Pollinator Homes on UBC Campus

Alexander Robertson-Mercer, Alyssa Quiring, Amy Stapleton, Anna Thomas, Cesar Niculescu, Genevieve Depelteau, Josh Potvin, Kara Verbeek, Karianne Howarth, Natradee Quek, Neal Qiongyu Li, Nicolas Dagenais-Lussier, Nicole Tischler, Niloufar Malayeri-Goodarzi, Patrick Beech, Reese Lewis, Stuart Lodge, Yekta Abolghasem-Tehrani

University of British Columbia

ARCH 577A

February 08, 2017

DESIGN MEDIA 3

School of Architecture and Landscape Architecture
Blair Satterfield - ARCH577
University of British Columbia
bsatterfield@sala.ubc.ca

POLLINATOR

ADAPT COOPT EXAPT

The concept of evolutionary adaptation is a familiar one:

"The adjustment or changes in behavior, physiology, and structure of an organism to become more suited to an environment. According to Charles Darwin's theory of evolution by natural selection, organisms that possess heritable traits that enable them to better adapt to their environment compared with other members of their species will be more likely to survive, reproduce, and pass more of their genes on to the next generation."

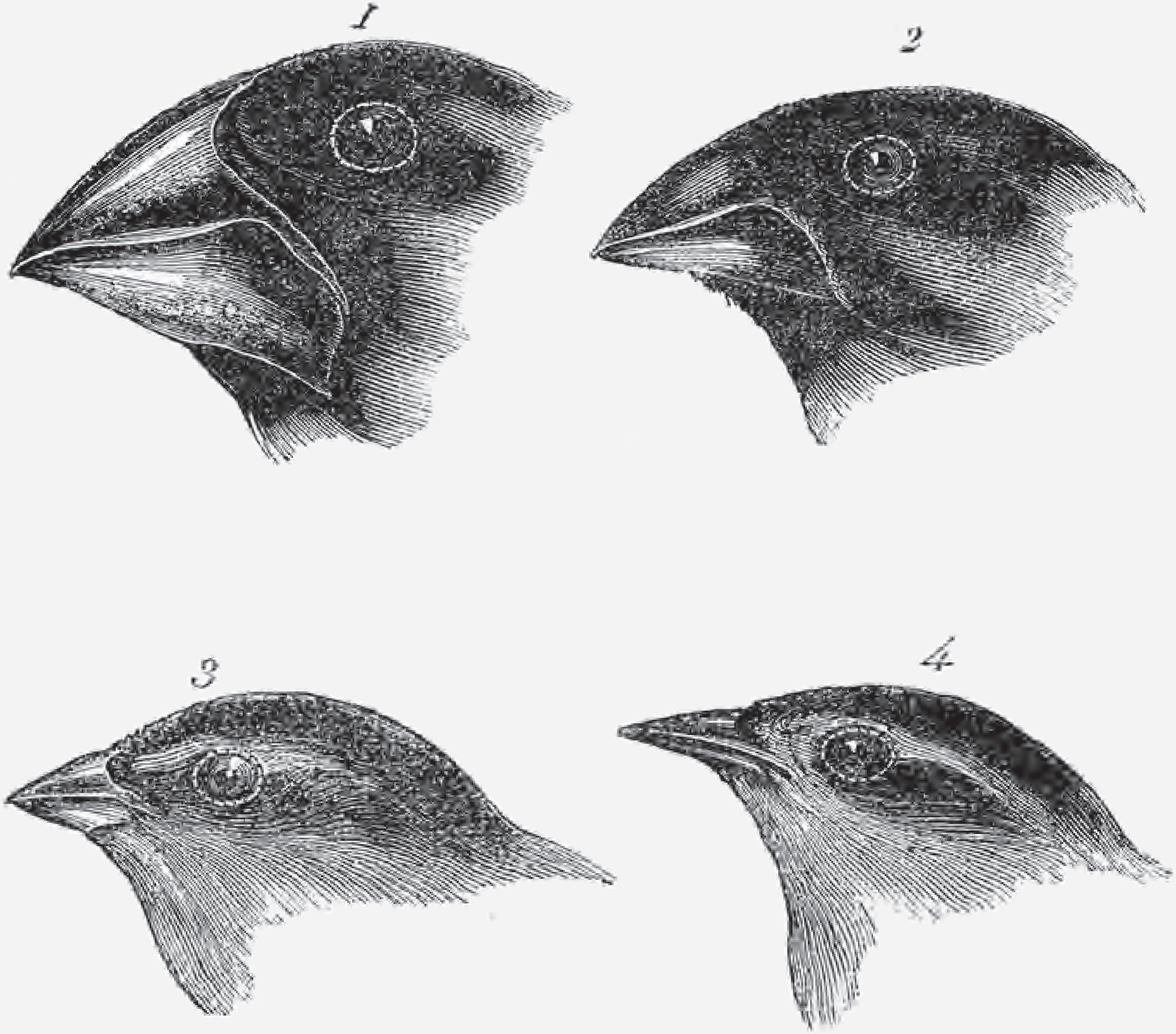
http://www.nas.edu/evolution/Definitions.html

Exaptation describes a situation where specific advantageous traits develop in response to one set of conditions (insulating feathers as an evolutionary response to cold for example) are coopted for another use (feathers used for flight).

This seminar explored the concepts of adaptation, cooptation, and exaptation as they relate to the use of tools in the manipulation of materials, media, form, and assembly.

(Opposite) *As recorded in Darwin's sketches on the facing page, "the same genes are involved in making a sharp, pointy beak or a big, broad, nut-cracking beak. What makes all the difference is how much you turn a gene on, when you turn it on, when you turn if off—the subtle differences in regulation. Specific genes are essential to make any beak, but it's the tweaking—the amount of the gene, the timing of the gene, the duration of the gene—that's actually doing the trick."*

(What is Evo Devo, interview with Cliff Tabin, PBS.org, October 26, 2009.)


1
2
3
4

THE BIRDS & THE BEES

(...AND BATS AND BUTTERFLIES AND WASPS AND...)

While the focus of research for DM3 centered on materials and tool use (topics for research were selected by students with input from Professor Satterfield), a project was available to students who wished to focus their explorations. The City of Vancouver's City Studio and UBC SEEDS Sustainability Program both expressed interest in having UBC SALA students deliver designs for "pollinator-houses" (for bumble-bees, mason bees, wasps, butterflies, and other pollinators). These houses are to be used in a "Pollinator Pop-up Park" planned for the City of Vancouver's Fairview neighborhood and at select locations on UBC's Main Campus. Students took the opportunity to design and prototype "housing" for these small yet extremely critical Vancouver residents. Other outreach/media related opportunities were also made available to students (signs, information graphics). Work on this project extended beyond the limits of the semester. After review, six projects were selected to move forward. The final six will hybridize to create the pollinator houses.

(Right) "You are worrying about the wrong bees" by Gwen Pearson, WIRED

"SAVE THE BEES!" is a common refrain these days, and it's great to see people interested in the little animals critical for our food supply around the globe. But...you're talking about the wrong bees. Honey bees will be fine. They are a globally distributed, domesticated animal...The bees you should be concerned about are the 3,999 other bee species living in North America, most of which are solitary, stingless, ground-nesting bees you've never heard of. Incredible losses in native bee diversity are already happening. 50 percent of Midwestern native bee species disappeared from their historic ranges in the last 100 years. Four of our bumblebee species declined 96 percent in the last 20 years, and three species are believed to already be extinct."

HYBRID VIGOR

NEXT STEPS

The total list of projects has been reduced to six. Each project presents a unique fabrication or material strategy and each project is designed for a unique pollinator. The projects selected are listed at left.

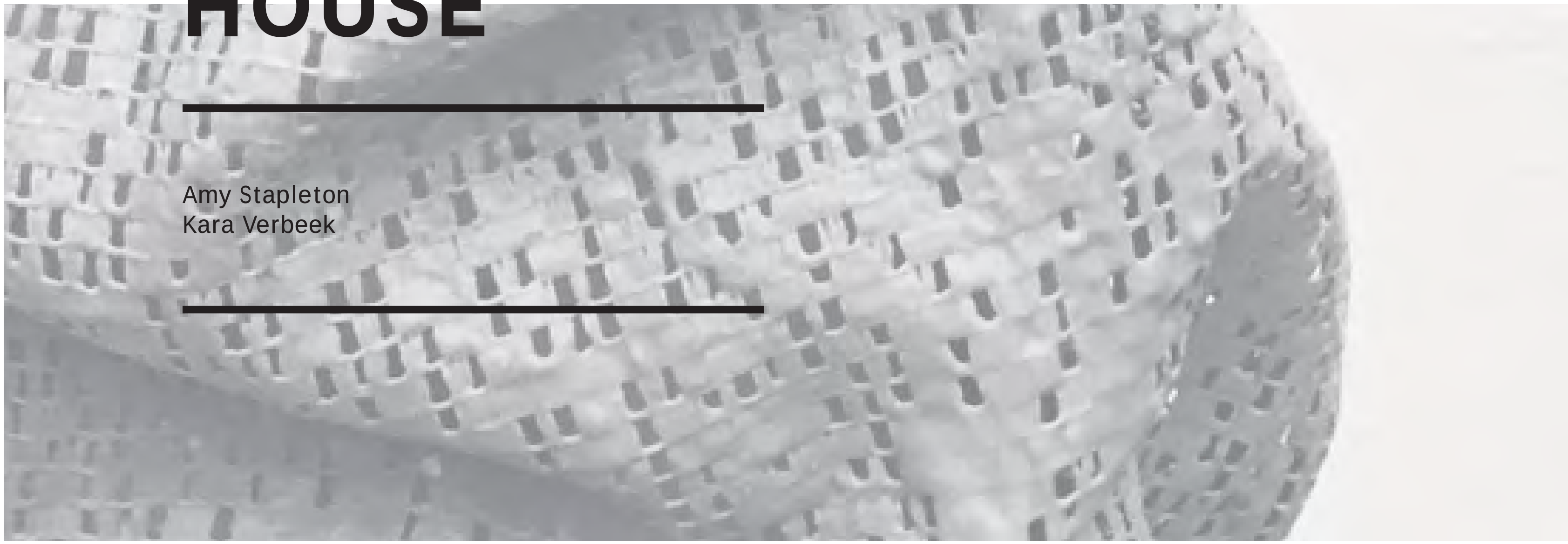
The intent is to design a few pollinator houses using strategies culled from the six selected projects. Each house will be a hybrid of ideas and techniques. Students interested in participating in the project will be given the opportunity to do so through a directed study. Other students are enlisted as research assistants support the project and to execute the final houses. If no student is interested in a directed study that moves their pollinator house forward, it will fall to the research students to complete the projects.

Time-line:
January - February 27 - Design Development
February 27 - April 10 - Fabrication
April 10 - April 30 - Installation

Initial research team includes
Stewart Lodge, Neal Qiongyu Li, Josh Potvin

Page	Project	Designers
01	Bat House	Stapleton Verbeek
28	Rain Shell	Howarth, Lewis, Mercer, Tehrani
43	SLAQ	Lodge Quiring
60	Pollinator Piñata	Beech, Depelteau Quek, Thomas
72	Catalyst	Dagenais-Lussier Goodarzi
94	Monster Oratus	Niculescu Tischler

BAT HOUSE



Amy Stapleton
Kara Verbeek

POLLINATOR

BATS

Pollinator bats are critical members of many ecosystems, yet they are currently threatened thanks to a combination of public misunderstanding and urban sprawl. Increasing public awareness of the importance of bats and supporting conservation initiatives for these lesser-known pollinators is more important than ever. These creatures are often cast as villains in popular culture or categorized as household pests. This negative cycle of public perception is amplified as urban development intensifies and spreads. Bats are faced with dwindling natural habitat and thus forced to seek refuge in attics, chimneys, and other domestic locations, reinforcing their classification as pests. It is a vicious feedback loop.

It is within this context, a scenario that sees a significant loss of biodiversity in our contemporary cities, that our project is positioned. Through our work we attempt to raise awareness of the true beneficial nature of bats and their important role in local ecosystems. Our goal is to provide a new prototype for man-made, urban bat roosts – one that fosters a mutually beneficial relationship between humans and the pollinators on which we unknowingly rely. We explore and apply new modes of material deployment to accomplish our goal, using them to design a project that reinterprets the conventional bat house.

The table on the facing page summarizes research conducted on various bat species local to British Columbia's lower mainland. Important factors that impact design include the physical size & characteristics of preferred natural habits during winter and summer, as well as frequently selected man-made roosting locations for each species. Research was focused on species known to use bat houses and on purpose-built man made roosting dwellings for one or more colonies of bat.

A great deal of field research on what constitutes the ideal bat house is available. The examples we found were conducted by biological and ecological academic units and by community and citizen-science groups. The sequence of diagrams on page 4 illustrates the requirements established by an assessment of successful man-made bat houses, organized to consider them in concert with various natural habits frequented in the lower mainland. These include caves and burnt out or hollow trees. Both present material possibilities.

little brown myotis
BL 2.4-3.9″
WS 8.7–10.6″

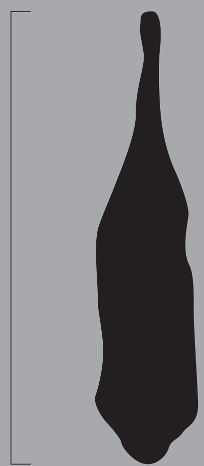
yuma myotis
BL 3.3-3.9″
WS 9.3″

california myotis
BL 2.8-3.7″
WS 11.0-13.0″

long-eared myotis
BL 3.0-3.7″
WS 9.0-10.0″

townsend's big-eared bat
BL 4.0″
WS 11.0″

big brown bat
BL 4.3-5.1″
WS 13.0″



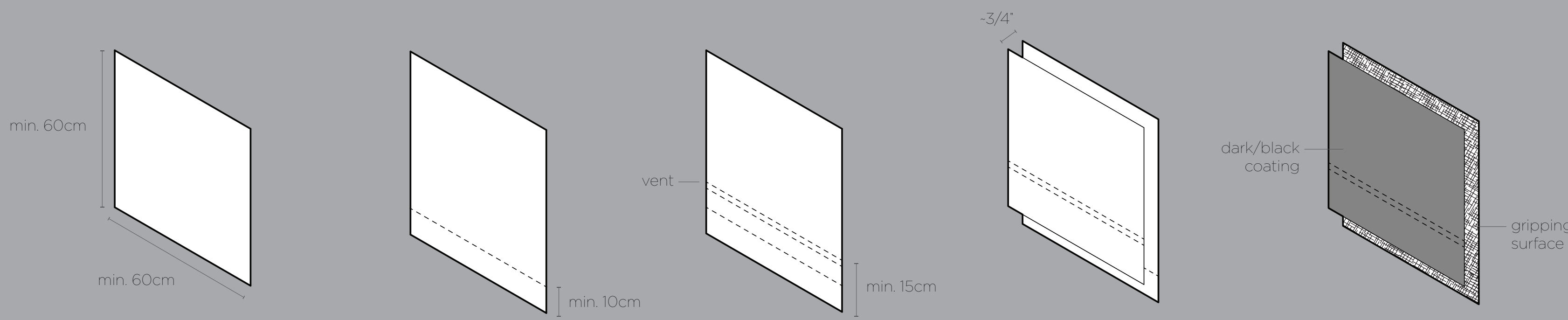
BC bat species	Vancouver?	Roost in buildings?	Bat house user?	Natural roosts (summer)	Natural roosts (winter)
little brown myotis	yes	common	yes	snags, rock crevices, cliffs, mines	mines, caves, rock crevices
yuma myotis	yes	common	yes	snags, rock crevices, mines	mines
long-legged myotis	yes	occasional	no	cliffs, rock crevices, snags, stumps	mines, caves, rock crevices
western small-footed myotis	yes	occasional	no	cliffs, rock crevices, mines	mines, cliff crevices
california myotis	yes	occasional	yes	snags, mins, bridges, rock outcrops & crevices	buildings, mines, caves, rock crevices
fringed myotis	unknown	occasional	no	mines, cliffs, rock crevices, snags	mines
long-eared myotis	yes	occasional	yes	cliffs, snags, stumps, slopes, outcrops, crevices, mines	mines, buildings
keen's long-eared myotis	yes	no	no	mines, cliffs, snags, rock crevices	snags, rock crevices
northern myotis	no	rarely	no	snags	mines
townsend's big-eared bat	yes	common	yes (big)	cliffs, caves, buildings, mines	mines, caves, rock crevices
western red bat	unknown	no	no	trees	migrates?
hoary bat	yes	no	no	snags, trees	migrates
silver-haired bat	yes	no	no	trees, snags (cottonwoods)	snags, mines, buildings
big brown bat	yes	common	yes	snags, cliffs, rock crevices	buildings, mines
pallid bat	no	potentially	no	cliffs, outcrops, snags, buildings, mines, orchard	rock crevices?
spotted bat	no	no	no	cliffs	cliffs, mines

Half of the sixteen bat species in BC are listed as vulnerable or threatened

BC has the greatest diversity of bats of any province

The provincial "Got Bats?" network has the goals to:
Raise awareness about bat conservation in BC
Identify bat roost sites in buildings
Conserve and enhance bat habitat
Provide support to landowners with bats in buildings
Engage residents in citizen-science to monitor bat populations

BATS OF BRITISH COLUMBIA



chamber dimensions

Dimensions vary depending on the type of bat house. A typical single chamber box is shown above, while a rocket box type is shown below.

landing strip

Boxes without a place for bats to land, or too slippery a surface are usually ineffective.

ventilation

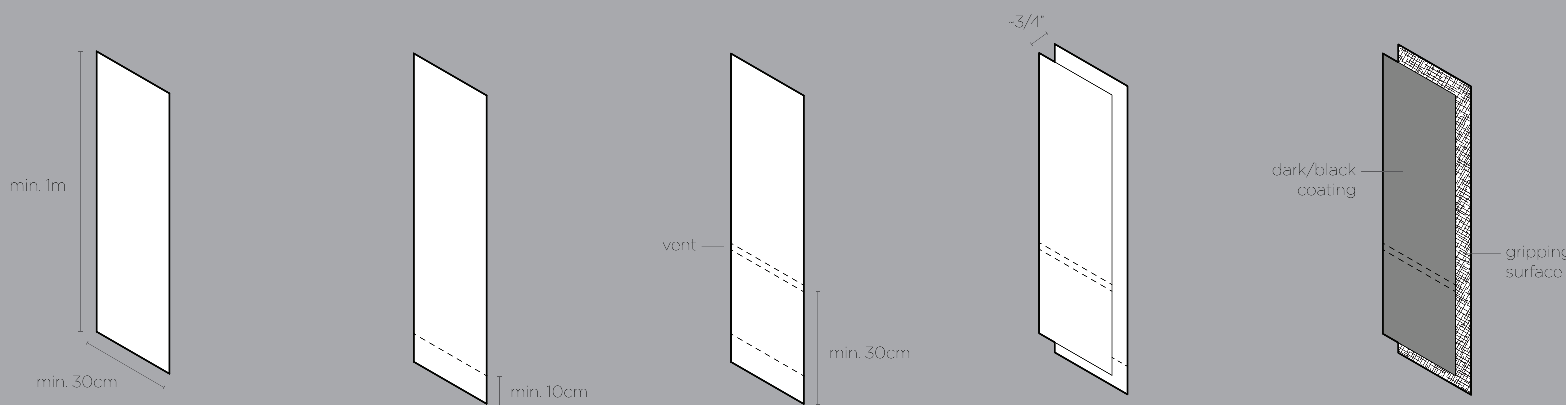
Vents can provide air movement and a better roost environment. They should be approx. 1.5cm wide and run the length of the house.

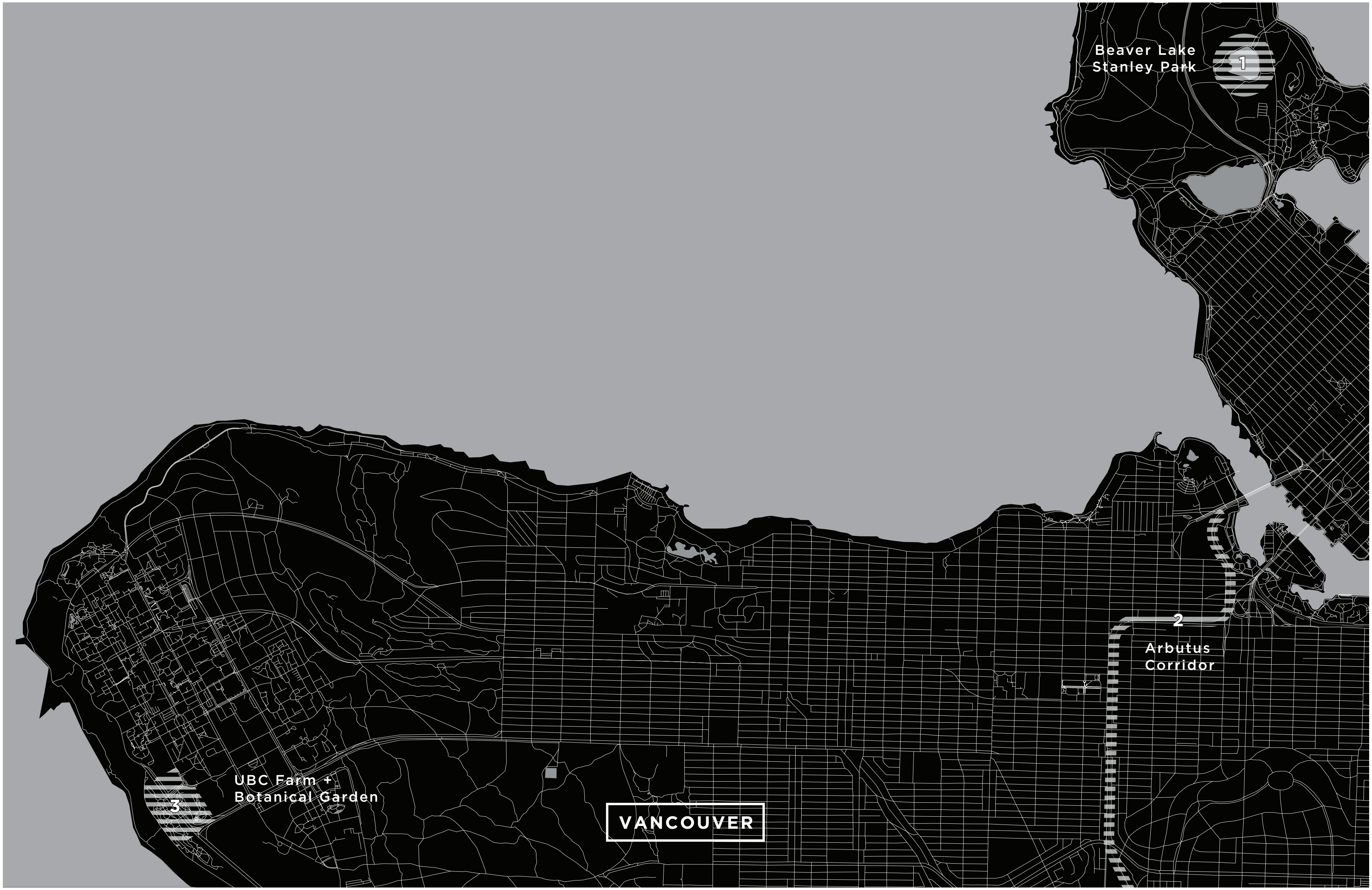
chamber depth

Limiting chambers to ¾" helps reduce occupation by wasps, whose nests can be an issue for bat houses.

surface characteristics

All areas where bats will be hanging (including landing strips and one side of the chamber) should be rough enough to ensure grip. Exterior surfaces should be black to absorb heat.





This map shows the areas within the City of Vancouver that were selected as potential sites for the project. Sites were chosen based on habitat-requirements, including most significantly: minimum 0.5 km from water sources, proximity of diverse vegetation (agricultural and/or native), and clearings away from immediate trees where the houses may be vulnerable to predators and for solar exposure. The site were also selected considering the potential for academic and community engagement as well as complementary adjacencies such as pest control for crops and the provision of bat guano for fertilizer at UBC farm - encouraging longevity of the installation.

MATERIAL

FABRIC + CONCRETE

Material research centered on an exploration of fabric form-work used in combination with concrete to create form and texture. We started exploring ways in which fabrics with different attributes (composition, weave, porosity, weight) behaved when saturated with concrete or plaster, and subjected to one or more of the form-making forces/methods shown on page 8.

Swatches were prepared, organized, and coated with material to test various strategies of fabric form-making. The results provided samples with a range of weights, densities, and surface textures. Variation in form was generated. The stretch, fullness, and weave orientation of each specific fabric dictated how the concrete cured in position.

A loose, lightweight mesh fabric was chosen for the interior layer. It was paired with layers of cotton batting at the exterior. Concrete was applied to both materials, and the wet fabric was allowed to drape. Once hardened, the mesh generated an ideal climbing and hanging surface with the appropriate dimension of textured surface for the chosen bat species. The material remained free of sharp edges and strings that could pose risk of entanglement. The batting exterior layers provided a dense protective shell that acted as a thermal mass. Stored solar heat will maintain preferred roosting temperatures and curb diurnal thermal fluctuations. These two materials were explored further. Various form-making rigs were deployed and different concrete mixture consistencies added. The team also tried splicing the cotton batting to alter its laminar thickness. The conceptual prototype shown on page 9 was produced by hanging the two fabric types to cure in concentric circles. It served as the precursor to the more developed bat house design. Finally, swatches were tested with an additive dye to achieve a darker shade in the concrete, mimicking a colour bats in this climate prefer. While the prototypes were made without dye, final versions would be closer to black.

METHODOLOGY

BIOLOGICAL REQUIREMENTS

species, roosting preferences, dimensions, habitats

+

MATERIAL POSSIBILITIES

explorations & configurations

+

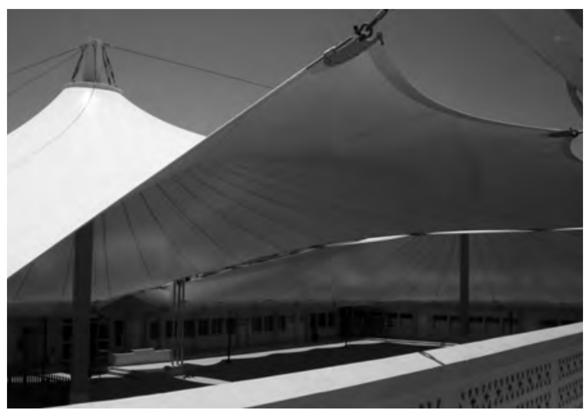
SITE STRATEGIES

installation, proximity to food & water, environmental forces & factors

MANIPULATION

http://dataphys.org/

gravity



http://www.mgsarchitecture.in/

tension

http://www.clubmarine.com.au/

molding

DESIGN

PROCESS

The photos on the following pages illustrate the process of moving the conceptual prototype forward at full scale. The team is responding to the dimensional and formal qualities required by the bats and incorporating space to accommodate the behavior of the target species. Special attention is paid to exploring the possibilities found in the materials used for assembly. Can we exploit material characteristics to further enhance the experience for the pollinator?

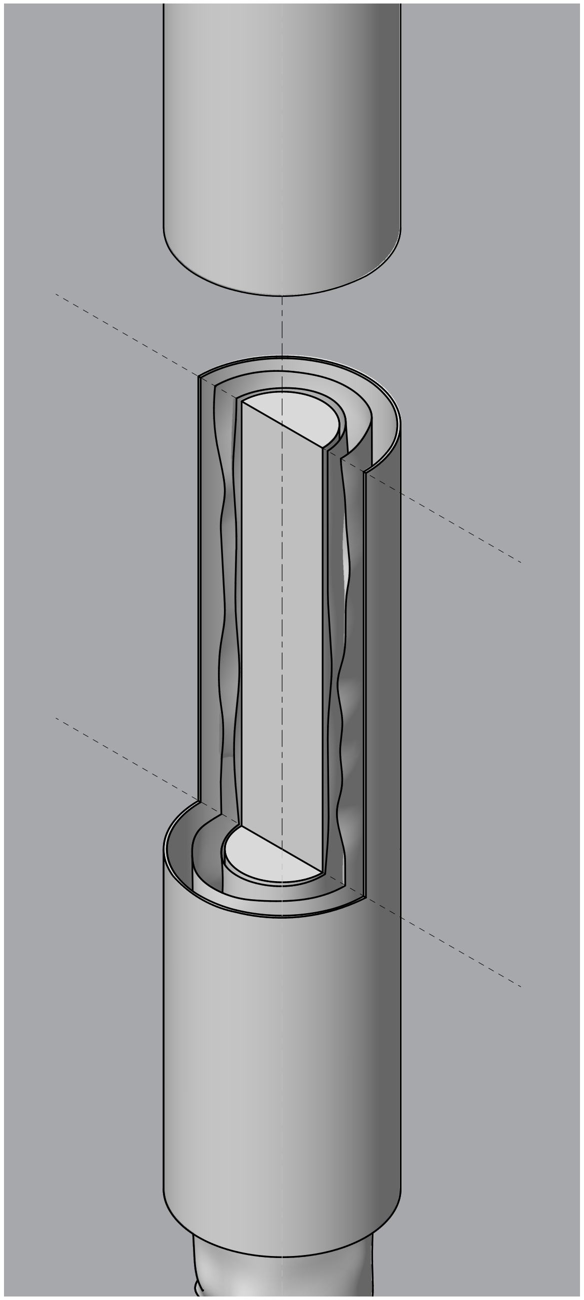
Techniques such as sewing, draping, and patterning were used to manipulate the fabric. These material actions were deployed before and after soaking the fabric in concrete. Form-work and custom-made rigs were used at various stages in the process. The rigging helped to maintain critical dimensions required in the full-scale houses. The strategy of restraining (as opposed to forming) allowed material layers to drape with gravity. The rigs controlled the size and locations of billowing and sagging. The rigging also allowed for more variation in the roosting surface. The resulting assembly mimics more closely some of the bat's preferred natural habits. It has the added benefit of providing volumetric variation to the occupied spaces, creating a spectrum of available micro-climates for the bats to use as they self-regulate their body temperature within the roost.

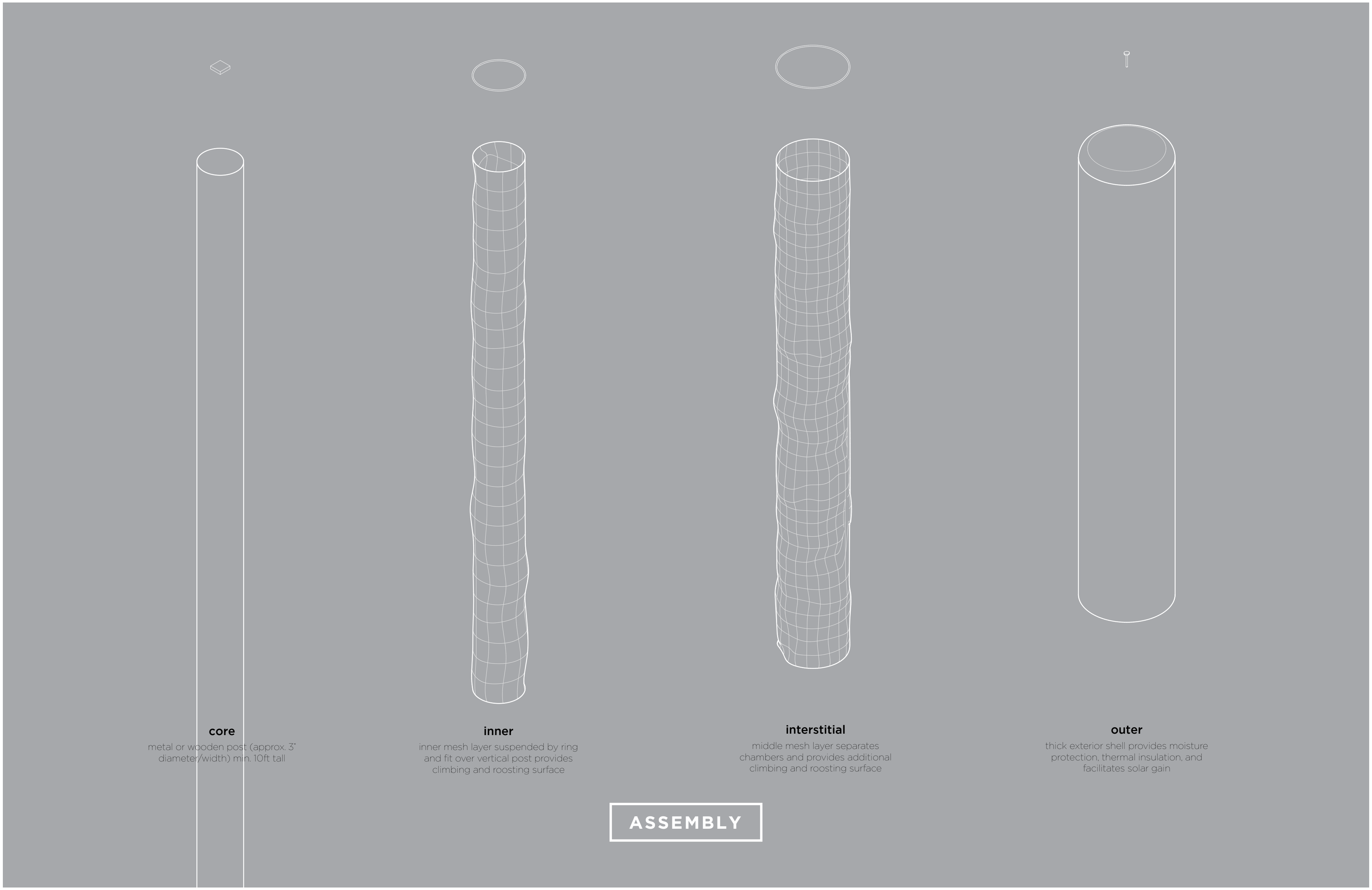
DESIGN

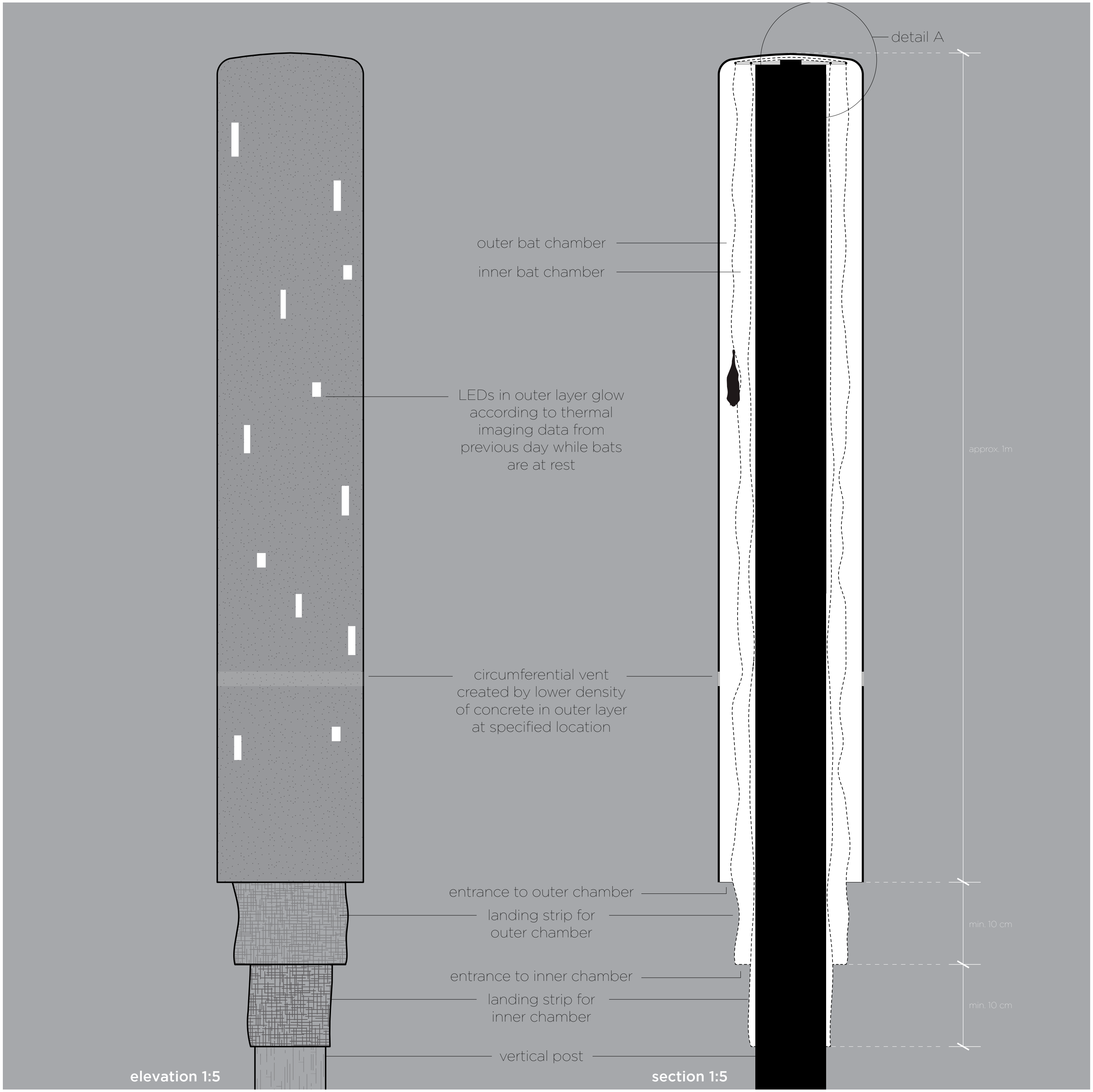
PROTOTYPE

After the material exploration and physical prototyping stages, a more detailed prototype was designed and digitally modeled.

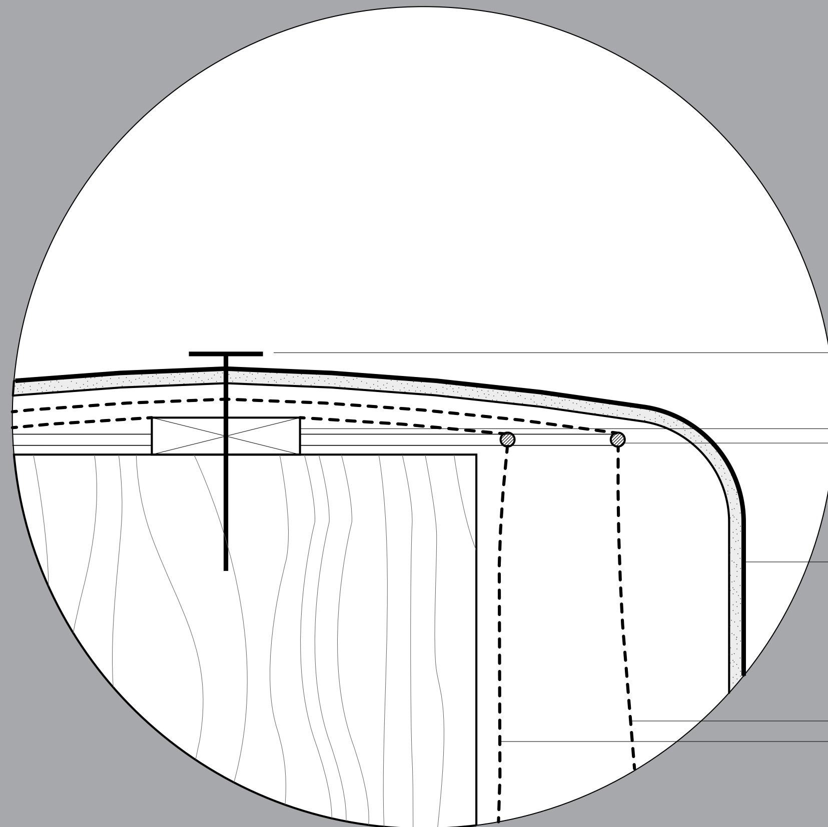
The drawings, details, and diagrams on the following pages delineate the design of a bat house with multiple concentric chambers, capable of being installed in a variety of urban or rural environments. The design references key spatial and material characteristics of natural bat roosts across the Lower Mainland, while incorporating important practical requirements found in existing successful bat houses. A series of renders show the prototype in situ at each of the three potential sites explored in the research phase of this project. Important environmental characteristics and opportunities for further engagement are highlighted for each site.



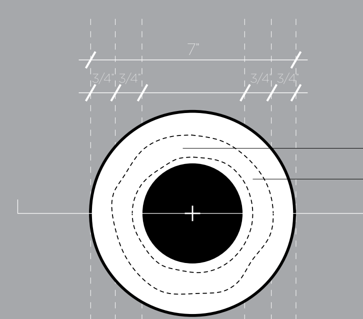

core
metal or wooden post (approx. 3" diameter/width) min. 10ft tall
inner
inner mesh layer suspended by ring and fit over vertical post provides climbing and roosting surface
interstitial
middle mesh layer separates chambers and provides additional climbing and roosting surface
outer
thick exterior shell provides moisture protection, thermal insulation, and facilitates solar gain
ASSEMBLY



detail A
outer bat chamber
inner bat chamber
LEDs in outer layer glow according to thermal imaging data from previous day while bats are at rest
approx. 1m
circumferential vent created by lower density of concrete in outer layer at specified location
entrance to outer chamber
landing strip for outer chamber
min. 10 cm
entrance to inner chamber
landing strip for inner chamber
min. 10 cm
vertical post
elevation 1:5
section 1:5

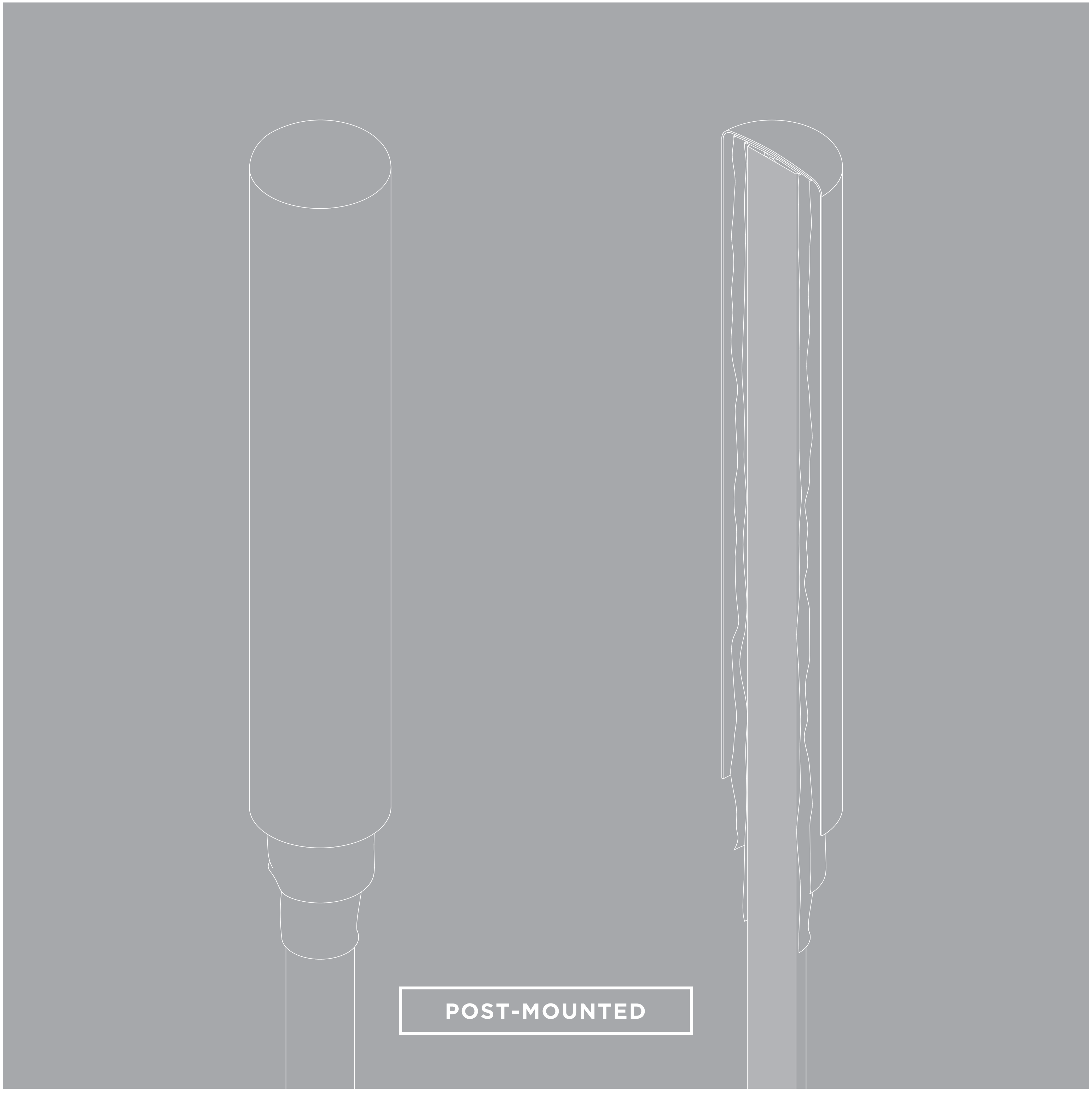


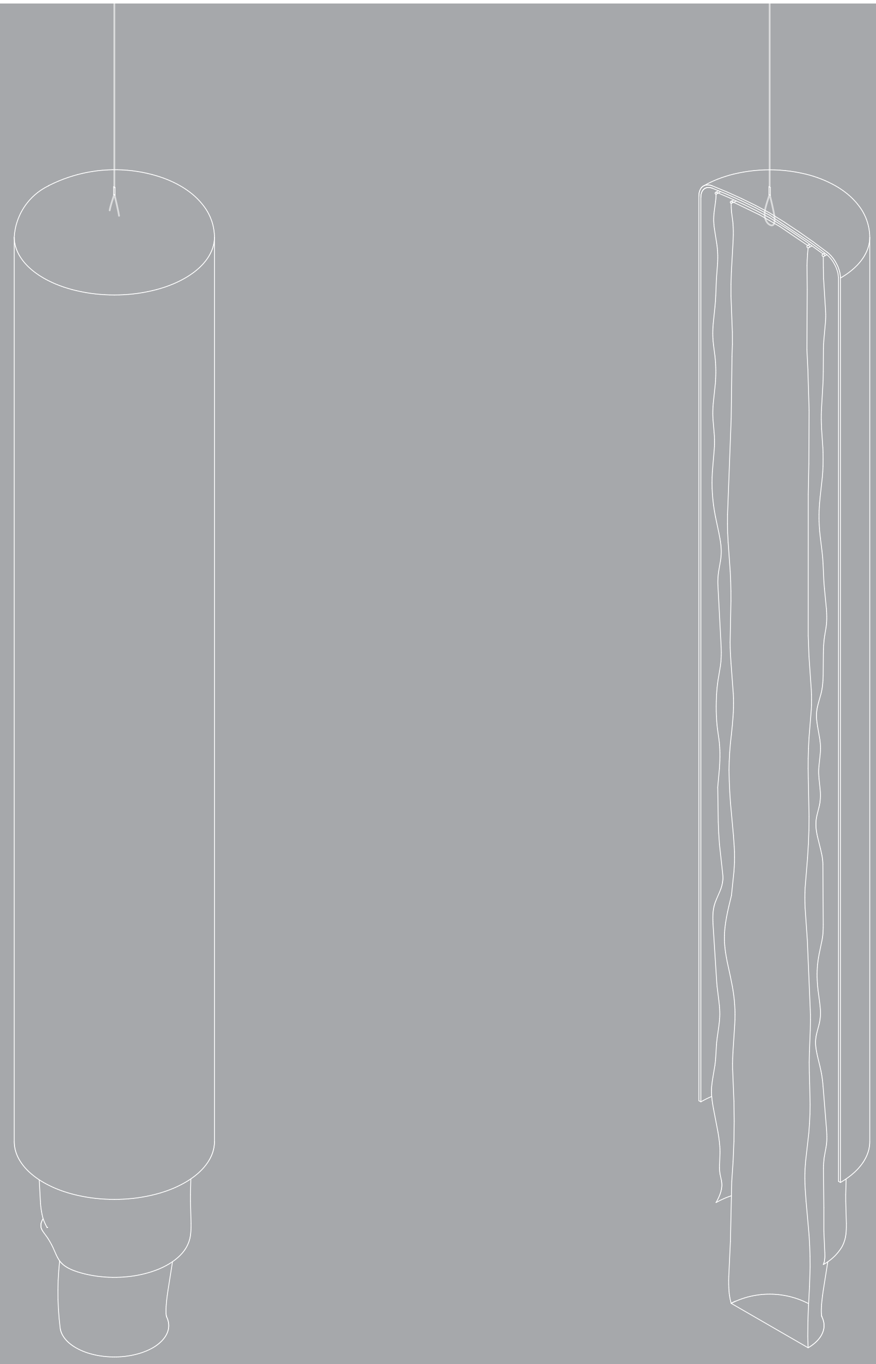
detail A 1:1



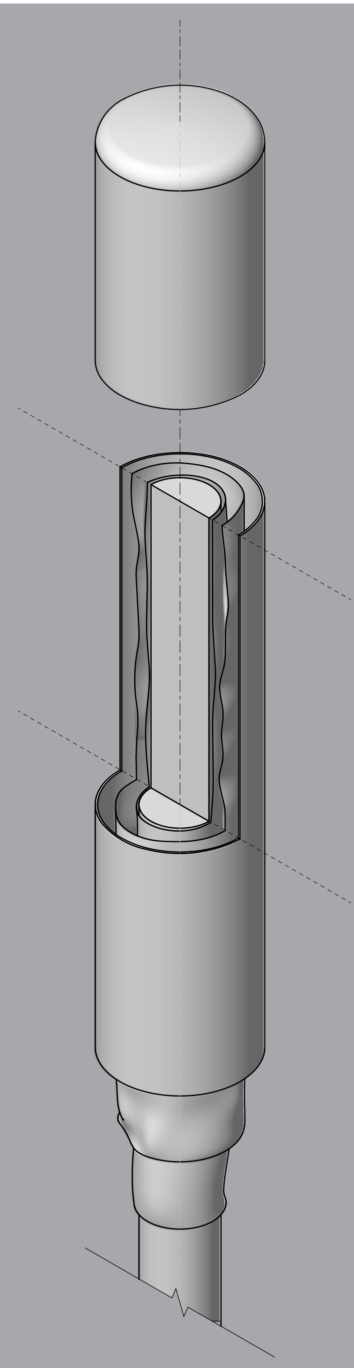
plan 1:5

DIGITAL PROTOTYPE

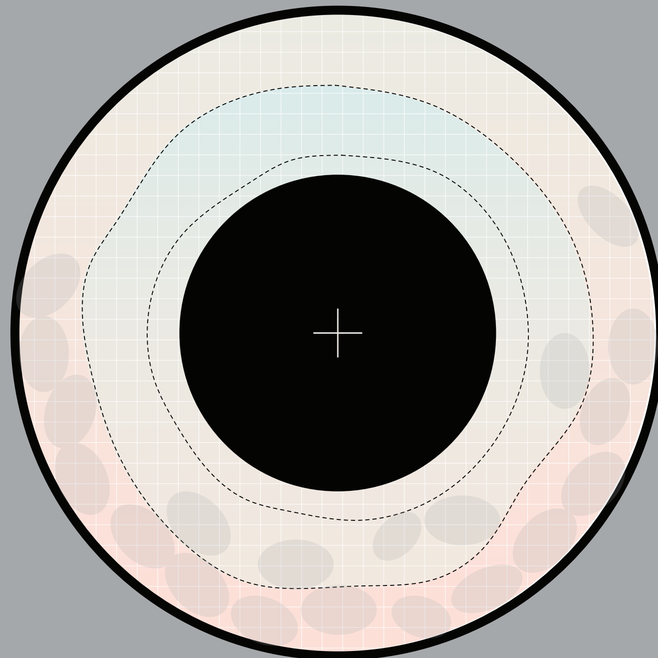

POST-MOUNTED



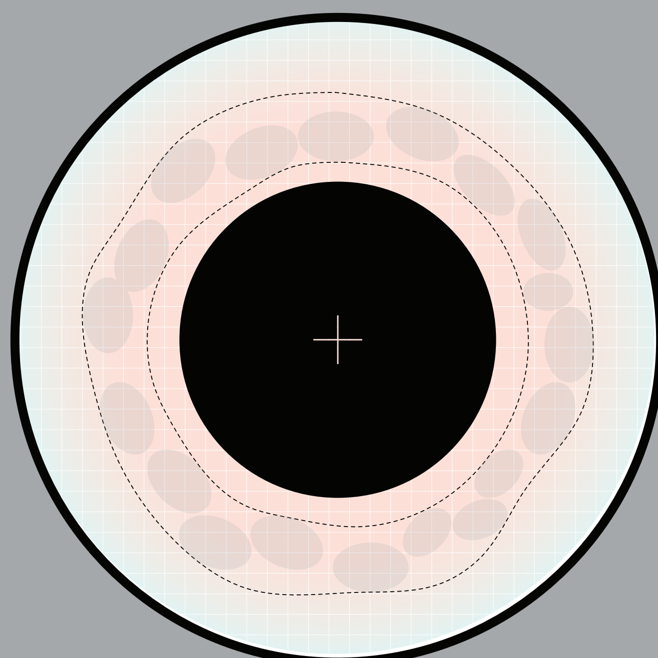
SUSPENDED



DIGITAL PROTOTYPE

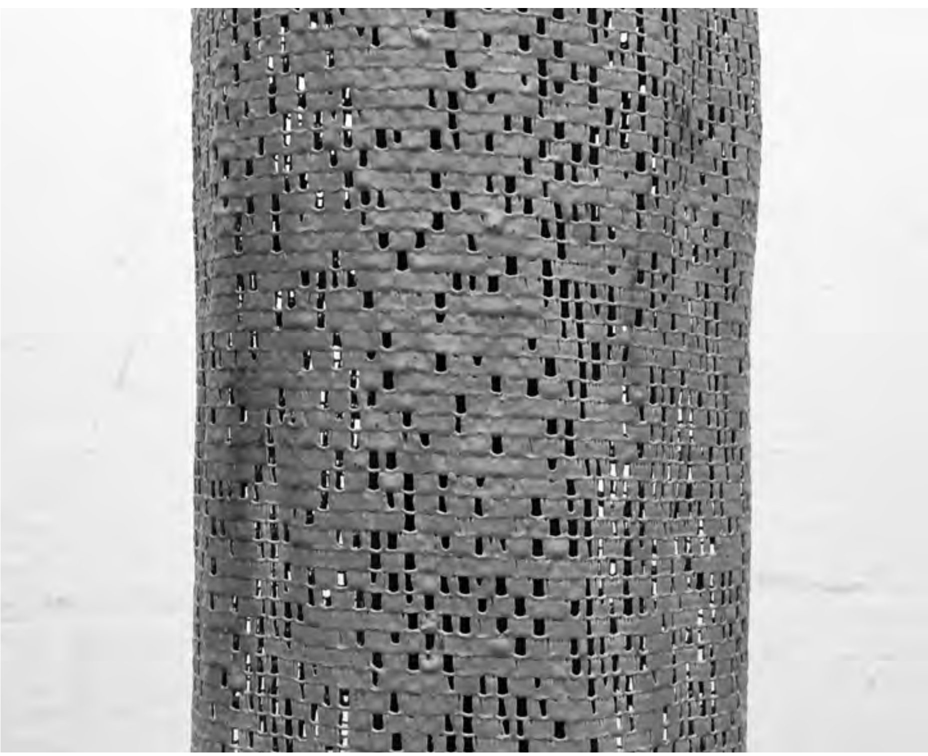
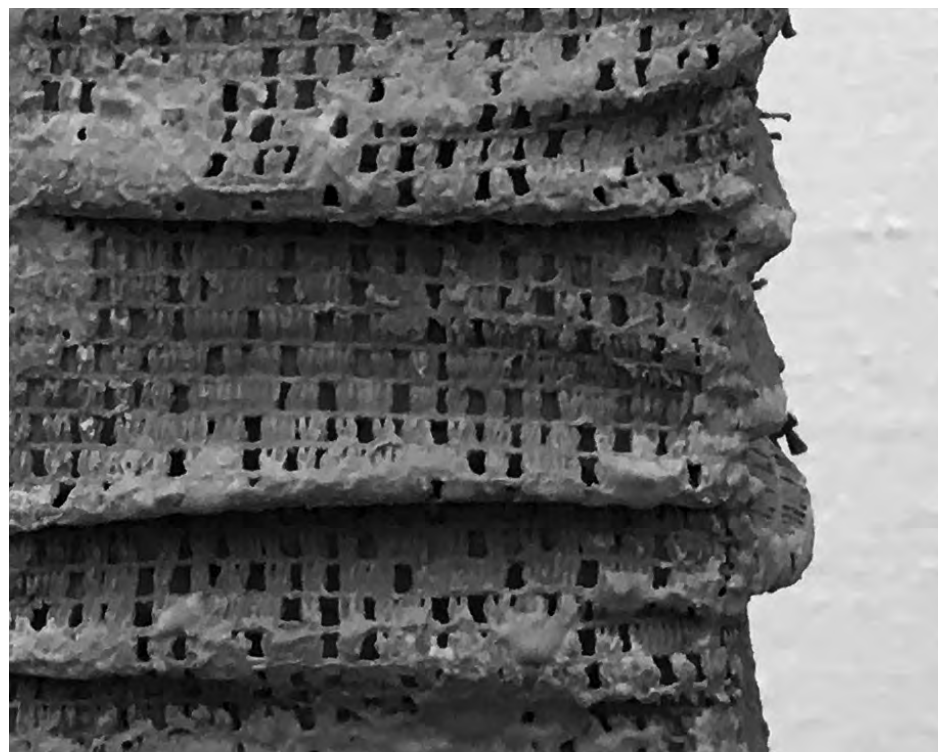


sun



overcast



POTENTIAL INSTALLATION SITES

5kids1condo.com

Beaver Lake

insidevancouver ca

Arbutus Corridor

TheUbyssey.ca

UBC Farm


the wilderness setting provides a darker and more natural habitat
the lake provides an opening in the forest with plenty of sun/ daylight for solar gain creating warm roosts
the lake provides drinking and foraging water
the site is highly protected, visible public signs along the trail raise awareness
BEAVER LAKE
STANLEY PARK
landscape: Bierophile


→
the surrounding homes provide shelter and are common roosts for bats
the site is highly visible from homes and paths providing public awareness
the open corridor provides sun/ day-light for solar gain creating warm roosts
the site is highly visible providing public awareness
bat guano will be harvested and used as nitrogen-rich natural fertilizer for the community garden
ARBUTUS CORRIDOR

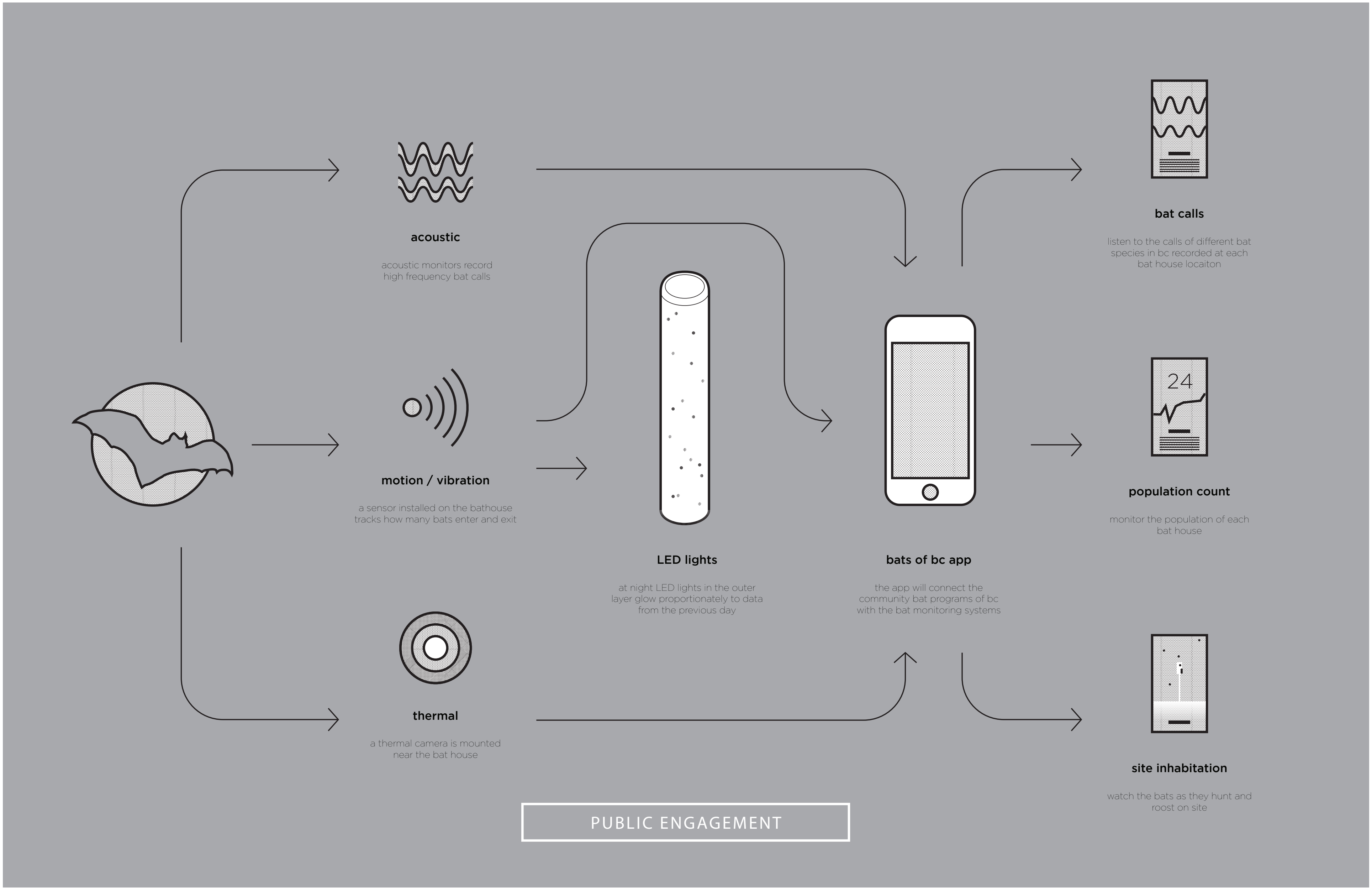

water sources at the botanical garden provide drinking and foraging water
the farm is an open field with plenty of sun/ daylight for solar gain and warm roosts
bats provide natural pest control to the crops
bat guano will be harvested and used as nitrogen-rich natural fertilizer for the crops
UBC FARM + BOTANICAL GARDEN

NEXT STEPS

AUGMENTATION

In addition to refining the prototype described in the previous section, next steps for this project include the development of an App that registers an integrated digital monitoring system. The monitors will be placed within one of the prototypes. This system is described at the primary phase in the diagram on the following page, and uses technologies already employed by the scientific community for the study and observation of bats in British Columbia.

The wired pollinator house is imagined for one of the more publicly accessible sites. One or more bat houses may be augmented with acoustic sensors, thermal imaging, and subtle lighting. The goal is to encourage public engagement and awareness while advancing important conservation initiatives. The hope is that the new “smart” houses will be of use to existing scientific and community groups, allowing population monitoring. With luck, the citizens of Vancouver will begin engaging with and enhancing the BC Bats seasonal bat count.


acoustic
acoustic monitors record high frequency bat calls
motion / vibration
a sensor installed on the bathouse tracks how many bats enter and exit
thermal
a thermal camera is mounted near the bat house
LED lights
at night LED lights in the outer layer glow proportionately to data from the previous day
bats of bc app
the app will connect the community bat programs of bc with the bat monitoring systems
bat calls
listen to the calls of different bat species in bc recorded at each bat house locaiton
24
population count
monitor the population of each bat house
site inhabitation
watch the bats as they hunt and roost on site
PUBLIC ENGAGEMENT

RAINSHELL

Yekta Tehrani
Karianne Howarth
Reese Lewis
Alexander Mercer

POLLINATOR

GROUND-DWELLING BEES

Incredible loss of native bee diversity in North America is threatening the future security of our current food production systems. Almost four thousand species of bees (aside from the common domesticated honey bee) are at risk due to habitat loss in urban environments and the overuse of commercial pesticides. Without intervention, it is possible that the decline of these species may become irreversible and prove devastating for both micro- and macro-ecosystems on the continent.

In the coastal British Columbia region there are three major ground-dwelling bee species which provide a large share of wildflower and crop pollination. These three varieties—the Mining Bee Andrena, the Sweat Bee Halictus and the Sweat Bee Lagioglossum—are unlike other bee species insofar as they create their own habitat by burrowing into dry, sandy soil. They do not create a complex nest structure in trees like the common European honeybee but instead opt for a more solitary lifestyle in the ground.

In Metro Vancouver, these bees can be difficult to spot due to their relatively small size and their unique choice of habitat. Despite this, their effect on our environment is substantial and their loss would prove devastating in the long term.

Mining Bee *Andrena*

Sweat Bee *Halictus*

Sweat Bee *Lasioglossum*

MATERIAL LOGIC

SHELTERED EARTH

As ground dwelling bees require such specific material conditions in order to create their habitat, our design team decided to focus specifically on how to best form and shelter this sandy soil medium. By raising the ground condition to a vertical posture, we hypothesized we could maximize penetrable surface area for mining bee populations despite Vancouver's exceedingly wet coastal climate.

In creating a kind of rainshell from the elements we aimed to provide the potential for habitat, rather than design the habitat itself. This was largely in response to the common complaints of other artifical bee habitats, which prioritized the visual aesthetic form rather than the local bee's specific requirements. As the author Marc Carlton writes:

"[M]any of the elaborate 'insect habitat hotels' illustrated in gardening programmes on TV, in magazines and at gardening shows are ornamental rather than functional: de-signed to appeal to human aesthetics more than being actually beneficial to solitary bees. Unless they incorporate serious shel-ter from winter wet... [the habitat] will become saturated and the structure will not be suitable for over-wintering insects such as solitary bees."

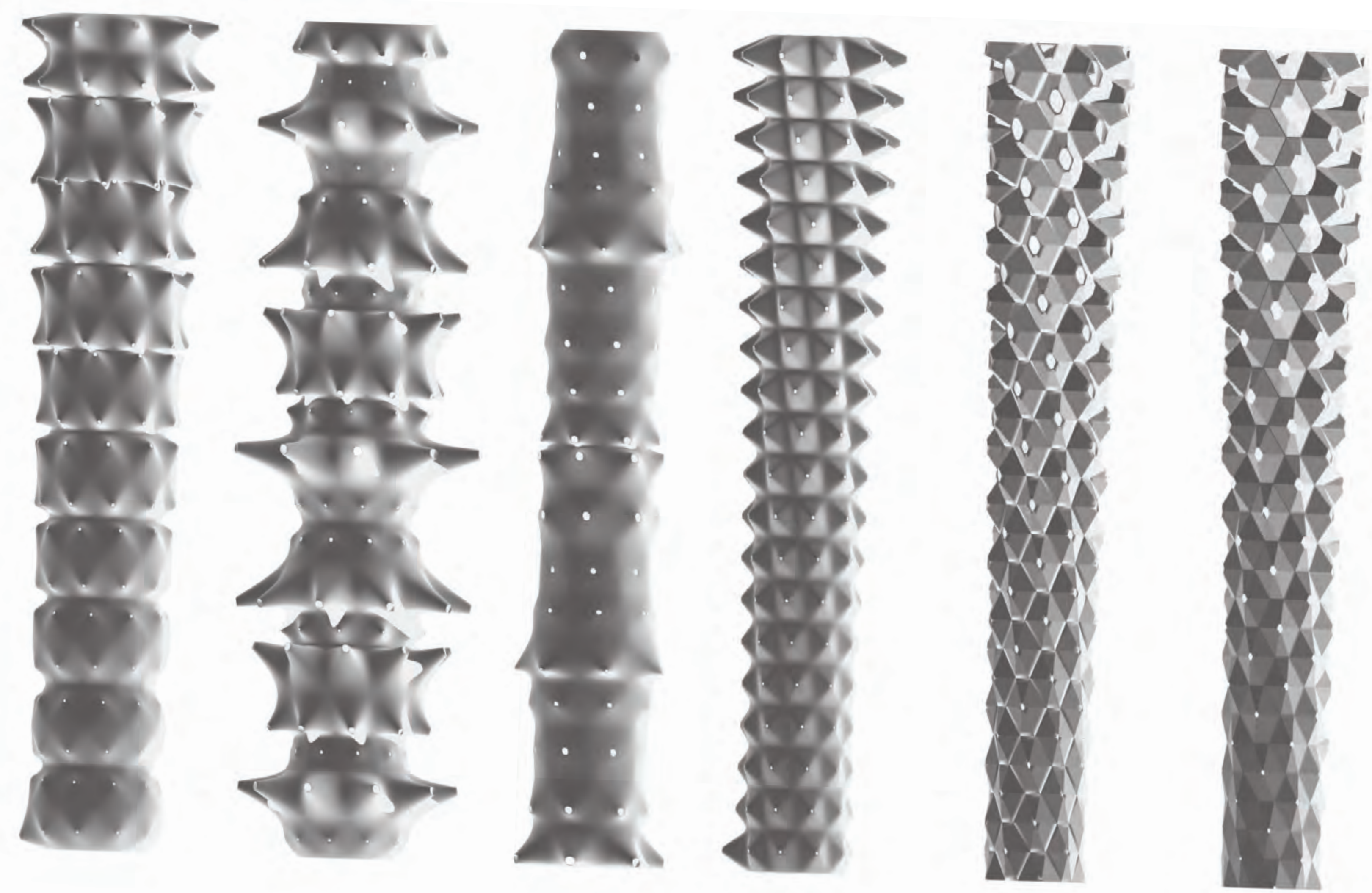
With this criticism in mind, our team moved forward thinking about how we could best integrate structure and organic material into one form optimized for our pollinator of choice.

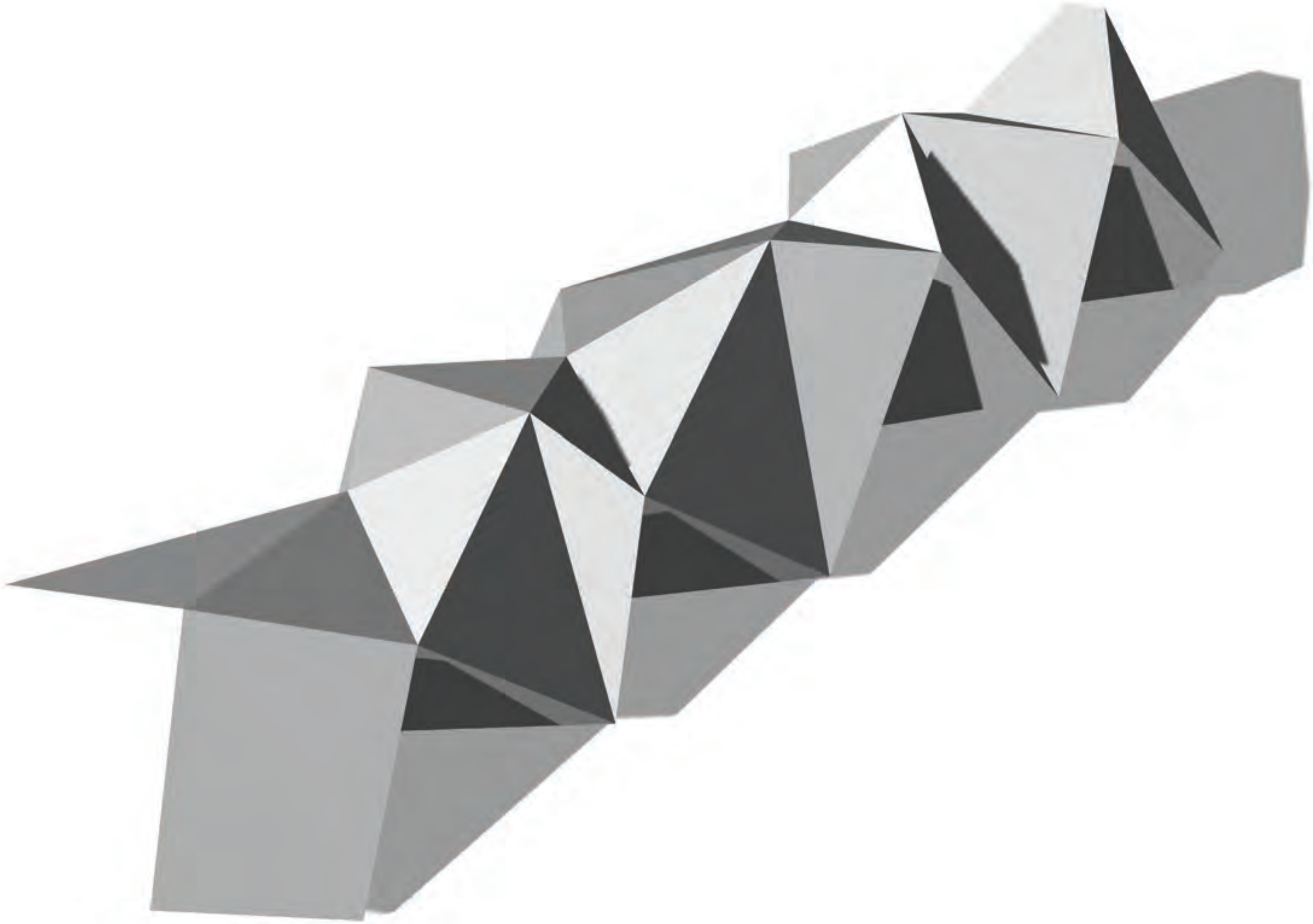
DESIGN

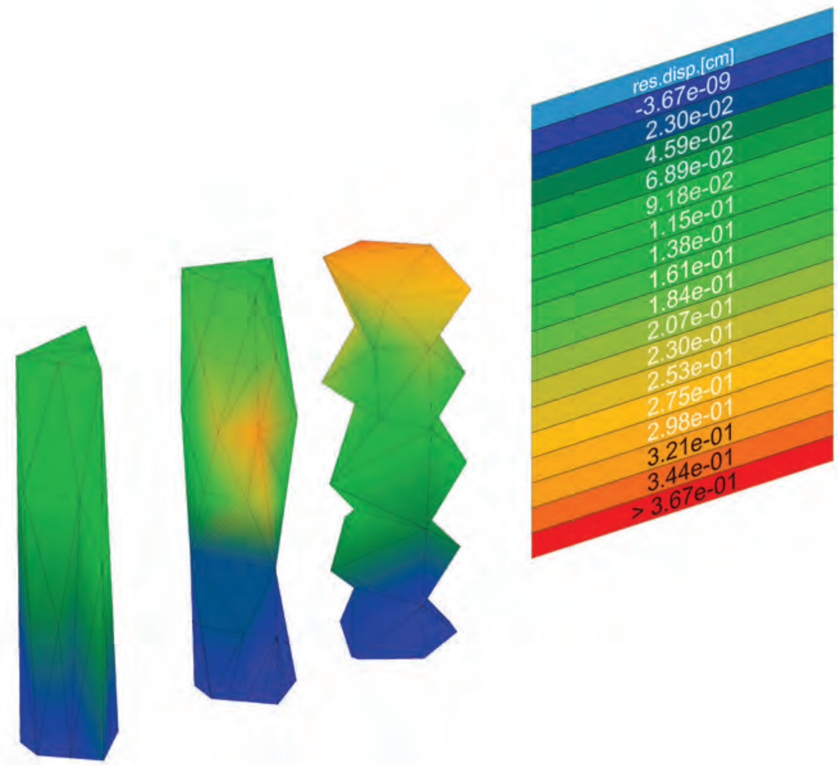
DIGITAL PROTOTYPING

In addition to early material tests, our team also began exploring the use of parametric design software for desiging and optimizing our rainshell form. Using primarily Grasshopper and Kangaroo scripting we continued with this notion of a perforated skin condition protecting an internal organic medium.

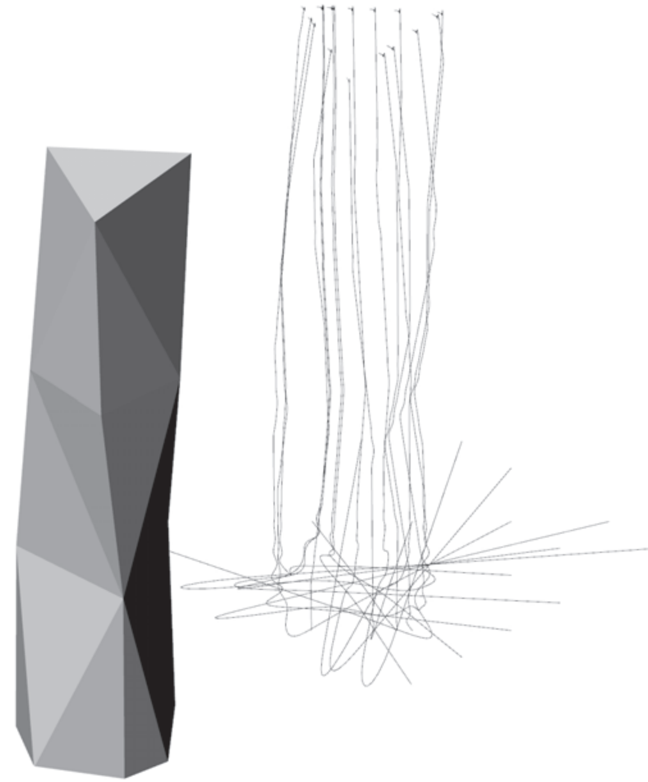
However, thinking forward to production, we began panelizing our form using both simple geometric and more complex mesh shapes. These panels were then distorted and shaped based on various data sets such as relative height, rain shedding ability and gravitational forces. Interrogating this reationship between digital and analog production, we let both experimental processes inform each other.







An example of early structural tests used on abstract tower shapes to better understand potential problems.



Using EVE Rain software, we were able to clearly visualize how water would travel down an exterior surface to better design our perforations.

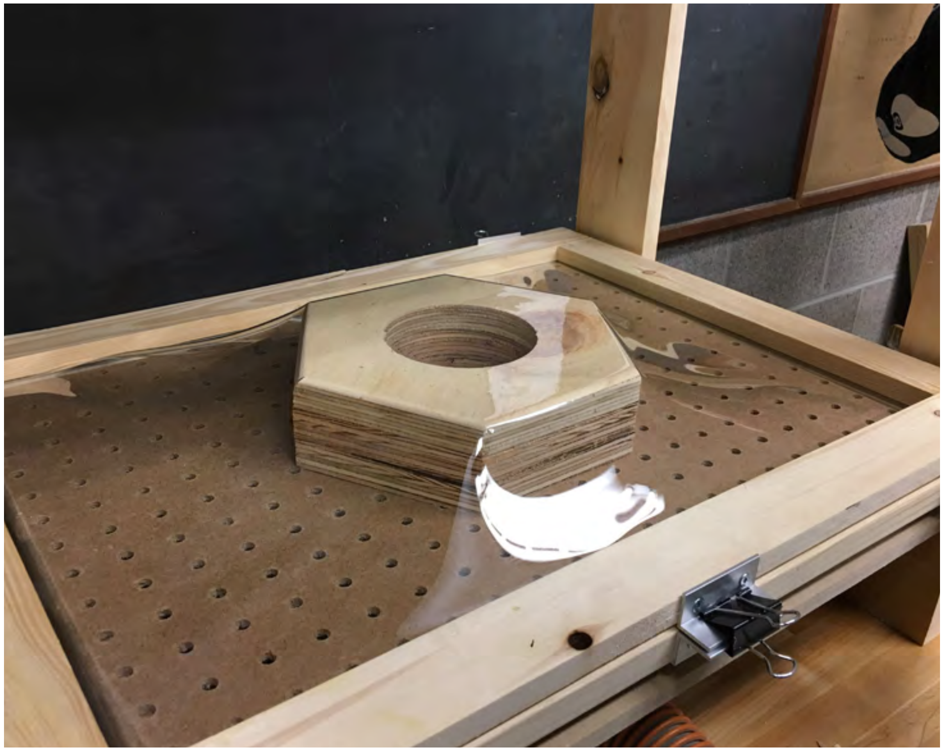
DESIGN

VACCUM FORMING

We explored the potential of using several different production processes to manufacture these complex panelized structures. Though the idea of 3d printing these computational forms at an industrial scale was our initial idea, we ultimately decided on using a tool that we ourselves could design and build.

Vaccum forming was a realistic alternative that we knew would be able to provide the complex shapes we were hoping to achieve. Even with a relatively minimal budget and a tight time-span we were able to create a tool which could take individual sheets of plastic and form them over a “buck” of our design. This process would allow a structurally stable yet lightweight alternative to most other material processes.

Early tests included using different plastics, shapes and temperatures to achieve lofted forms and complex curves.



The vaccum former itself proved to be a suprisingly inconsistent tool, and challenged us to rethink our design consistently.

NEXT STEPS

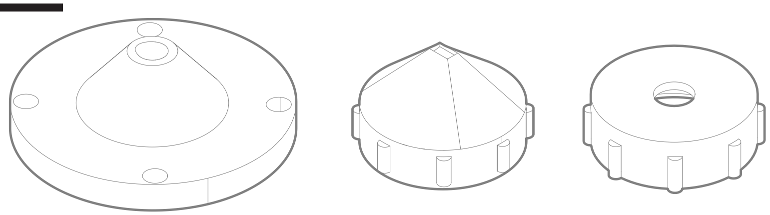
ASSEMBLY AT SCALE

Looking forward, we hope to further explore the relationship between digital and analog production methods and attempt to flesh out our connection logic between panels. If we ever hope to have this skin provide the structure for our vertical tower then these edge-to-edge connections have to be better understood and implemented in construction.

Furthermore, we would also potentially work with the idea of having these panels create more complex shapes based on their specific site context. Rather than isolated tower structures, perhaps these panels could be arranged into a wall or abstract form using a variable angle connection.

SLAQ

Alyssa Quiring
Stuart Lodge



MATERIAL

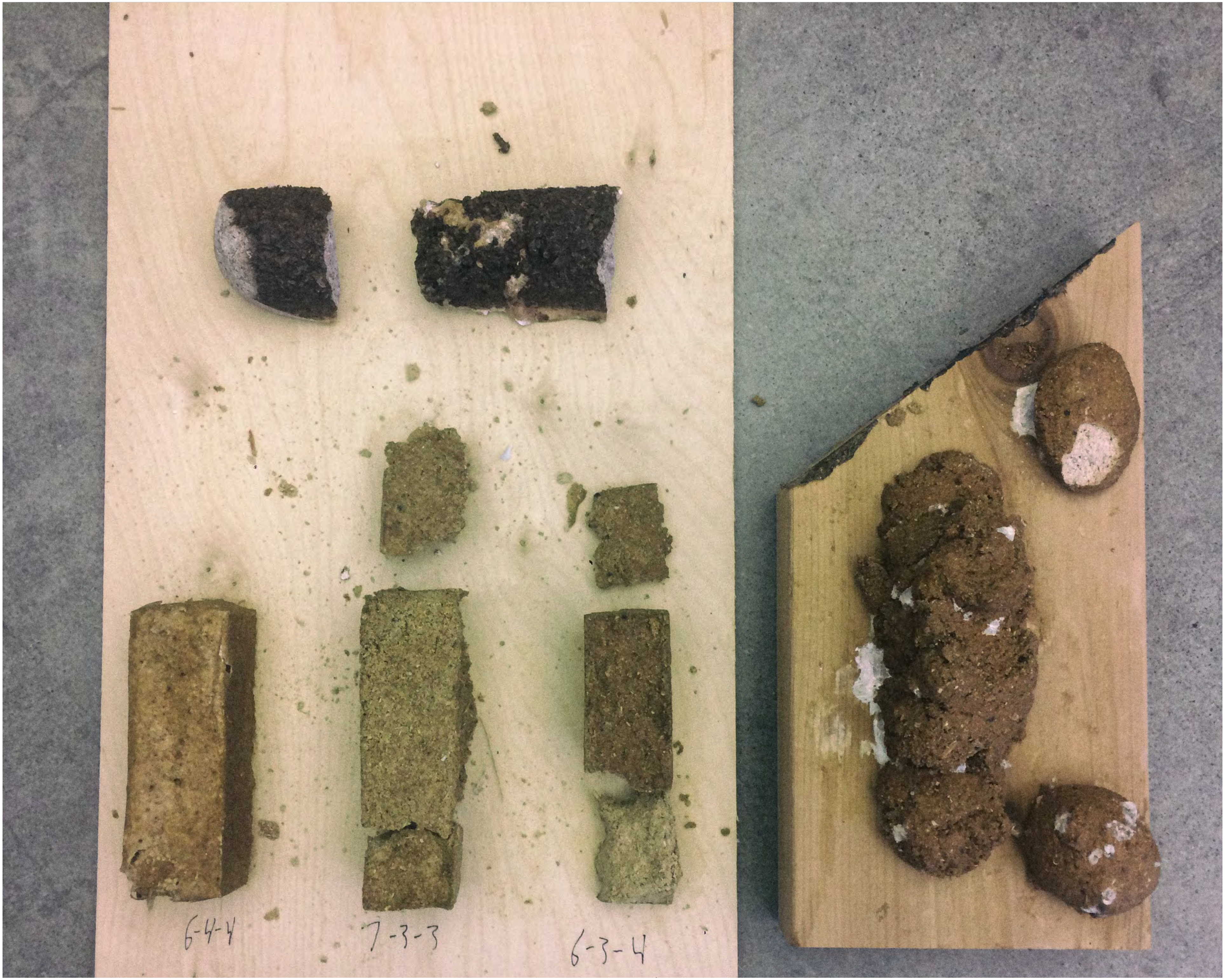
3D PRINTED WOOD PULP

Our project is broken into two parts. First, a material study was conducted to convert wood waste into a printable medium. Second, we constructed a tool to print the media we developed.

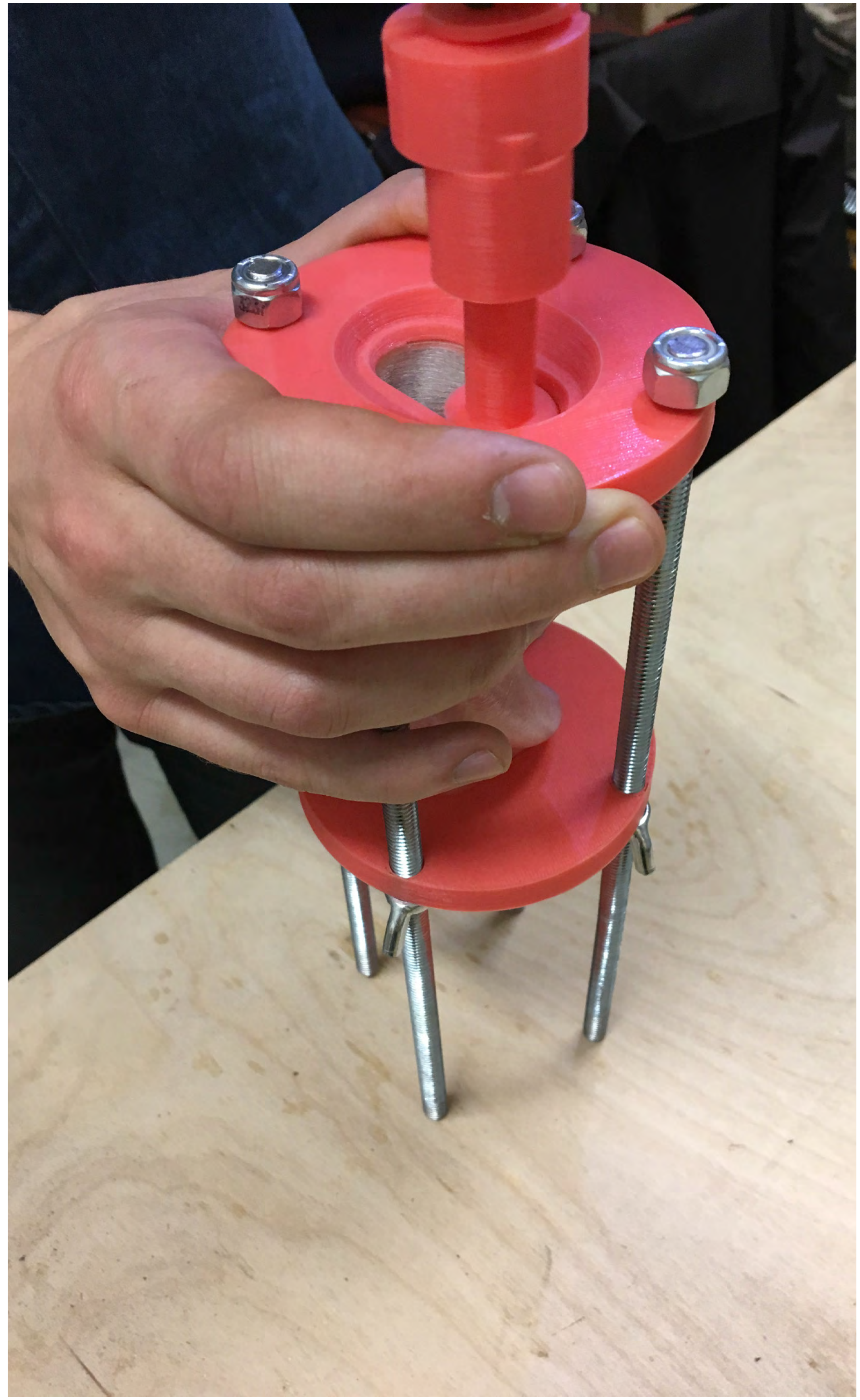
The material proposed seeks to harvest material from the waste generated in the CNC milling of wood. In its current iteration, the material developed uses fine wood powder extracted from a commercial CNC mill (a relatively uniform, consistent, and available material). This material is mixed with wood glue in an approximate ratio to 7:3 (seven parts powder to three parts wood glue). These two materials are mixed with tepid water in a specific sequence to create a paste material with the following attributes: smooth, tacky, fluid, and slow hardening. The material has the ability to bond with itself over a set period of time (1+ hour). This hour long period of malleability and workability is invaluable during long 3D printing sessions.

This mix of materials has a low slump coefficient which allows it to be built up in relatively small thickness to produce free standing walls and structural systems. This also means it is possible to achieve a reasonable degree of resolution with the medium. After the printing of the material is finished, the constructed result is placed into an autoclave for approximately 2 1/2 hours to activate the glue and remove water from the mixture.

In the future this material could be sourced from any waste wood production centre, and milled to the density and size appropriate for the printer. Material could also be custom produced to correspond to the size and density of a required print.


6-4-4
7-3-3
6-3-4


MGA

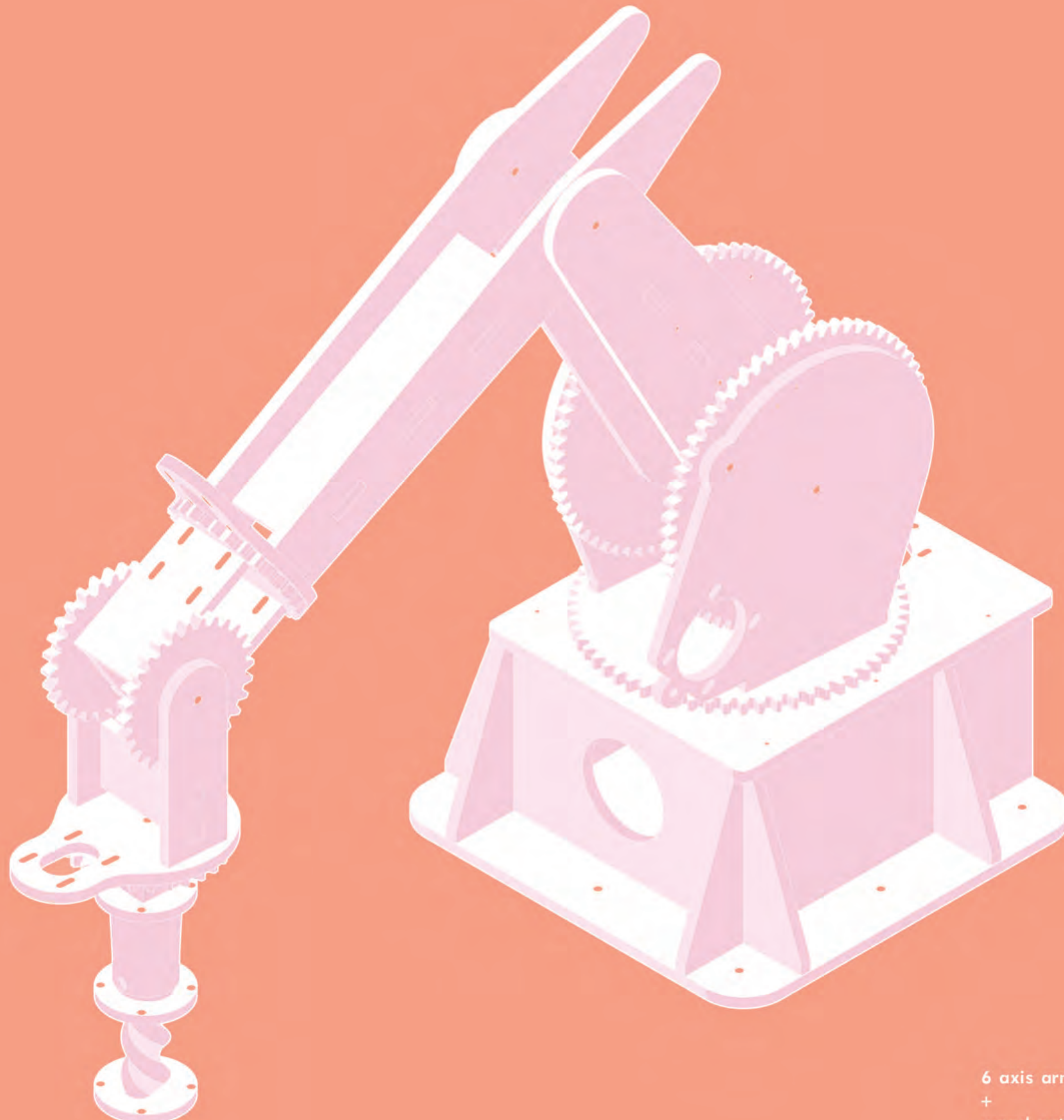


TOOL

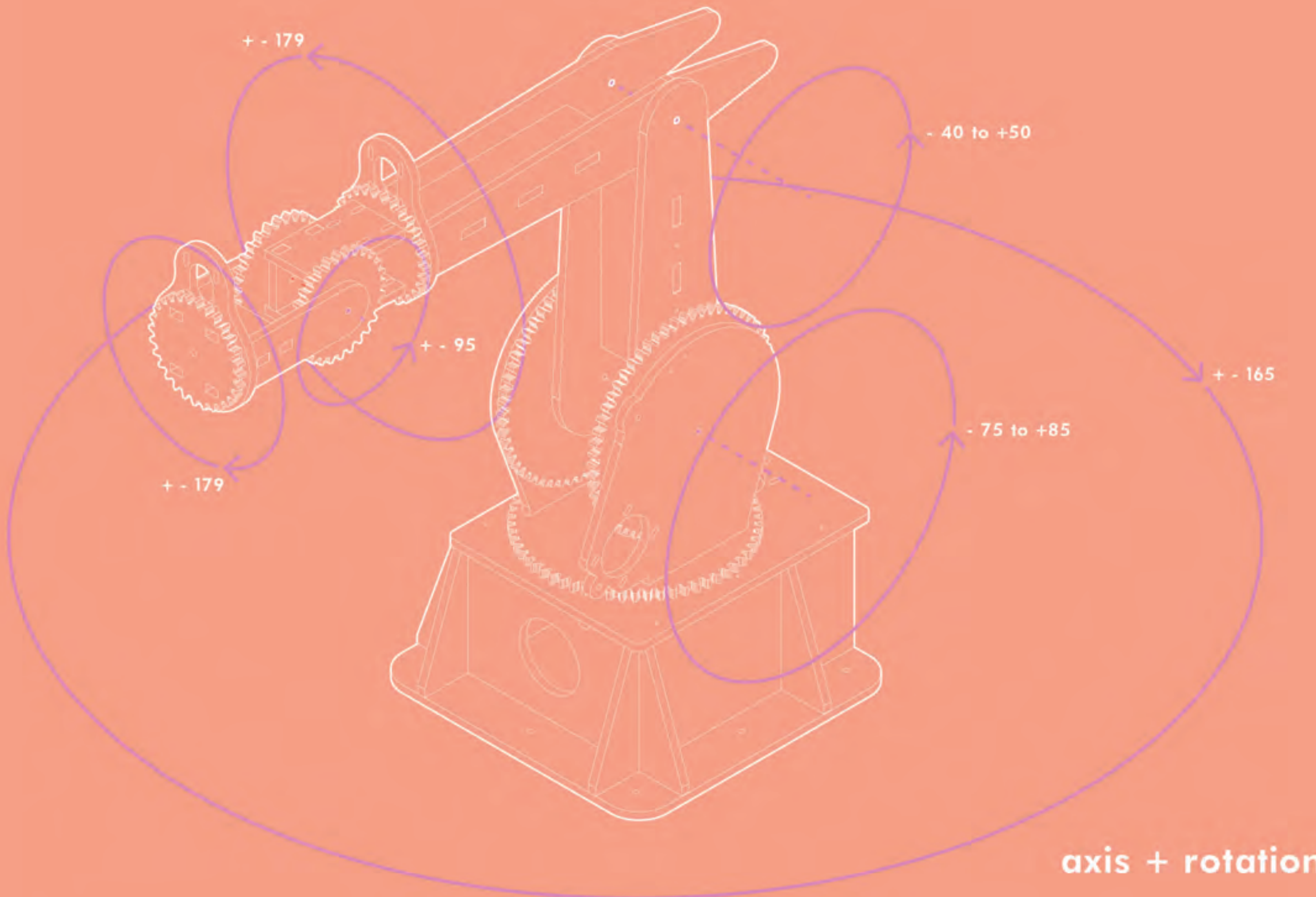
ROBOT ARM

Our material investigated the potential of mining the wood waste stream for usable material. The next step was to develop a tool that allowed the maximum flexibility for printing in three dimensions. We began with a kit robot arm, available as a series of plans, parts, and actuators. The tool first needed to be assembled. Once complete, we moved to wiring and programming of software, a process that took time to troubleshoot. The robot arm has six axis of freedom, which allows it to place material at virtually any location within its designated range of motion.

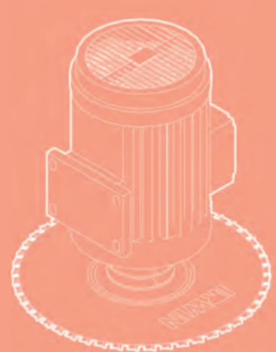
Then next step was the modification of the original tool. We identified a few areas of key modification to best accomplish our goals. First, we needed to develop a pump system capable of delivering the print medium without modifying the mixture, or separating the water in the mix from the adhesive and wood powder. The next step was retrofitting the head of the robot to accommodate the new pump attachment. This meant modifying the physical tool at several locations as well as the software that runs it. It was necessary to recalibrate the software so the machine wouldn't bind or break itself apart during operation. This process consumed most of the time alloted during the semester.



6 axis arm
+
wood extruder



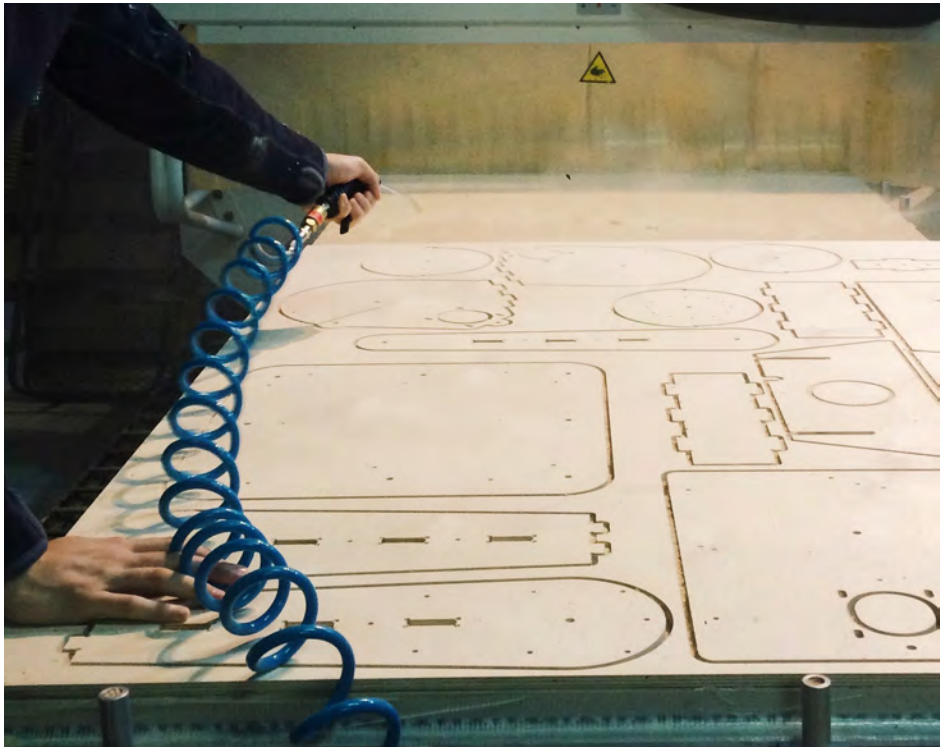
axis + rotation

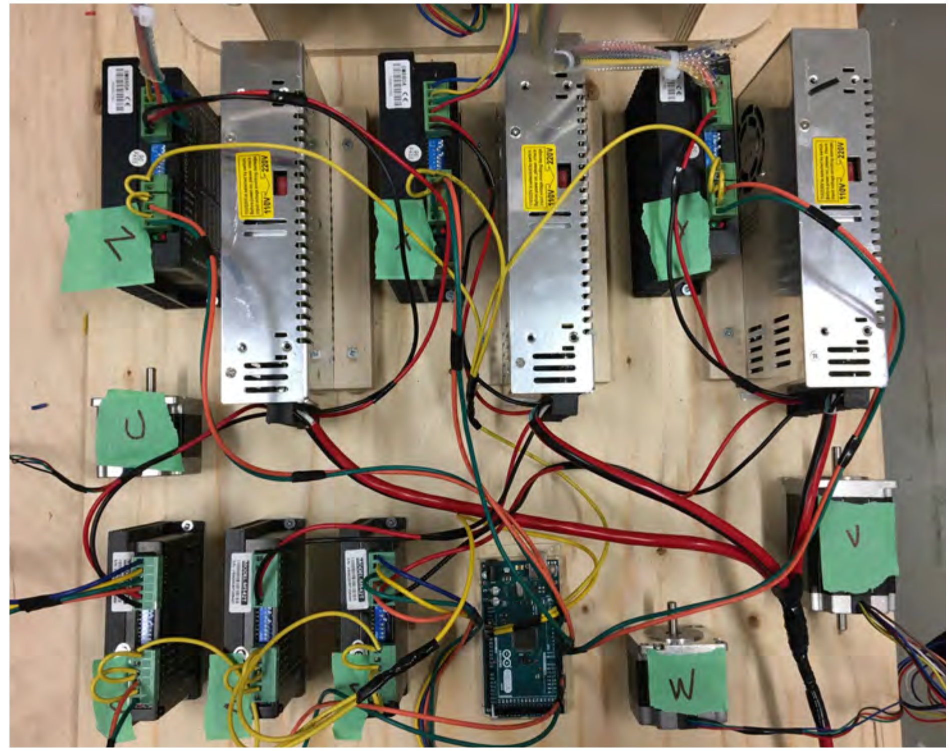


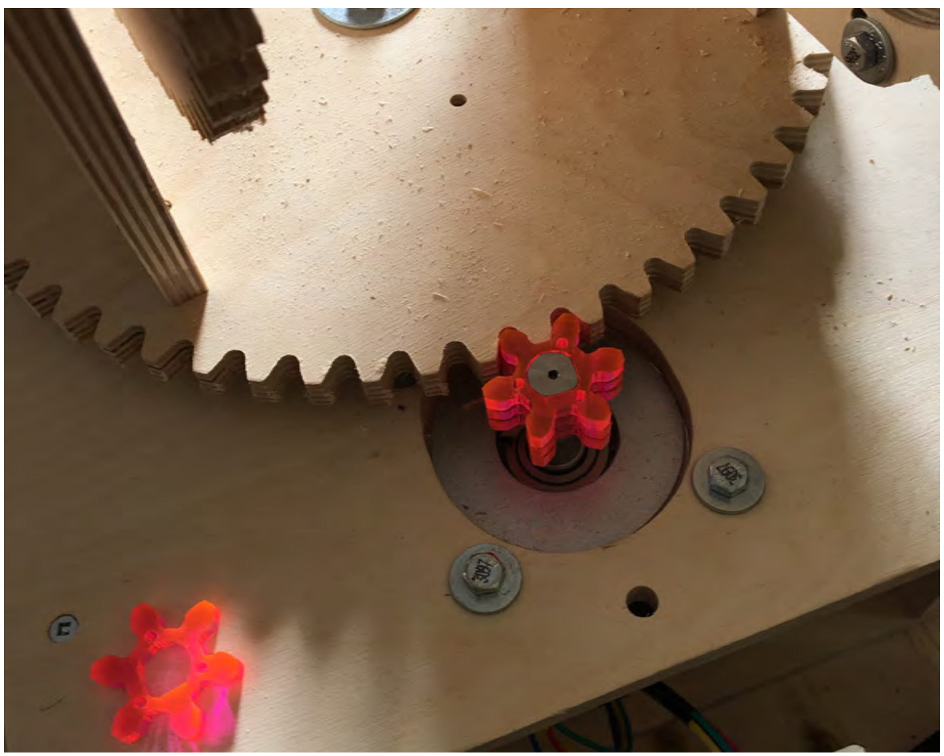
circular saw

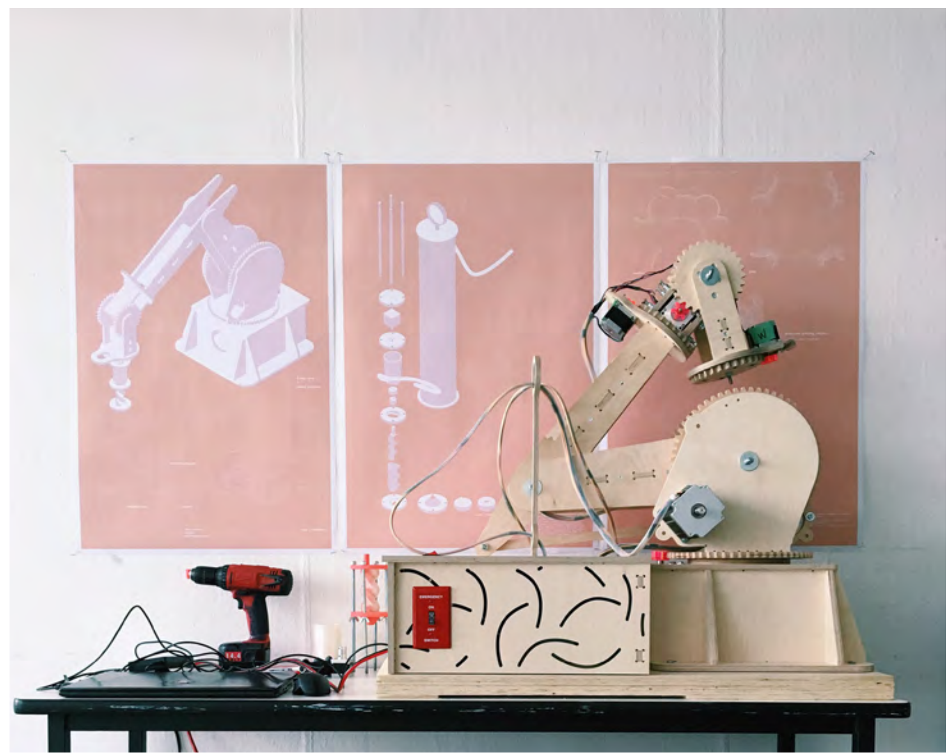
router

vaccum gripper




Z
U
V
W





DESIGN

PROCESS

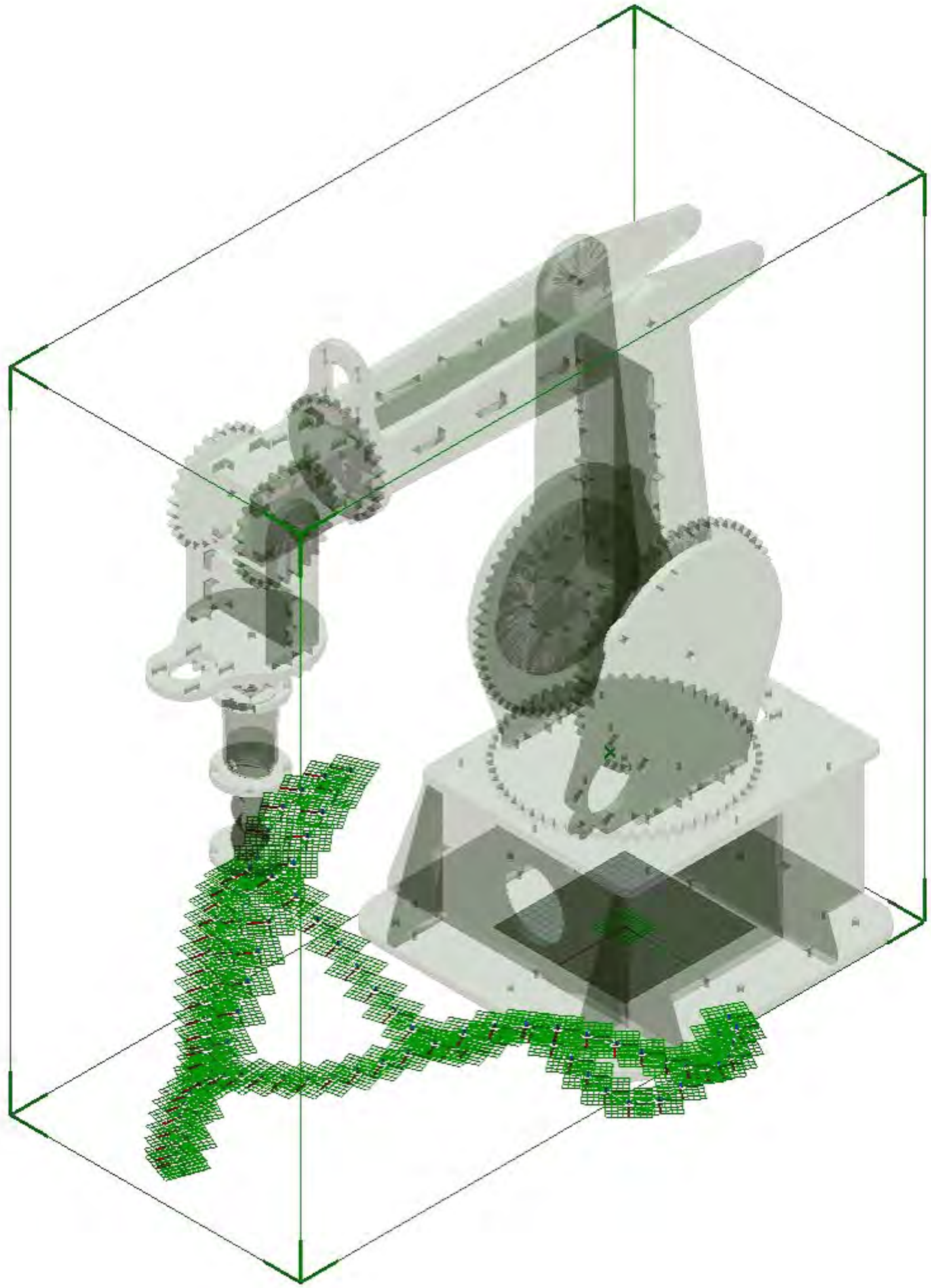
Our decision to focus on tool integration allowed for a flattened approach to design and fabrication. The result is what is termed a 'SOFT' approach to architecture.

"Behavioral fabrication strategies are not based on the "materialization" of detailed blueprint drawings or digital models, but rather on the execution of specific tasks that unfold out of the interaction between the machine and the environment through a sensor-actuator feedback strategy. Based on the feedback from both the material and the tool approach to design and fabrication."

~ Giulio Brugnaro, M.Sc.

We are currently experimenting with our process. So far, we have tuned the robot arm and the necessary software interfaces required to allow a structure to be created, tested (via fluid dynamic testing), and vetted the material to be printed. Many of these steps happen within Grasshopper and Rhinoceros 3D software packages.

The process will be better understood once precision tests have been analyzed and the extruder head is mounted on the system. A discursive tool-material-tool loop will be created to best understand how to deliver a product.

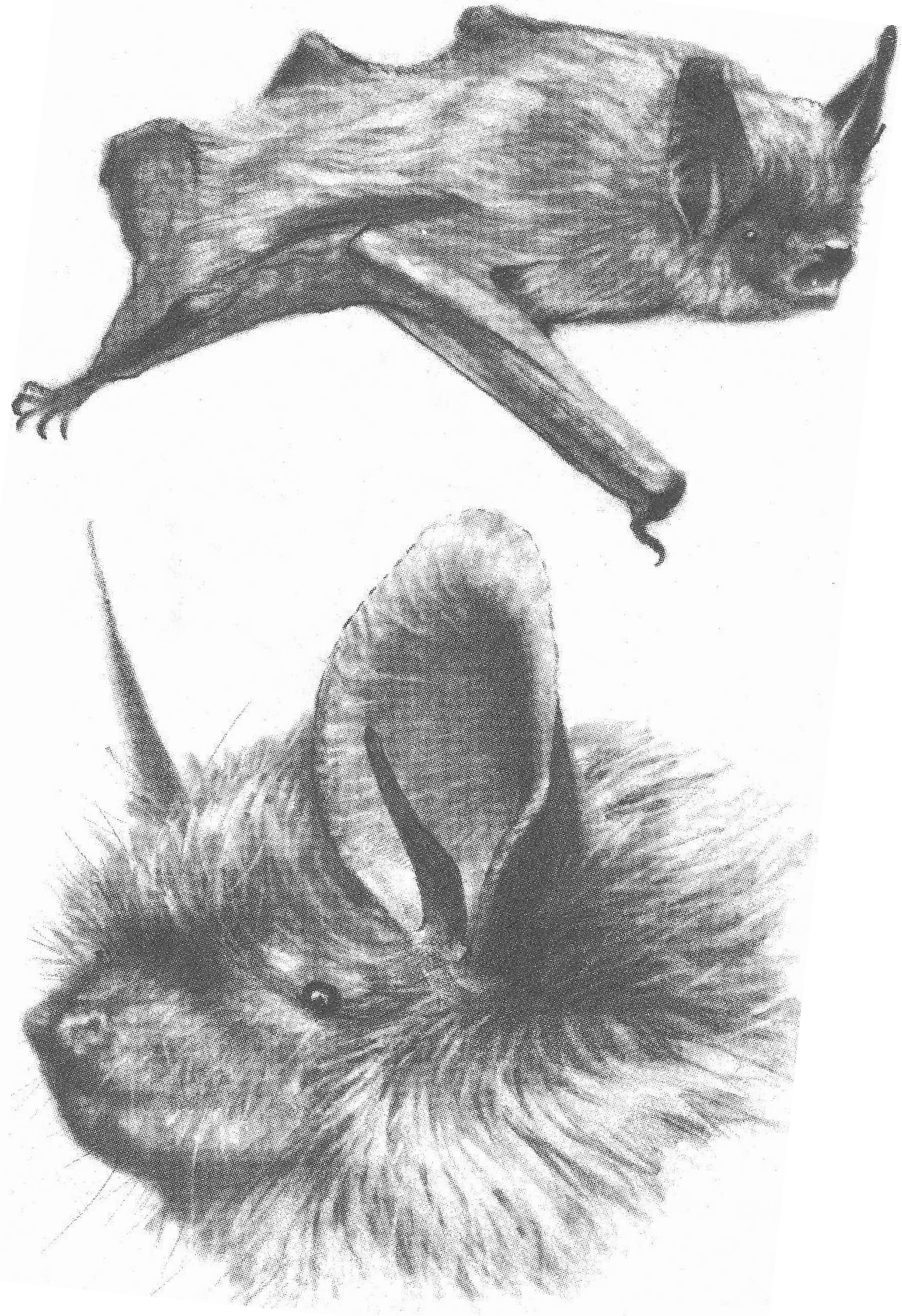


POLLINATOR

KEEN'S MYOTIS

The Keen's Myotis is a small bat that inhabits the lower mainland. In winter months these tiny pollinators hibernate in small caves, protected from wind and other elements. During summer months, they roost in a variety of comparable habitats, spending the night hunting and eating insects. We are designing for this animal.

Keen's myotis are small specimens, measuring between 79 and 88 mm and weighing between 7 and 9.5 g. They require consistently sized nooks and crannies for roosting but are relatively unspecific about the makeup of the roosts themselves. They require only adequate warmth and protection in their roosts.

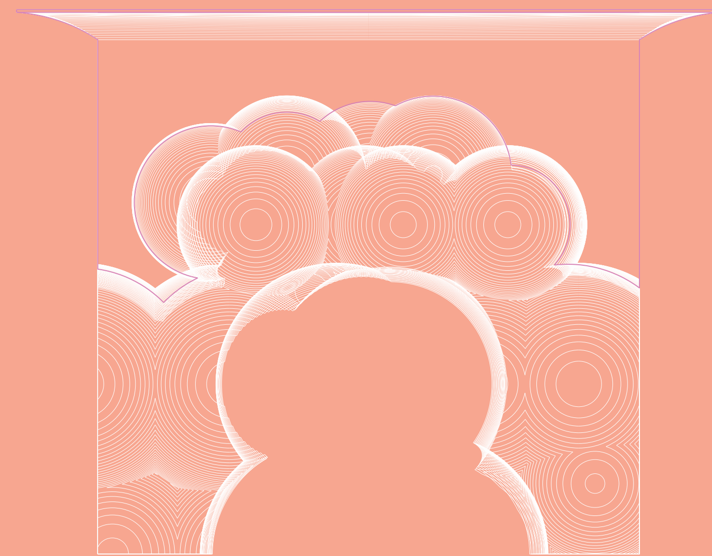


DESIGN

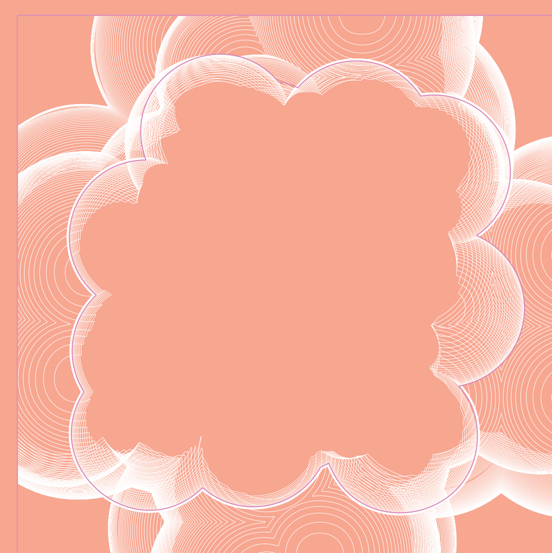
PROTOTYPE

The SLAQ pollinator house is based on analyzing and combining physical, technical, and natural inputs gleaned from an understanding of materials, tool capabilities, Keen's Myotis behavior,and Karst Cave attributes. The following attributes are investigated in both physical and material testing:

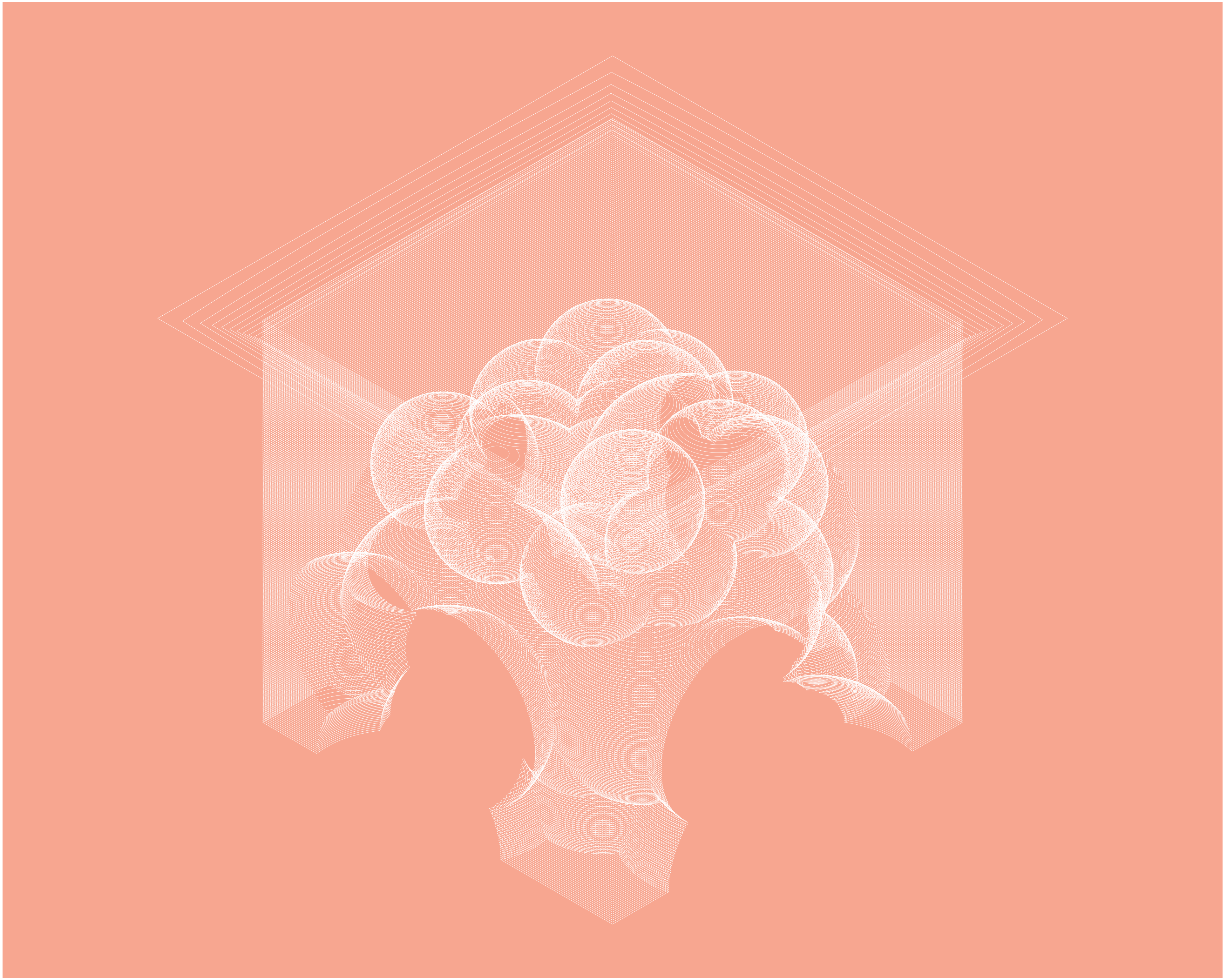
// The ability to regulate heat exchange within system, based on material thickness.
// The ability to control moisture level through material placement
// The ability to regulate surface quality to provide grip and comfort on interior surfaces



section



plan



NEXT STEPS

CALIBRATION

The next steps for this project include further testing and refinement of the robot arm. We also intend to release drawings, tool kit, and system parameters to the architecture community for feedback and suggestions for improvement.

Second, the robot needs to go through a series of tests to establish and predict accuracy for subsequent work. This will involve ‘touching’ objects in physical and digital space to ‘teach’ the tool limits and movement, and a series of drawing tasks in three dimensions to test agility and accuracy.

The extruder system is also poised for its next series of tests. We hope to remake the mechanism with updated geometry and linkage systems. Our printing system will require our building a gravity feed system to move the material to the extruder nozzle. Other improvements to this system could include the development of a low pressure air system to deliver the material to the extruder.

The combination of these two strategies (material and tool) will allow us to construct small architectural walls and details. It will be important to begin testing material properties (strength) of the cured wood pulp.

POLLINATOR PIÑATA

Patrick Beech
Genevieve Depelteau
Natradee Quek
Anna Thomas

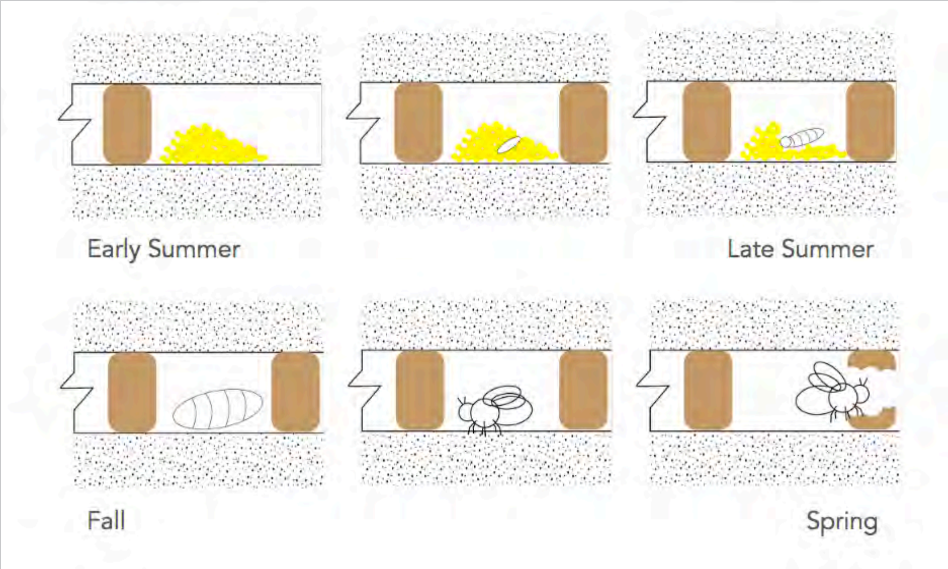
POLLINATOR

LEAF CUTTING AND MASON BEES

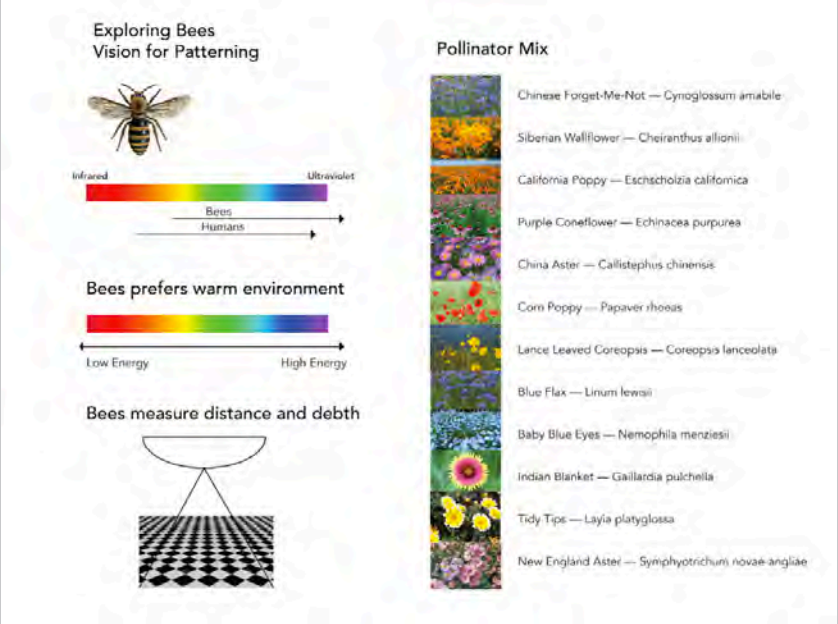
Leaf Cutting and Mason bees are solitary insects that lay eggs in cavities naturally occurring in the wild. Examples include beetle-bored wood and plant stems. The tubes must be horizontal for the insects to utilize them. The tubes must be dry and face towards the south. They must remain intact and stable for one year to allow the eggs to turn into larvae, pupate, and mature over the winter until they emerge in the spring. The bee will enter an acceptable tube and modify it to serve as a nursery. Partitions are constructed to separate each egg laid. These are composed of leaf pieces, leaf hairs, and mud.

Leaf Cutting Bee

Mason Bee



Life Cycle of Solitary Bee



Colours and Plants that attract bees

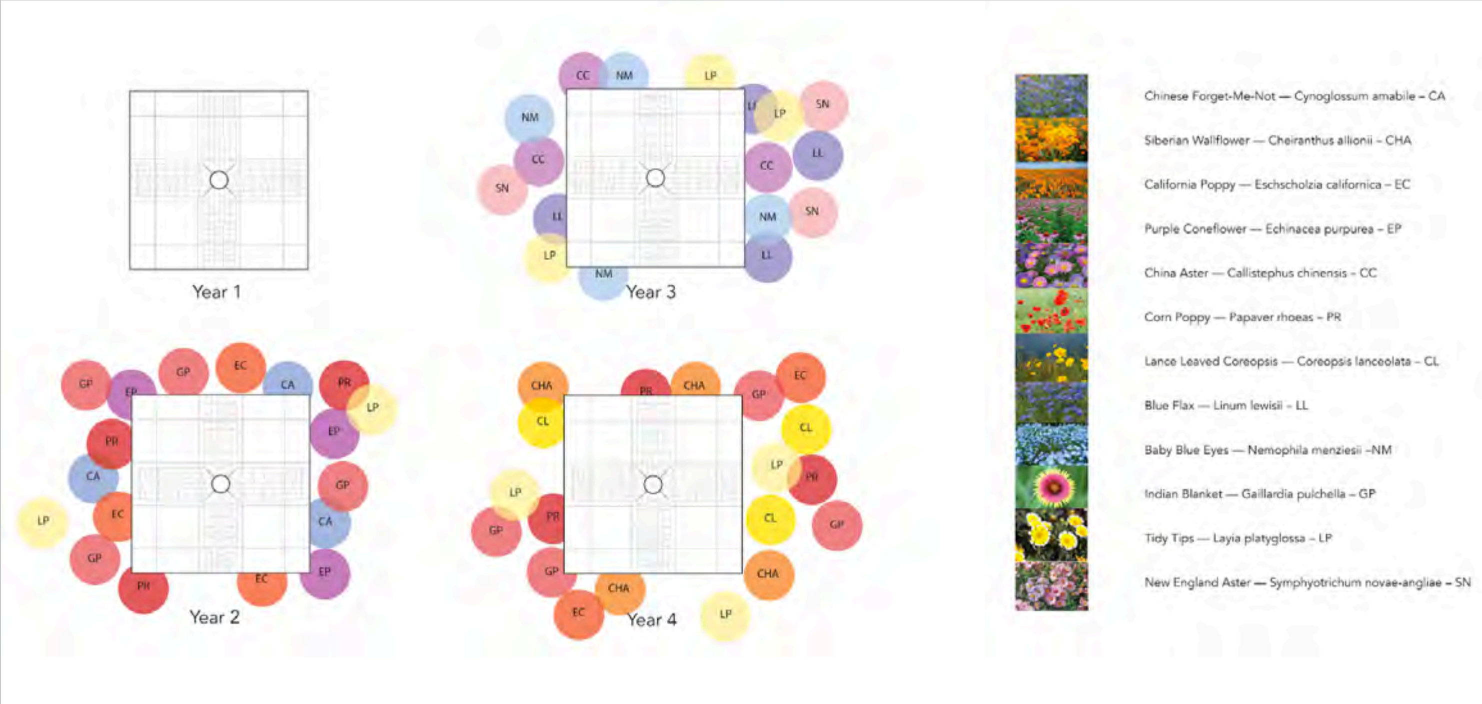
MATERIAL

CALIBRATED DECAY

Our project began with materials, sourced from the community. We combined waste streams from local coffee shops and bakeries to create a biodegradable material appropriate for constructing habitat tubes for solitary bees. The material is also selected as a medium for seeds, providing vital nutrients to nourish the soil. Our goal was to create a material that would house the bees for one year and then decay and fall to the ground, decomposing into the soil. The final matrix is comprised of crushed egg shells, coffee grounds, paper pulp from blended egg cartons, and seeds of essential pollinator plants.

Eggshells add calcium to the soil. As coffee grounds decompose they release nitrogen, potassium, phosphorous, and other minerals that support plant growth. We put seeds into our material to create a ready-made perennial garden. After the material has begun to decompose on the ground the seeds are revealed and allowed to sprout in the fertile mix of nutrients. The plants grow and create an ideal habitat and food source for the next generation of solitary bees.

This strategy supports our ultimate goal. We aim to nullify the need for any artificial pollinator homes. We hope to enhance the natural habitat by increasing the fertility of the soil and diversifying the plant species and native bees found in the pollinator park.



Sample Planting Plan for pollinator home

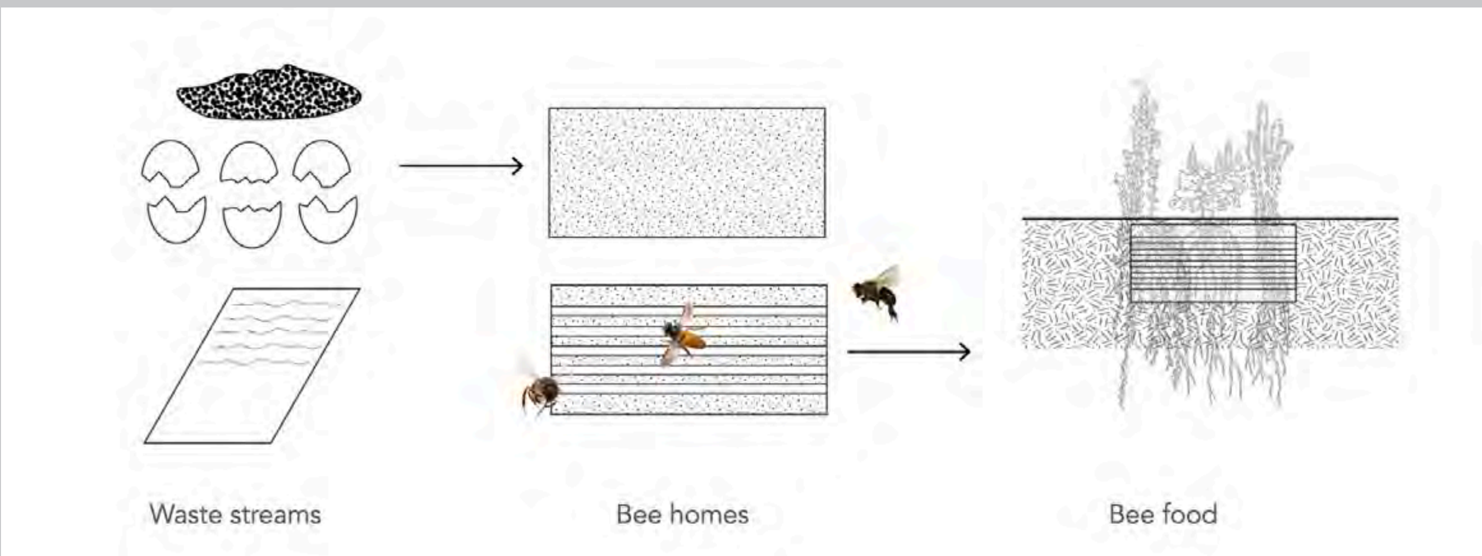


Diagram of Project Concept

DESIGN

PROCESS

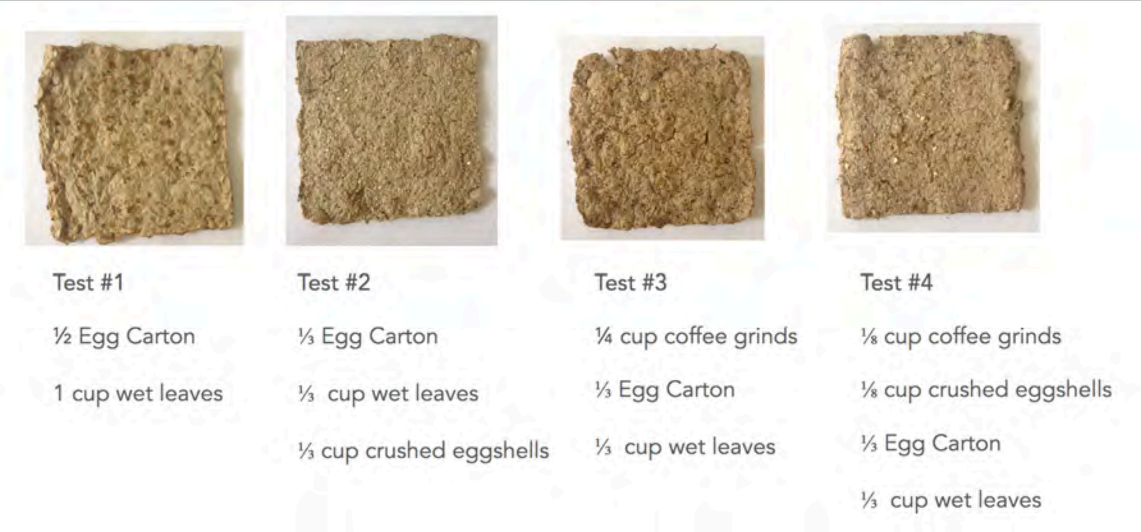
1. Gather materials from local commercial waste streams. Sources include local coffee shops and bakeries.

2. Conduct material experiments.
Iterate to find combinations of degradable materials with the most strength, water-proofing ability, flexibility, and structural endurance.

3. Develop the form of pollinator home.

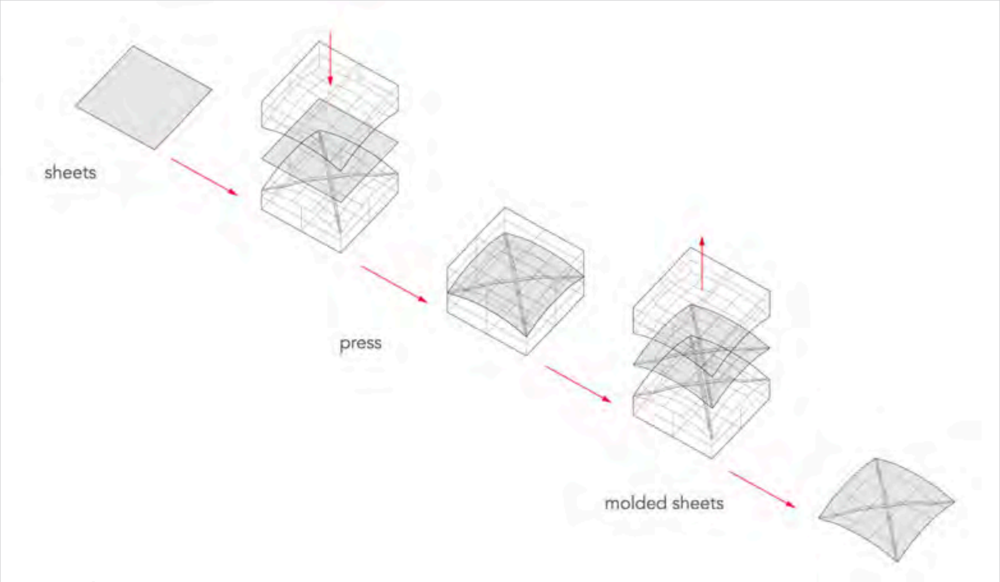
4. Build tools including a press to streamline assembly and create continuity of form.

5. Build prototype.



Material Tests

Material and Form Tests



Press Diagram

DESIGN

PROTOTYPE 1

Goals:

- Create a site design (a figural garden?) that can be added to year after year
- The shape of the garden should be thought of as a cycle. This makes the process of decay visible over the course of years, as each piece from the previous year[s] fall. Each section will be in progressed state of decay when a new one is installed
- Tubes will be created when two layers are put together. A productive section is generated by the topography of each specific sheet.
- Wax barrier applied to top layer to create water proofing .

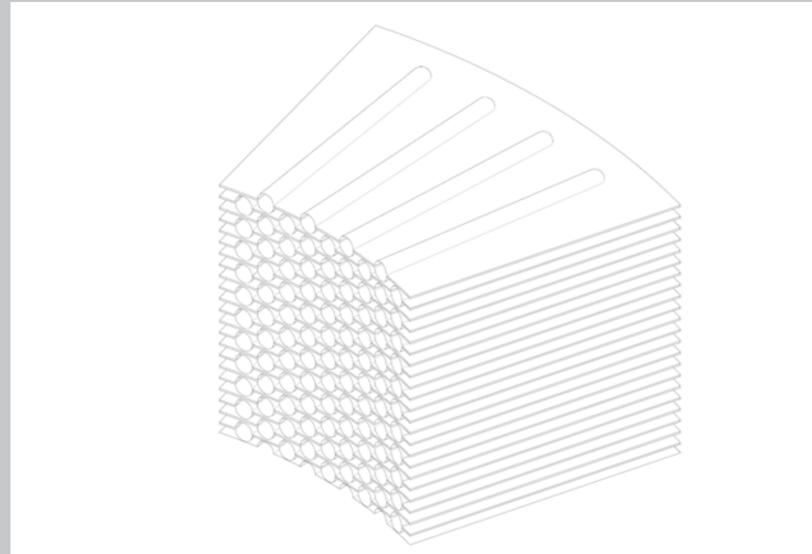
Issues:

- Low endurance levels
- We need a framework structure to hold the assembly together and to add structural support the home
- There is too much variance between form of each layer. Consistency would be beneficial.
- The team needs to create a water barrier and anticipate and design for directional flow of precipitation.

Successes:

- Found successful material combinations for production of houses.
- Defined an effective way to construct and dry layers of material.
- Discovered a form related strategy for incorporating tubes for bee habitat

Prototype 1



Form Drawing

Prototype 1 Concept Diagram

DESIGN

PROTOTYPE 2

Goals:

- *Create stable structure to support pollinator homes.*
- *Homes free from figural garden strate-gy may be placed at various locations.*
- *Form of design directs water to edges and "drip tip."*
- *Top layer has water proofing barrier made of bees wax.*

Issues:

- *Process of making each layer is too time consuming.*
- *Need to have more layers that are more closely nested.*
- *Form has become too monotonous.*
- *Need more tubes per layer.*

Successes:

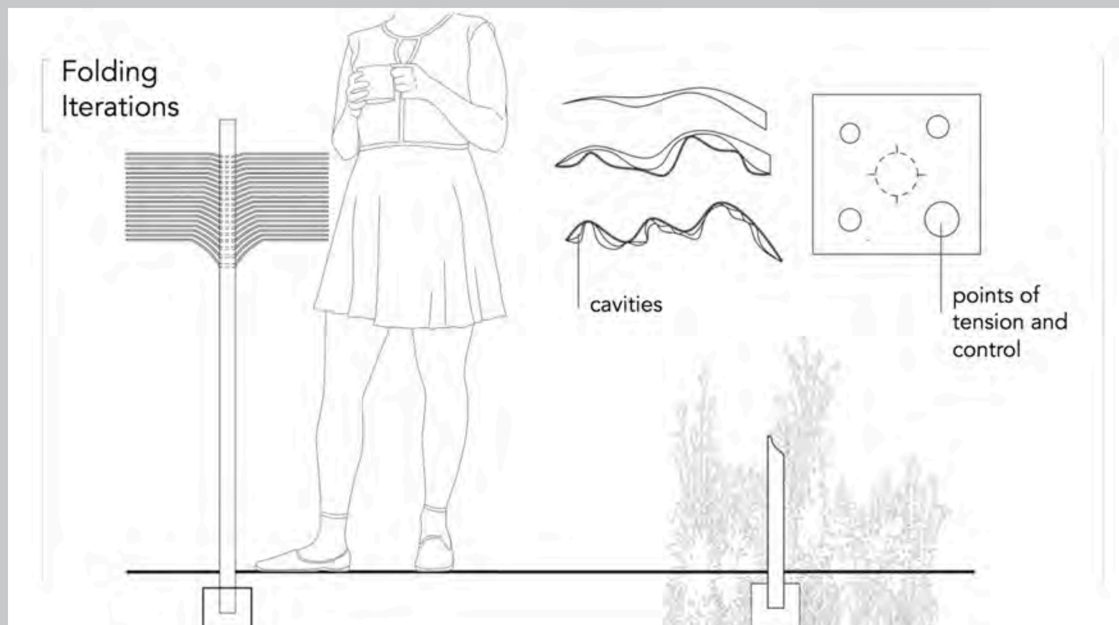
- *Created stable mounting structure.*
- *Defined successful form for layers.*
- *Defined successful mixes of materials and variance of them within each layer, which allows for strength in certain areas and decay in others.*
- *Successful use of press to create conti-nuity of form .*
- *Visually compelling .*

Prototype 2 3D Model

Biomimicry of Tropical Plant’s leaf

Detail Photos of Attachment

Prototype 2 on Support



Prototype 2 Concept Drawing

NEXT STEPS

PROTOTYPE 3

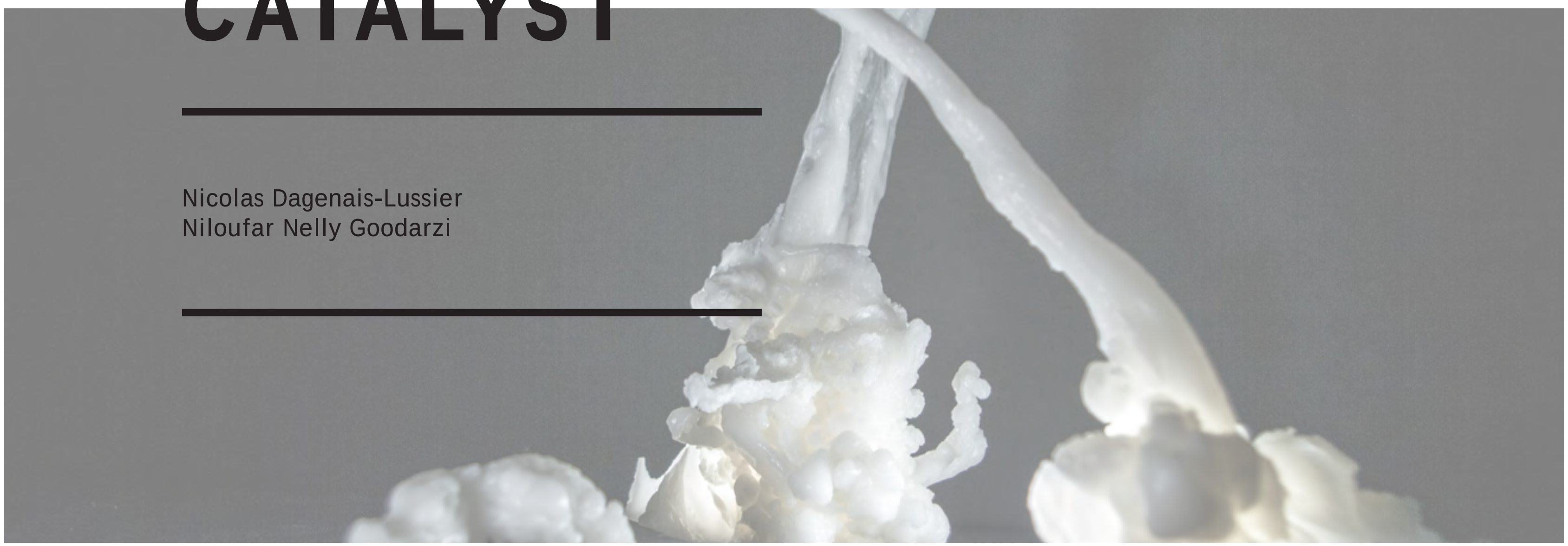
1. Perfect form of pollinator house by allowing for more habitat tubes per layer and increased variance of form between layers. This will generate a more compelling form.

2. Test pollinator home outside to gauge endurance and viability.

3. Streamline process and cut down on time to construct each layer:
- Creating larger sheets that can be broken into several smaller ones
- Collaborate with robotic arm team to 3d print layers using our material.

4. Create blog to document success of pollinator home and allow for community feedback / interaction
5. Design signs to be installed with pollinator homes
- Communicate process and materials used to fabricate new habitat.
- Describe benefits of providing increased natural habitat for bees, seeds included in material, and general information about native solitary bees and their importance.

CATALYST



Nicolas Dagenais-Lussier
Niloufar Nelly Goodarzi

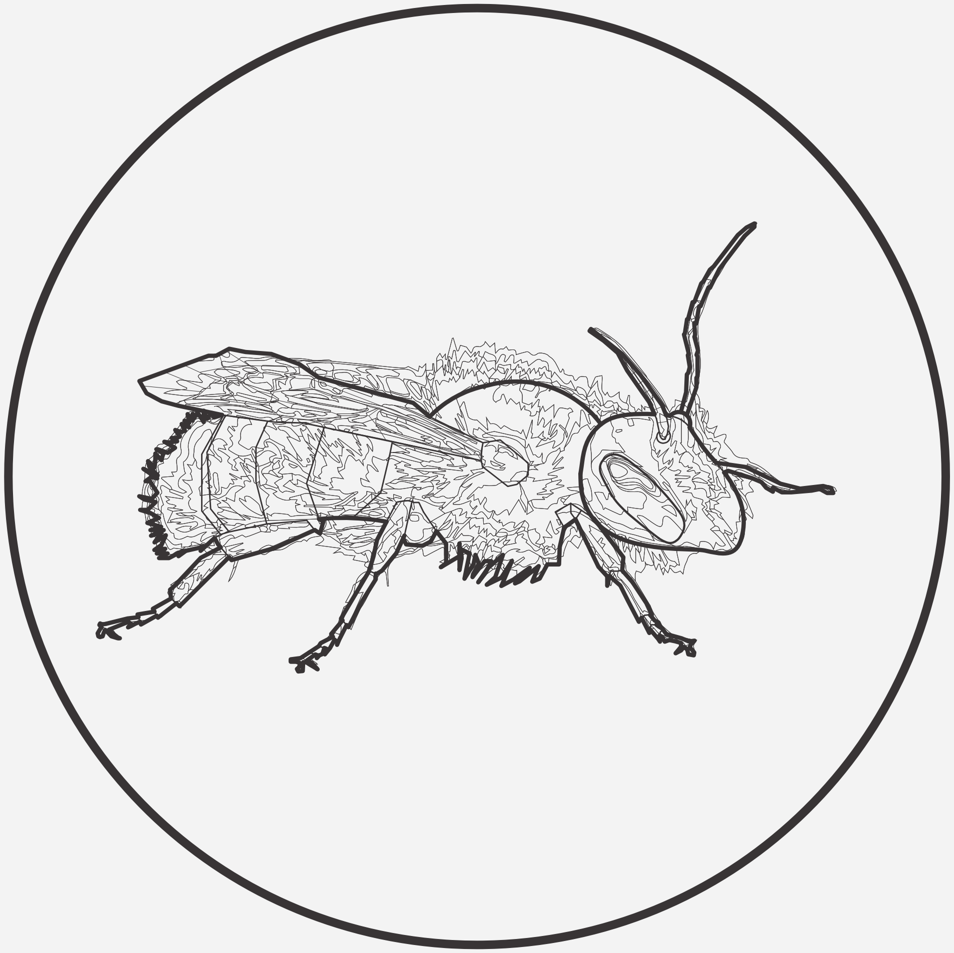
POLLINATOR

MASON BEE | OSMIA

Osmia Lignaria, more commonly known as the Blue Orchard Mason Bee, interested us as we began our research on pollinators. This particular Mason Bee is one of the most common in the Southern British-Columbia region, with over 30 species in Metro Vancouver alone. Known to be a solitary bee, these pollinators do not form large hives and are known to be fairly docile. The male mason bees do not sting, a trait we believe makes them an ideal species of bee to introduce as a pollinator in denser urban areas.

The mason bee generally nests in two stratas in relationship to the ground: 0-150mm off the ground level or 1500mm and up. This striated habitat rendered the space in between those outer dimensions unused, and available for other program.

The bees make their homes in tube-like spaces. Within the tubes, the bees organize to protect the female. Male bees will station themselves near the mouth of a tube, a sacrifice should the nests be attacked by predators. The diameter of nesting tubes are between 7mm-8mm. They are typically 130mm-150mm deep. The selected habit is typically in close proximity to mud and food. A dry, dark tube is preferred with easy access for seasonal cleaning.



1 Solitary

135 different species of mason bees

30 species in Metro Vancouver

6 weeks lifespan

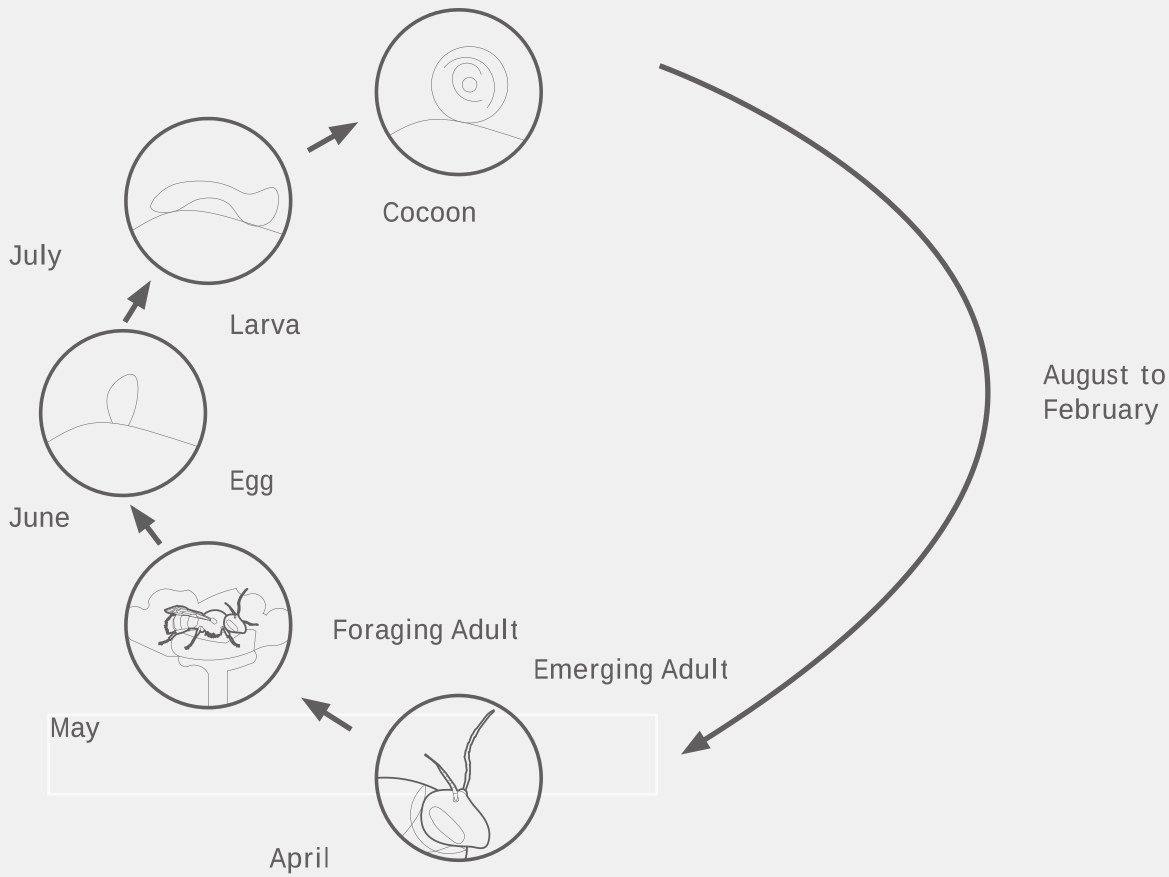
100 meters max traveling distance from nesting site

14°c Minimum activity temperature

26°c Optimal temperature of development from pupa to adult

Stingless male bee

Successfully pollinate fruit trees such as apple, cherry, almond & berry bushes


Cocoon
July
Larva
August to February
Egg
June
Foraging Adult
Emerging Adult
May
April

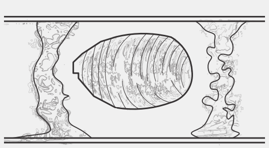
7.5 mm diameter average holes
7-8mm range

130-150 mm holes depth

150 mm off the ground and above 1500 mm
optimal nest location height

Food & Mud source required nearby

Color marking prefered _ mauve, pink, blue, yellow



Front 80-100mm produce male bees | remaining lenght hosts females

MATERIALS

Wood

Paper/Cardboard

Plastic

Corn

Styrofoam

Water protection needed

Wind protection needed

N

W → E

S

East facing holes prefered _ early morning sun exposure

DESIGN
PROCESS

Material experimentation is at the forefront of our design process. We adopted a form finding approach from the outset and chose to focus on a series of experimentations that relied on a materials ability to change states at specific temperatures. This work lead to a final sculptural pollinator home. We began our research by conducting experiments with wax. We measured melting and cooling points, and tested the predictability of the material's behavior through a series of hands-on maneuvers and production processes. We dropped hot wax into water for example.

Our analog materials tests revealed the need for further design development and tests that had more precise relationships to our specified design objectives. This required we push our process towards the digital realm. With the a set of basic forms established and a clearer understanding of the physics behind the material transformation, we were able to replicate the formal qualities of wax through the use of Rhino and Grasshopper software.

3D digital models were output using 3D printers. With a rapid-prototype in hand, we switched focus from our initial wax experimentations to porcelain. We developed a pieced plaster mold which we used to cast a final porcelain prototype.


016-2640E

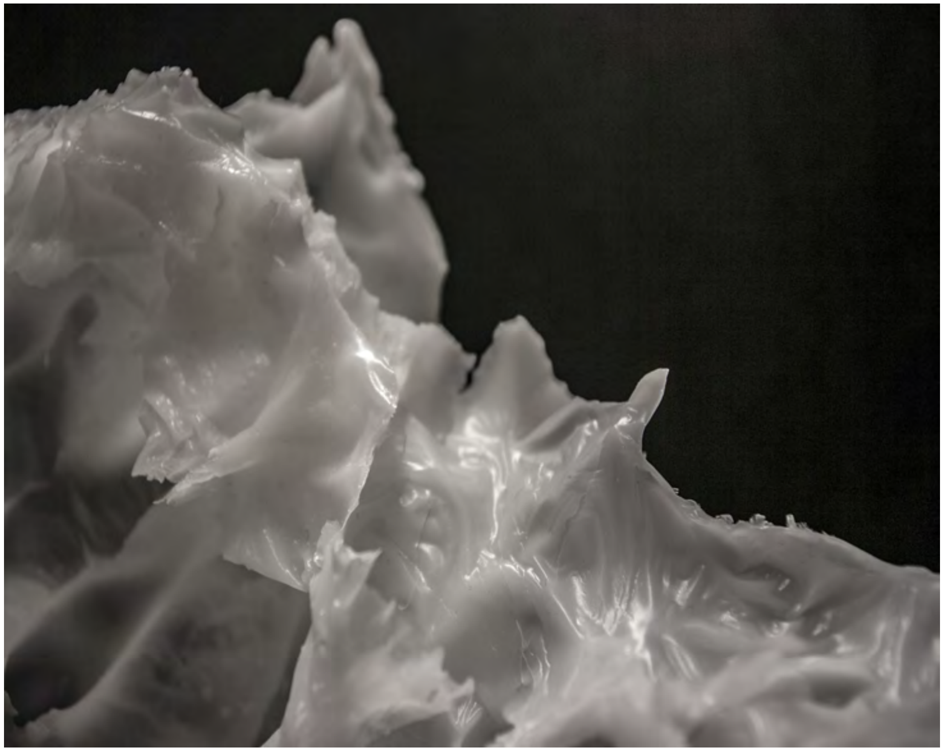
MATERIAL

WAX

The images provided are documentation of material exploration with wax. We used both petroleum based wax and bee's wax. The resulting sculptural forms were made by dipping, pouring, and pumping molten wax into cold water. The wax is hydrophobic by nature, causing it to congeal in the cool liquid. Once hardened, it has the ability to transmit diffused light.

Though inspired by more familiar bee hives and insect constructed wax structures, we decided to move away from the geometric and structured forms associated with bees. We began our experimentation studying the physical change of molten wax, learning from how it solidified when dropped in cool water. A rapid drop in temperature when immersed in a liquid gives the wax a smooth satin, almost drape-like finish. Pouring the wax over ice gave us an opportunity to sculpt an interior cavity. This was accomplished with some control. The ability to create form and volume allowed us to envision occupation, structure, and how form might be deployed at an architectural scale.

All of these explorations resulted in tools and strategies for finding form generated by material behavior. We could deploy that knowledge with sculptural intentions and at the beginning of our design process.

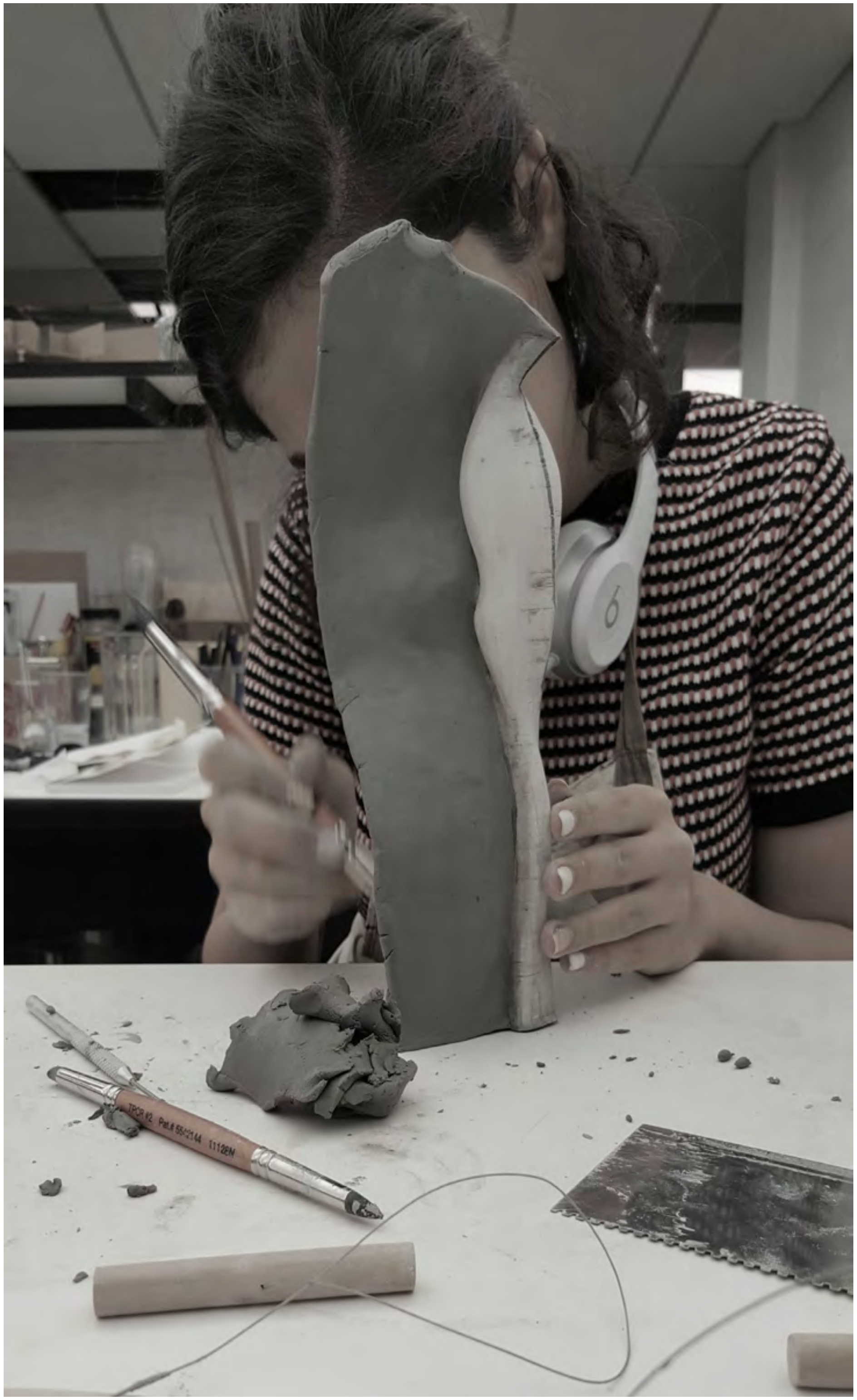



MATERIAL

CERAMIC

An object that is intended to reside in the public realm needs to be resilient. Wax is not an appropriate material for use in an uncontrolled setting. Given that our design has to endure weather and survive the abuse possible in an outdoor public park, the decision was made to use porcelain.

We used plaster to create a 6-part mold for the top half of one of the prototypes. The parts were produced by using our rapid-prototyped model of the wax design as a blank. The images that follow show the careful, calculated division of the plaster mold. This complexity was required to allow the form-work to release by eliminating undercuts. This is necessary as undercuts can cause issues in the final stages of the slip casting process. Any form that has an undercut will make it impossible to remove the porcelain cast without significant damage to the object being formed. Our process images show the final sculpture in a raw and slightly fractured state. This was caused by a lack of drying time for the mold.




LASSERRE

500 ml (cc)
400
300
200
100
50

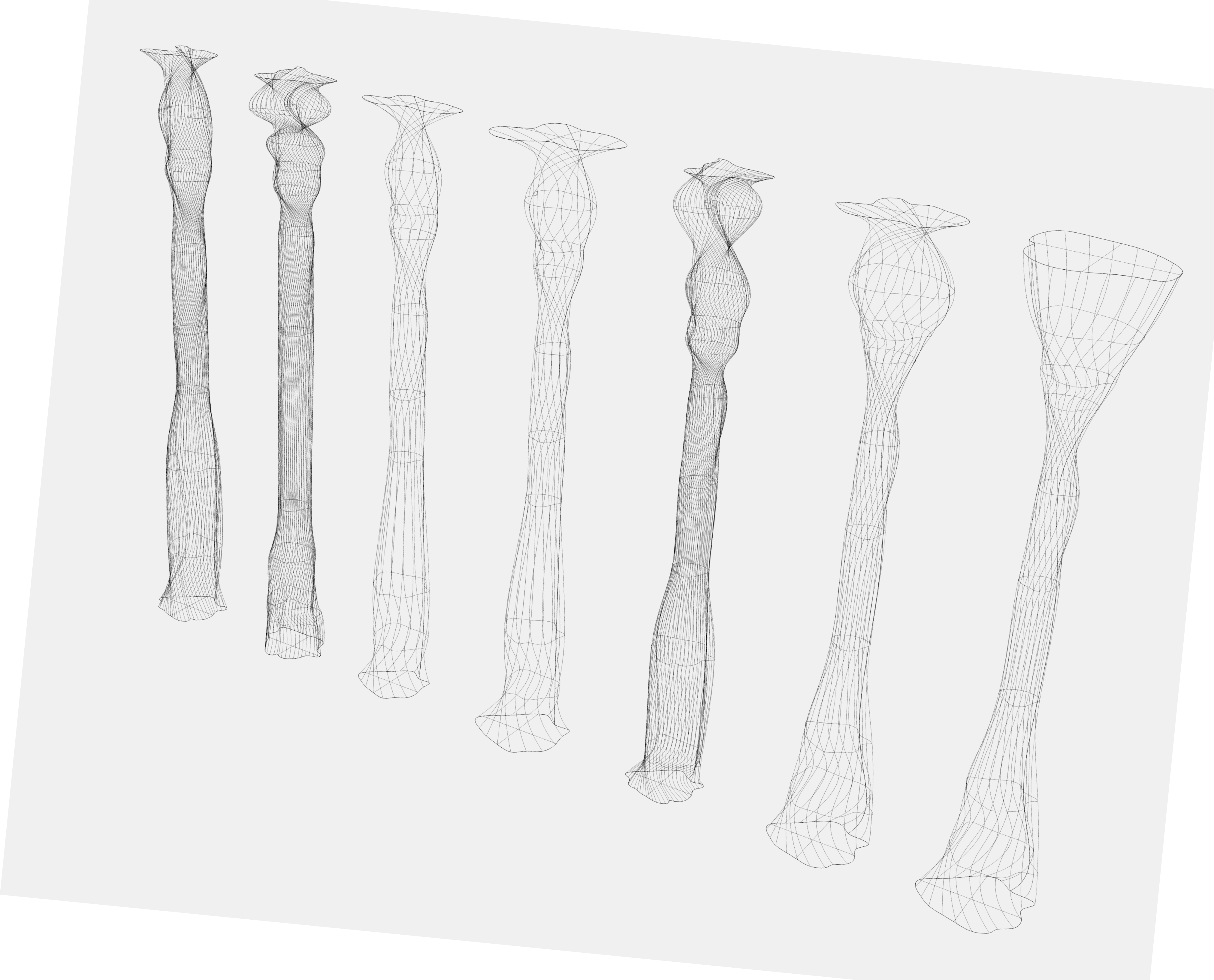
DESIGN

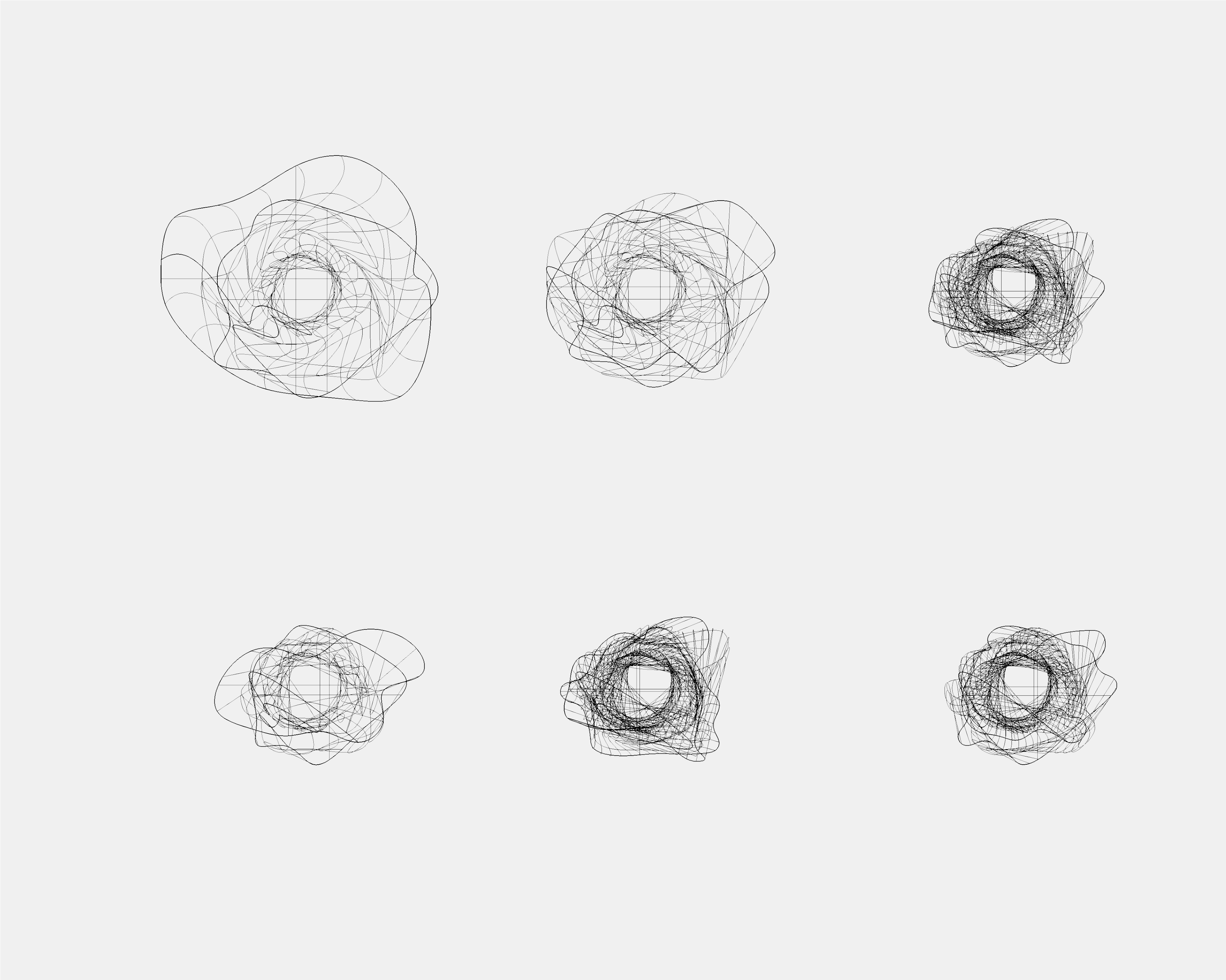
PROTOTYPE

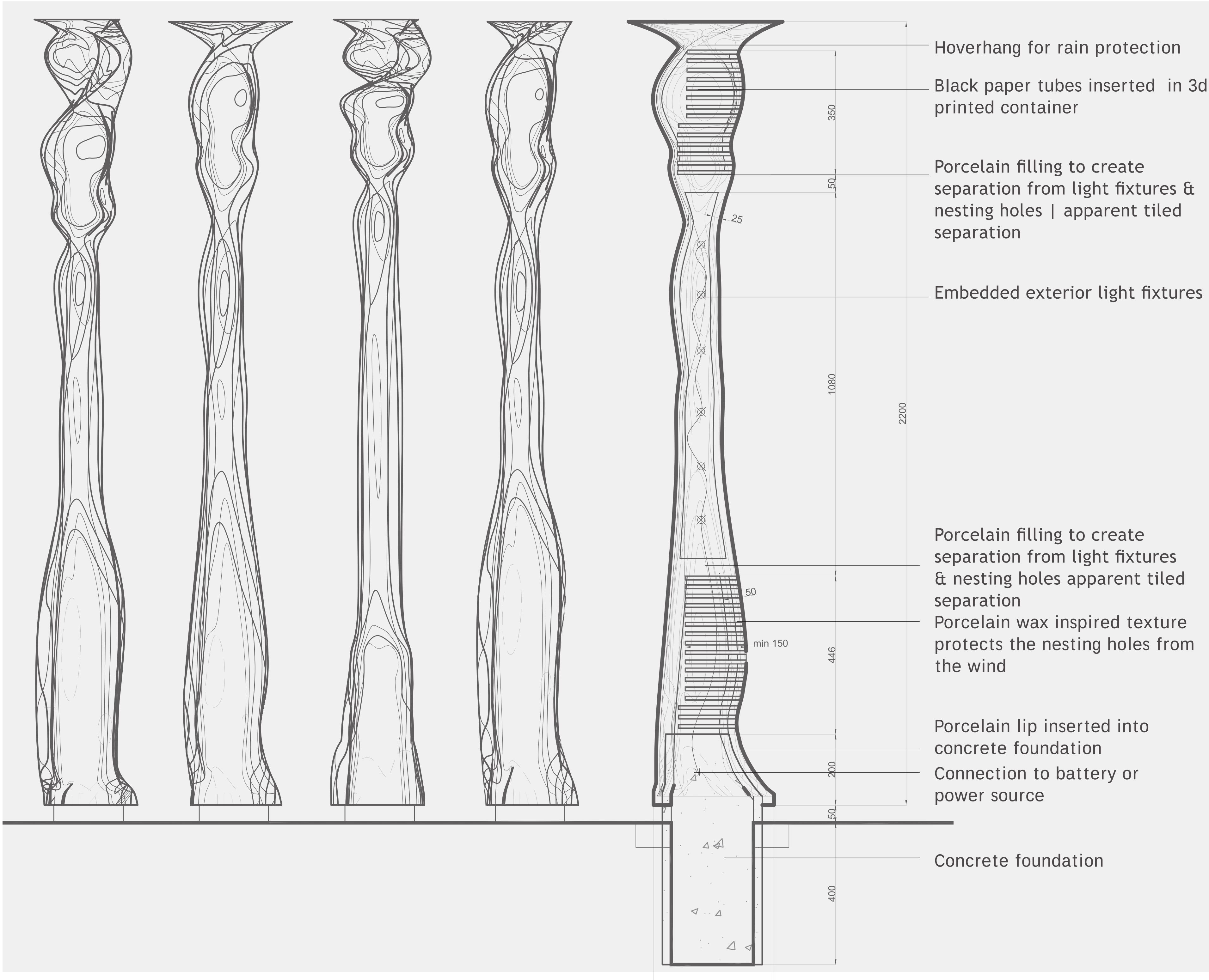
Our final design proposal consists of two interventions. One intervention is to house pollinators with-in the pop-up park site provided by the City of Vancouver. The second is to promote the park and the pollinator home interventions publicly through the use of bus stop advertisement infrastructure. The pollinator home in our proposal has been designed to be formally distinct and bring members of the community out to the park. Its ability to act as a lighting fixture will enhance the experience of being in the park and add beauty. Our design is an attempt to positively address a lack of aesthetically appealing pollinator homes available for use or installation.

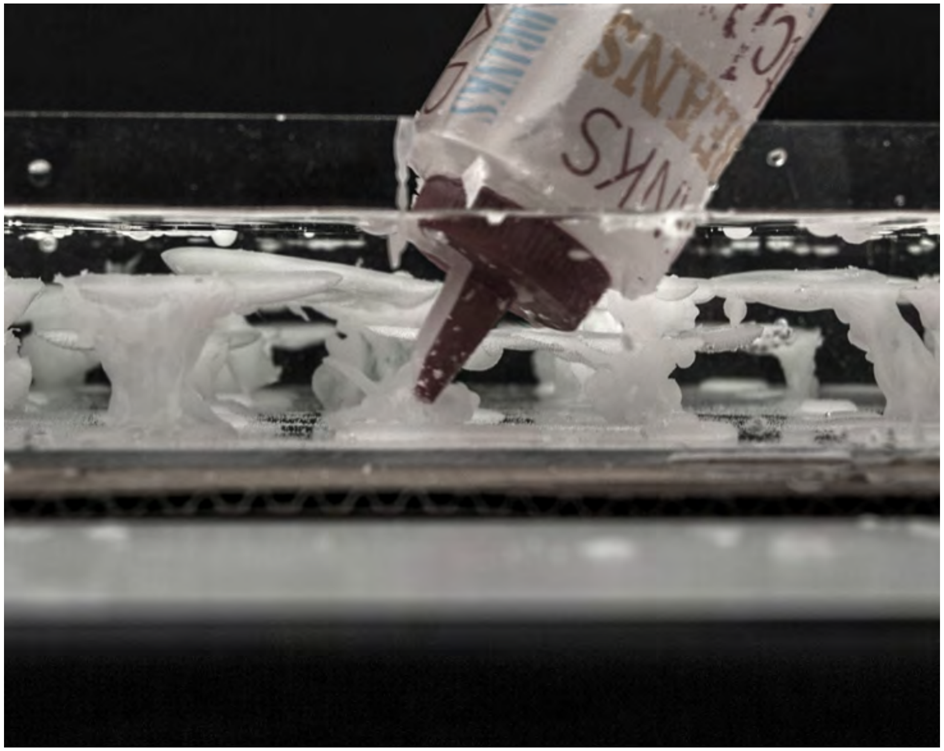
We positioned the tubes for bee occupation at the top and bottom of the sculptural form. This decision was based on our research findings. The space inside each tube would be sleeved with rolled black paper, capped closed at the interior end. These paper tubes can easily be removed and replaced at the end of each pollination cycle. The black paper also eliminates direct light from reaching the insect. The mid-span of the sculpture holds lighting fixtures that provide ambient light in the park. The decision to provide lighting was inspired by a public request for a better lit park space (taken from a community survey conducted about the park's design).

The bus stop add would feature a map of the park with wax elements placed where they would be found in the pop-up park. The glass holding the wax would have pollinator awareness information and direction to the park etched on it. Several bee houses would be included to the sign. The add would be an active intervention. The wax placed within the glass box would ultimately melt, symbolizing the slow but definite demise of the pollinator community within the urban context.






Hoverhang for rain protection
Black paper tubes inserted in 3d printed container
Porcelain filling to create separation from light fixtures & nesting holes | apparent tiled separation
Embedded exterior light fixtures
Porcelain filling to create separation from light fixtures & nesting holes apparent tiled separation
Porcelain wax inspired texture protects the nesting holes from the wind
Porcelain lip inserted into concrete foundation
Connection to battery or power source
Concrete foundation
350
50
25
1080
2200
50
min 150
446
200
50
400




VIACOM JCDecaux

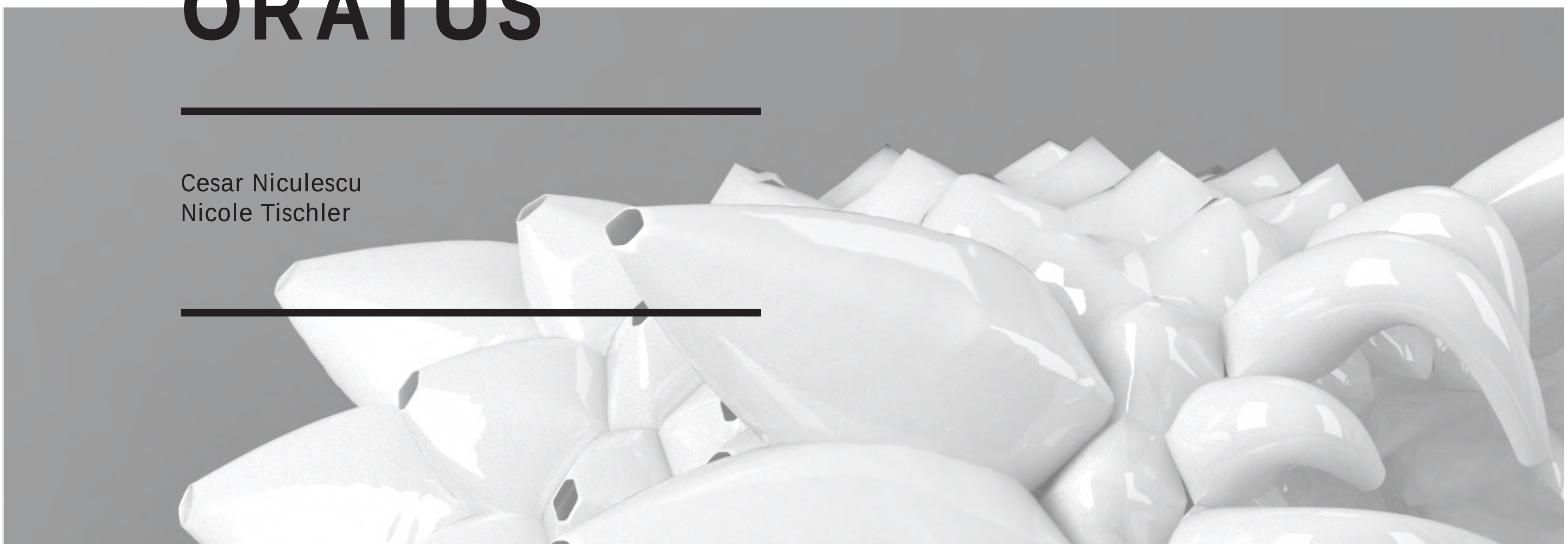
NEXT STEPS

REFINEMENTS

The next step for the project requires the refinement of both analog and digital processes. Our team has contacted an external source who has developed a grasshopper definition to simulate a melted wax textures. We are hoping to incorporate parts of the sourced software definitions to refine the digital model. This should give us more control over the simulated form by simulating effects generated in the analog material studies. We will deploy these tools while accommodating the mason bee's needs. Once the form is established, a mold would be meticulously constructed and fragmented into parts for porcelain slip-casting. We also want to determine a more ephemeral way of fixing the sculpture to the ground.

MONSTER ORATUS

Cesar Niculescu
Nicole Tischler



POLLINATOR

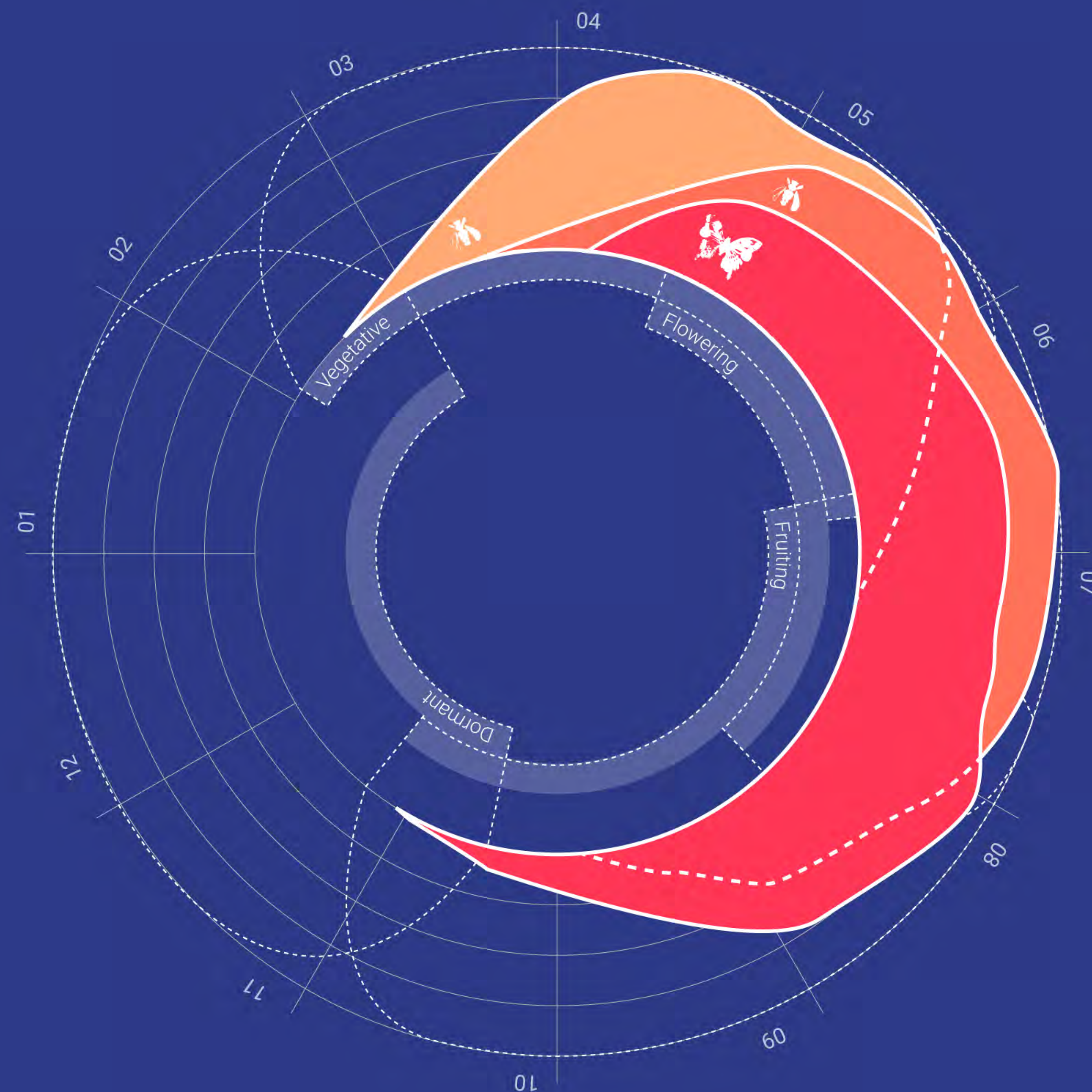
BUTTERFLY + BEE

Butterflies need relatively sunny habitats (requiring 5-6 hours of sunlight per day). This habitat must also be out of the wind. Proximity to plants favored by both butterfly and caterpillar are essential for a successful habitat. A successful habitat should also contain a textured surface for the proleg crochets of the creature to attach.

Mining bees and sweat bees are solitary bee species which prefer to burrow into loosely packed soils to create nests. The females will make a nest of pollen in an opening with a diameter of 2mm-10mm and up to 150mm deep. The opening should be shaded from wind and rain.

YEARLY POLLINATOR ACTIVITY

VANCOUVER BC, CANADA



SITE

VANCOUVER

Southeast corner of 5th Ave. and Pine St.

For two years the pollinator park will thrive as a site of increased interaction between the biological pollinator network and the flowering plants located in the neighborhood.


W 5th Ave
W 6th Ave
Pine St.
Fir St.

(nymphalidae)
Limenitis
Lorquin's Admiral

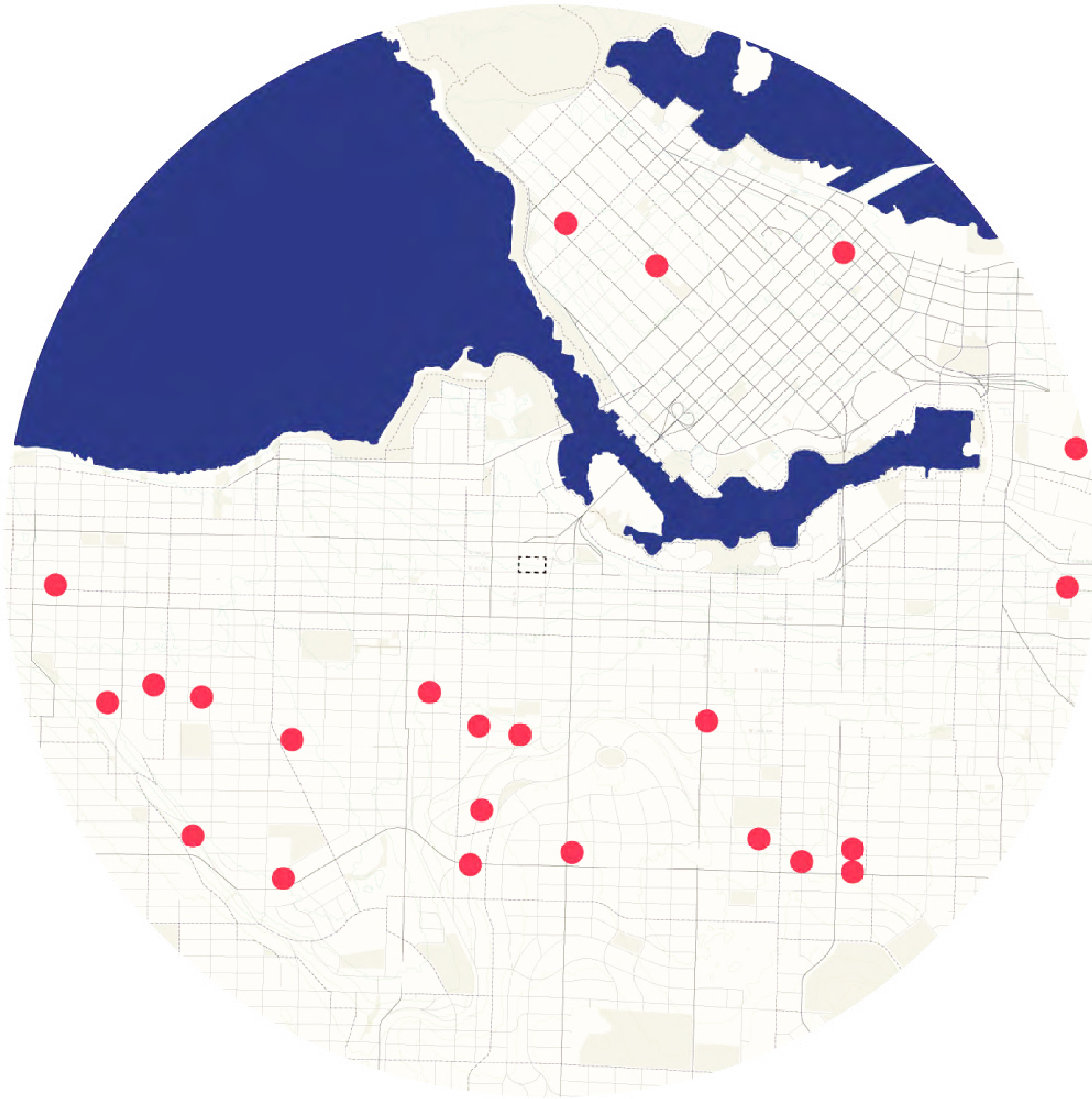
(nymphalidae)
Vanessa
Painted Lady

(papilionidae)
Papilio Zelicaon
Anise Swallowtail

(apiaceae)
Daucus Carota
Queen Anne's Lace

(violaceae)
Viola
Violet

(apocynaceae)
Asclepias
Milkweed



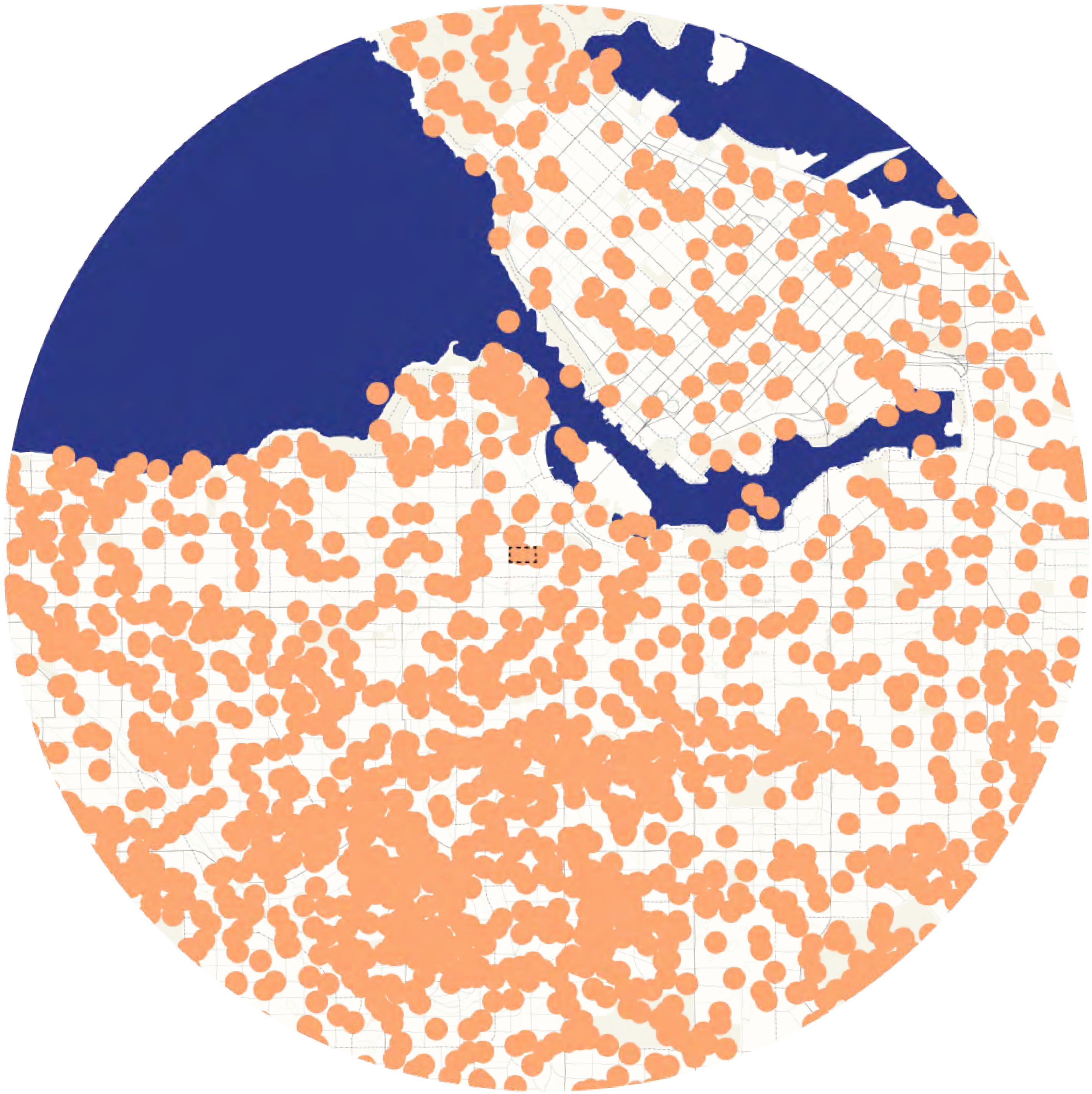
(andrenidae)
Andrena
Mining Bee

(halictidae)
Apoidea
Sweat Bee

(ericaceae)
Calluna Vulgaris
Heather

(asteraceae)
Calendula
Marigold

(asteraceae)
Aster



DESIGN

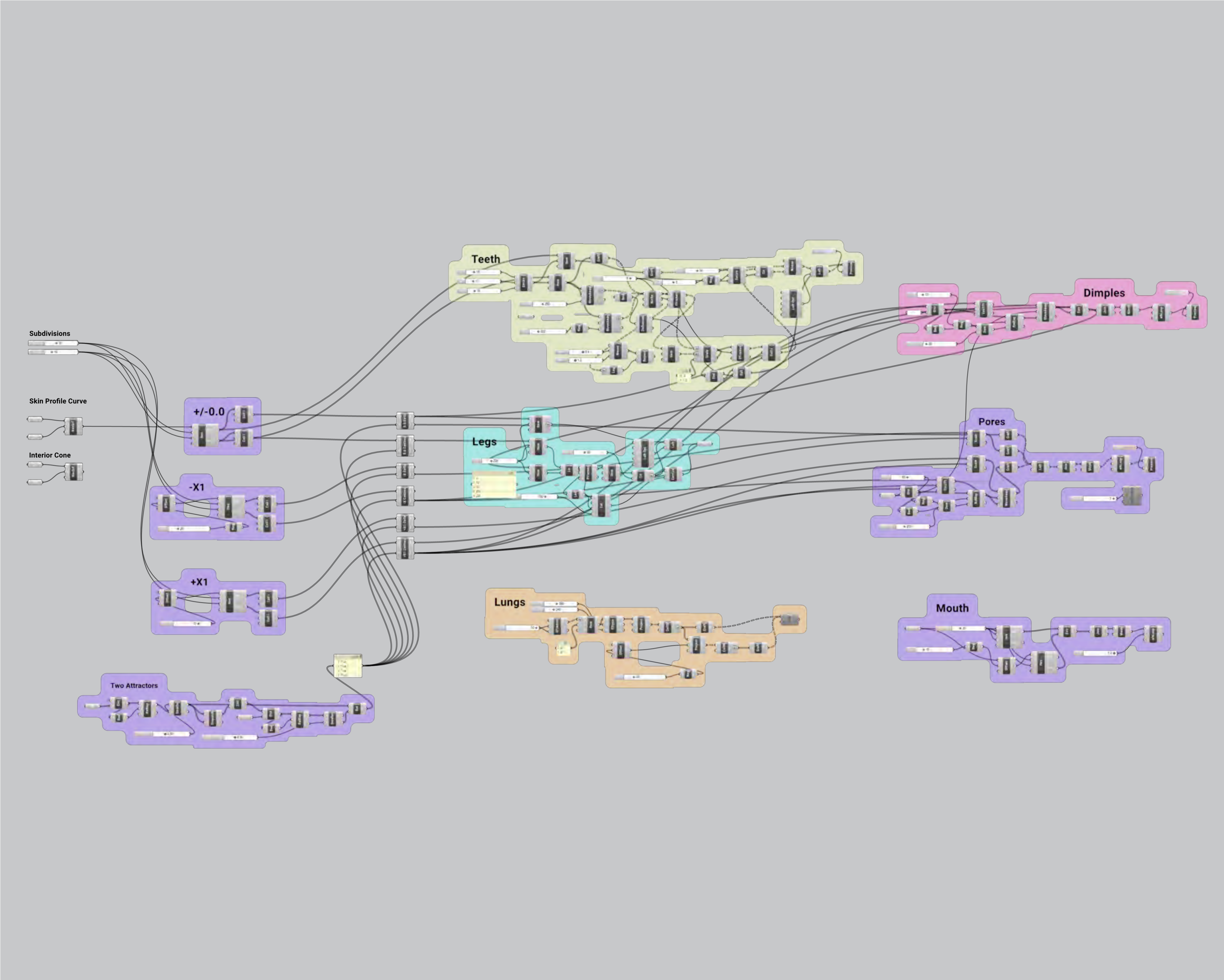
PROCESS

The geometry of the monster orator is defined by a global cylindrical shape that is then subdivided into functional component parts. The definition begins with a revolved curve that generates the base geometry of a twin walled speaker which is subdivided into hexagonal segments. These subdivisions form the base or individual body parts of the "monster" and serve different functions for the orator. The modules serve as both house and speaker for bees and butterflies.

The "teeth" and the "mouth" establish the environment for the butterflies - providing enclosure to create openings for butterflies to enter the structure, while keeping birds outside. Dimples form the tactile surface necessary for butterflies to nest. The tooth-like elements are arranged around the rim of the form using a cylindrical array. Butterflies enter through the resulting vertical slots.

"Pores" provide the bee habitat. Individual nesting holes are available for several bees. The shape of each opening is calibrated to reduce water penetration into nesting environments and to create a wind barrier for the majority of the holes. This specificity was generated using a point attractor (in Rhinoceros) to deform hole openings as they moved further from the centre of the mass of the assembly.

"Lungs" serve as the acoustic amplifier for the bees. They define the geometry of the nylon mesh used to funnel sound from individual pores to a microphone in the interior of the body mass. Lastly, the "legs" hold the monster up above the ground. Five cells are selected from the global geometry and deformed. Each contains a fitting for threaded rods.



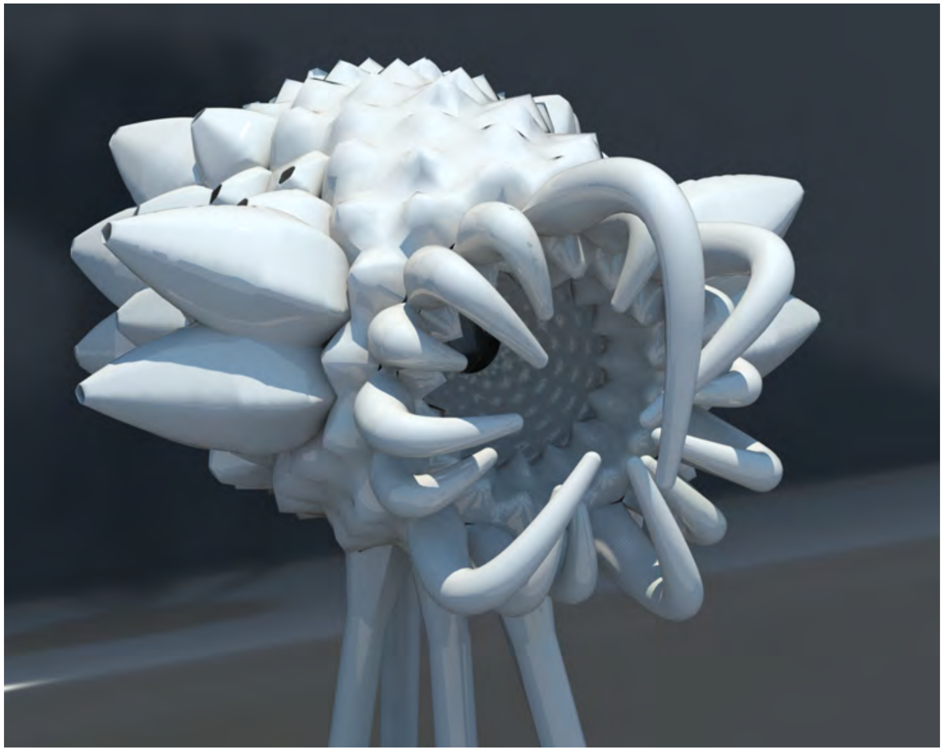
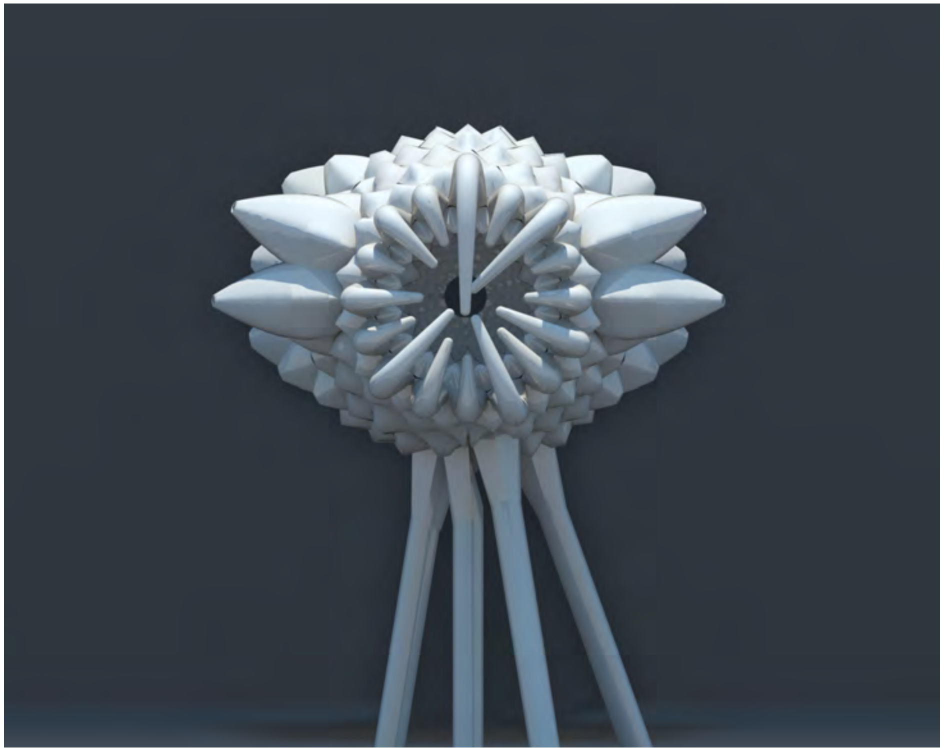
Subdivisions
Skin Profile Curve
Interior Cone
+/-0.0
-X1
+X1
Two Attractors
Teeth
Legs
Lungs
Dimples
Pores
Mouth

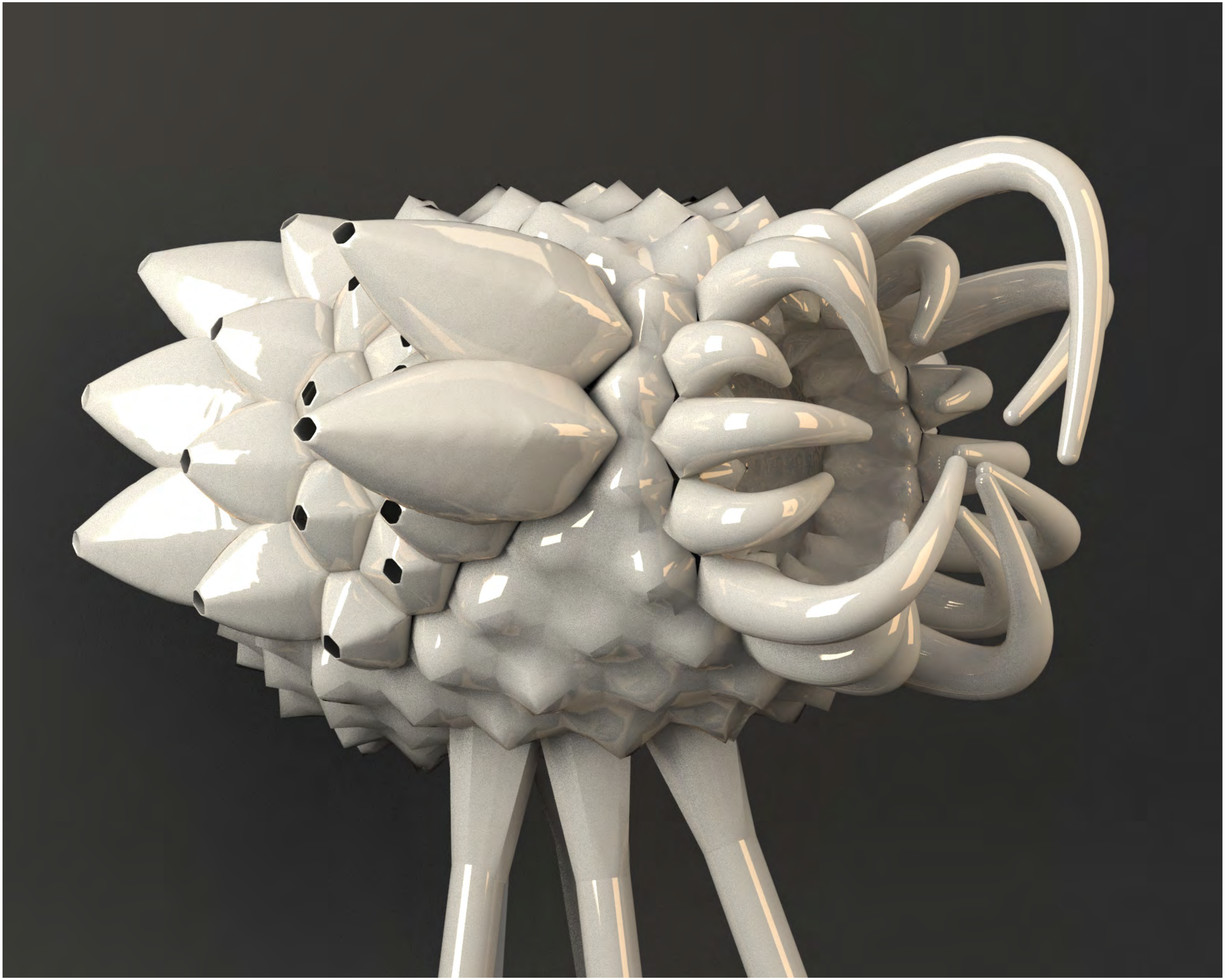
DESIGN

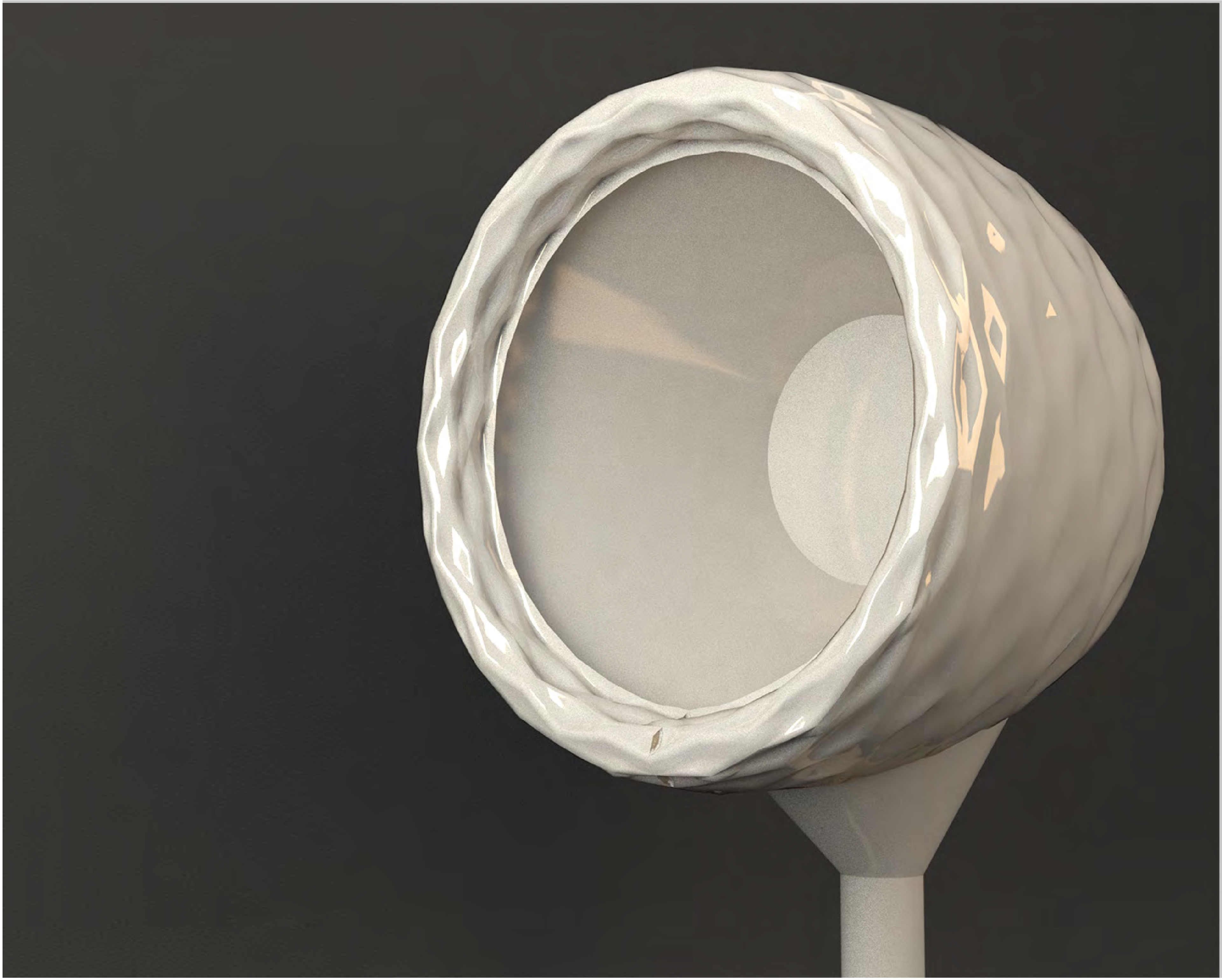
PROTOTYPE

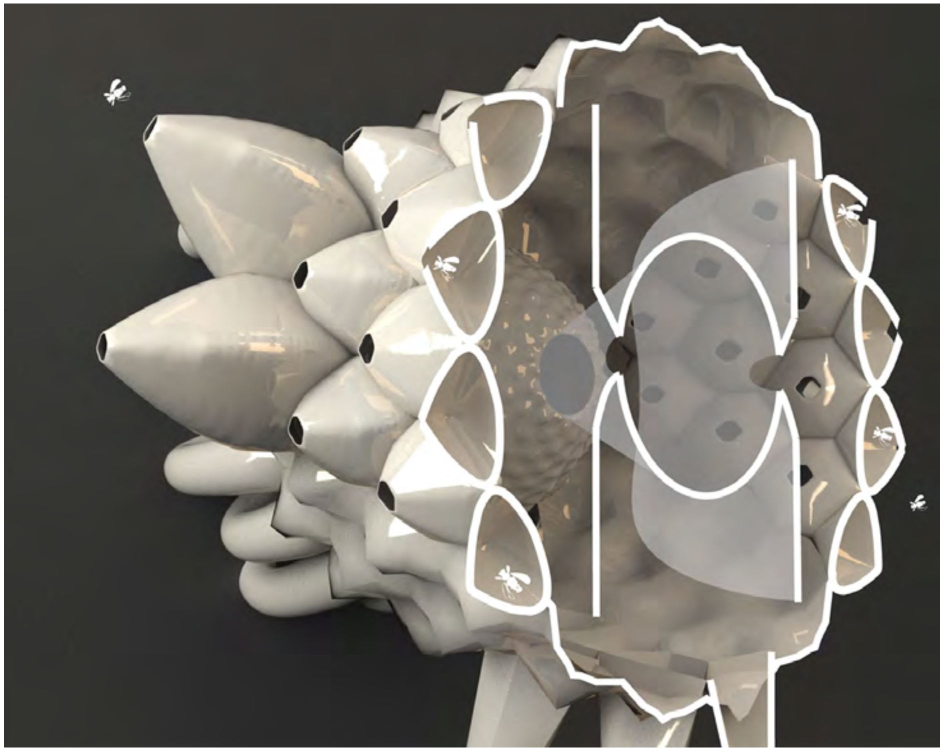
A parametric script was written to code and manipulate the various body parts of the monster to the specifications for each pollinator. This was accomplished using Rhino and Grasshopper.

An organic material will be chosen for fabrication so that after the bees have laid their eggs and the monster will decay overwinter. It can be replaced in the spring with a new Oratus, once the larvae have hatched. Further analysis on how the pollinators use the structure will allow the team to recalibrate future Monster Oratus. This feedback loop is a way to allow bees and butterflies to have a voice in the engineering of their own habitat.

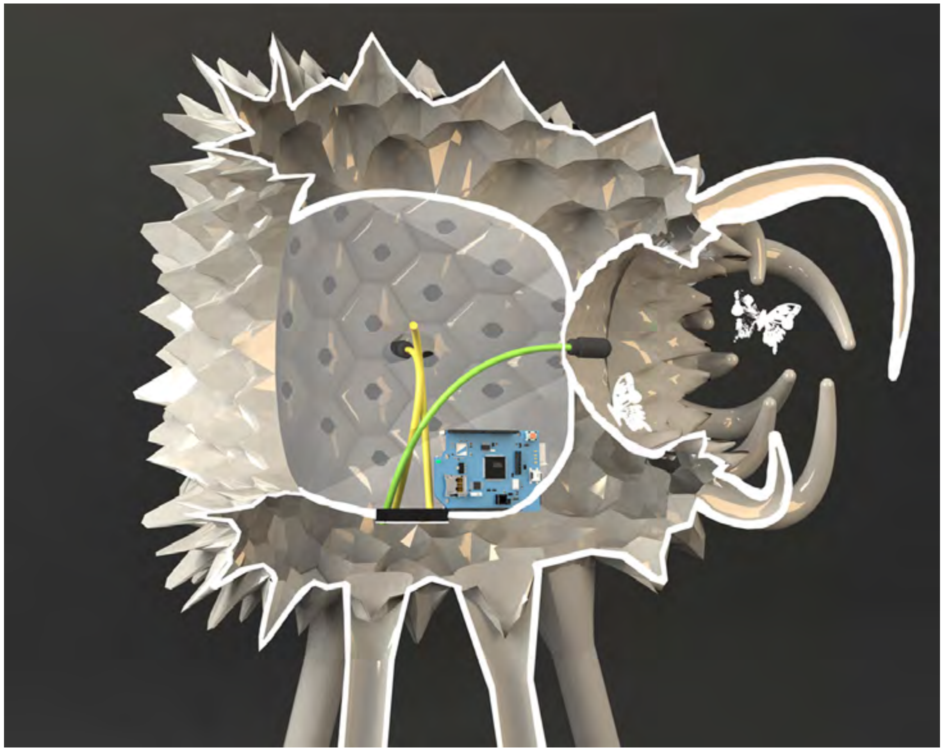









Section through bee habitat and inner walls.



Section through Monster Oratus showing arduino and micro-phone section of butterflies.

View of the park with the Monster Oratus installed to create sound making humans aware of the pollinator habitat around them.

NEXT STEPS

PRINT

We are currently sourcing printers capable of making the Monster Oratus. We have been in contact with the engineering department as well as the SLAQ team at SALA. First a material which can degrade quickly but extrude easily will need to be found. Further material studies will be conducted to streamline the process.