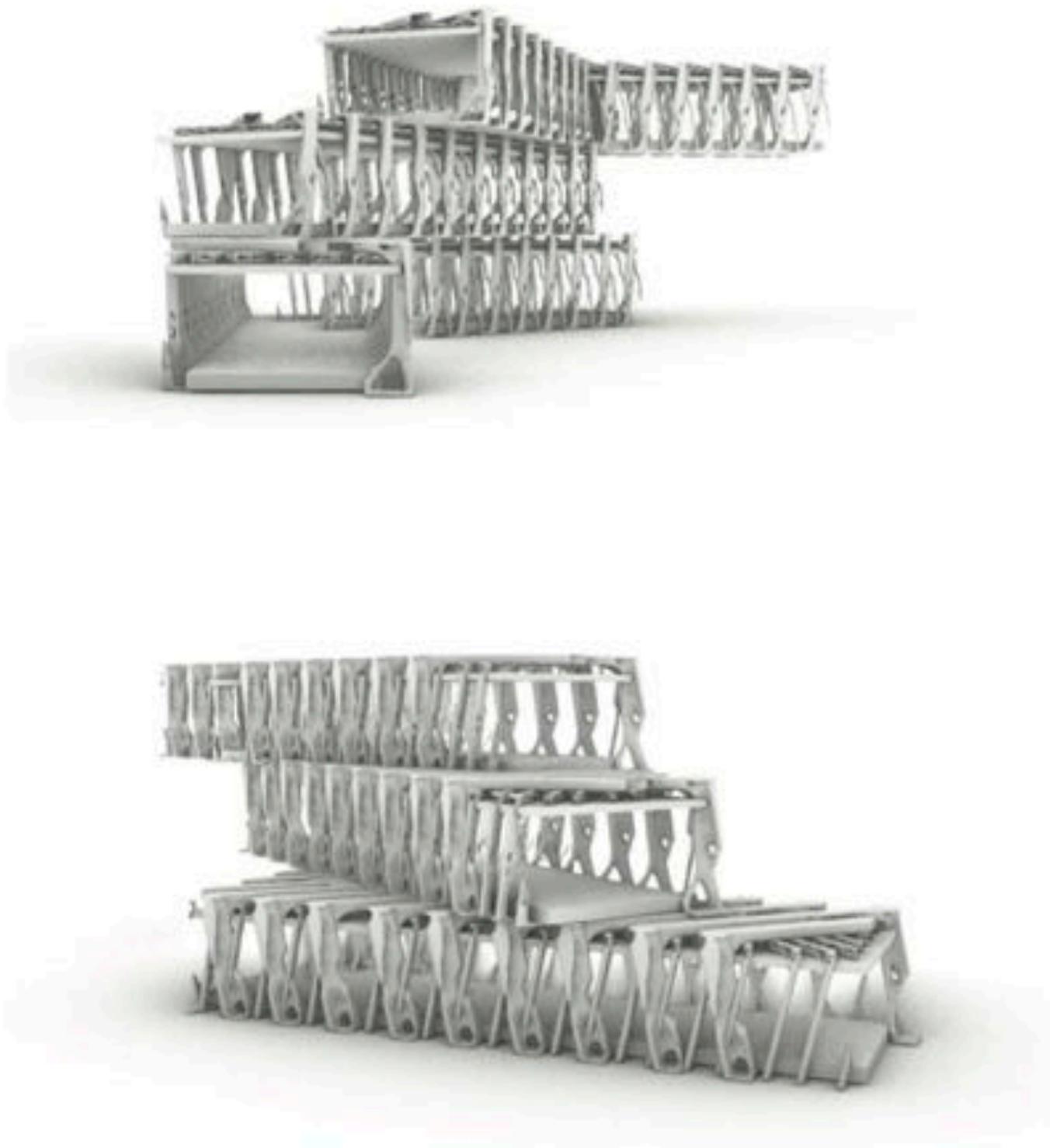
DESIGN INTEGRATION

THE SKELETAL STRUCTURE



DESIGN INTEGRATION

THE SKELETAL STRUCTURE



FINAL DESIGN PROJECT REPRESENTATION