philharmonic
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# Abstract

All too often, the musical performance venue is designed in such a way that its aim is to create a perfectly passive backdrop, in which composers and musicians can perform. My aim, however, is to design performance spaces that take an active role in musical composition and performance and to provide a place for all of this to happen simultaneously.

# Thesis Paper

Listening to recorded music is primarily an aural experience, but attending a live musical performance is an experience that excites all of the senses. I am intrigued by the role a venue plays in this entire experience. Traditionally performance venues are designed in such so that they provide perfect acoustics for performance. But what if the spaces took an active role in both the composition and performance of music.

From the beginning of any musical career, public performance is something the musician is always exposed to.  On a daily basis musicians will inevitably play their instruments in a place where people can hear. These spaces vary tremendously, from a small practice room at the end of the hallway to the large stage at Frank Ghery's Walt Disney Concert Hall. The design differences in each of these spaces have caused changes in each spaces  acoustic character.

These differences in character unquestionably alter the way sound is perceived in a space. A room that is walled with carpeting sounds quite different than a room clad in finished plywood.  A concert listened to while on the lawn at pine knob sounds different than a show experienced at a local bar. A small room sounds much more vibrant and loud due to its lack of interior volume, and the same occurs when a space is clad with a hard dense material. When a room is large however, the sound must travel farther and the room sounds flat and level. These effects are amplified due to the large number of cloth seats and humans present at bigger venues.

These basic differences in venue and performance type dramatically affect the character of the sound being produced. Three distinct types of performances are noticed: performance for ones self, performance for a small group of friends, and performance for the public. Do these factors alter the way the musicians actually conduct their performance? The answer to this question, in short, is yes. While playing in a small room, individual care must be taken to not let one part of the performance overpower the rest. To keep this from happening the musicians dial back their volume accordingly to preserve the clarity of the performance. The room's small size makes even the slightest change in the volume of seem very noticeable. In large rooms however, this is hardly ever the problem. Instead, performers must worry that they are not projecting enough and are leaving the audience listening for missing parts. Musicians consciously and continuously alter their performances in order to suit their ever-changing stage. While playing for ones self, the performance tends to be reflective, analytical, and experimental. This is because of the inherent safety of performing while no one is listening. A performance for a group of friends is similar in terms of general safety from judgement, but an added layer of thoughtful, conversational critique is added. Public performance however, is by far the most dangerous type of performance for the musician, a public performance cannot be taken back, and is free to be judged (quite harshly at times) by all. The public eventually judges all forms of art and for this reason large public performances seem to have become popular over time. But why is this the case?

The audience at a performance is integral and also affected by venue. Without an audience, any musical performance is simply a rehearsal, an exercise. The give and take between the feelings projected through the music and the emotions felt by the audience is of utmost importance. Without this relationship the full power of a performance is never realized. While it may seem as though the play between the audience and the performer is solely dependent on the temperament of the audience at the time and the extent to which they enjoy the contents of the music, this is not really true…at least with classical performances While performing, the musicians tend to suppress their perceived presence of the audience so that they do not become distracted. Only when someone coughs or sneezes do they notice. In jazz performances however, the venue is often a smaller restaurant or club where the audience is in clear view of the performers. Here the musicians can see the expressions on the faces of the audience, and can hear them clapping when a solo is finished. This sharing of emotion and energy is often used to bolster the confidence of a soloist and encourage a longer, more original solo. The space in which the performance is held is actually much more responsible for the success of this relationship than initially indicated. A small cramped venue places audience members at a proximity that implies physical contact and in turn makes them feel exciting and alive.  A performance in a concert hall orients people in a regular fashion along a series of parallel planes. This arrangement of performance space causes the audience to pay a certain amount of respect to the performers and their fellow audience members. This isn't an observation of an unfavorable circumstance but rather a comparison of the different moods that these circumstances impart on their audience and its performers.

Music type also plays a role in the character of every musical performance. A death metal concert will cause the performers and audience to act rowdy and aggressive regardless of where the concert is held, and a beach boys concert will have everybody swaying in unison and singing together, whether the performance is in a concert hall or a small music club.

An experiment was conducted to examine how all the aspects of live performance come together to create unique experiences. The experiment consisted of recording an actual live performance on the site. A wooded hillside that terminated in the Clinton river was chosen for the performance location, and two musicians were used for the performance. With such a small band and a site that could almost guarantee no audience interaction, a jazz call-and response improvisational performance seemed like an appropriate type of music to be recorded. In a typical call and response performance, two musicians speak to each other with their instruments. One performer plays a "call," the second performer then listens to the "call" and interprets it. A response is then played by the second musician that is a replica of the initial call or  a variation on its theme. The initial musician receives the response and the process is repeated again and again.

Due to the remote location of the performance, documenting the music produced would be a challenge. To solve this problem a diesel generator was used to power a digital recorder and an interface for a studio microphone.  The generator was placed far from the microphone so that its droning wouldn't interfere with the sensitive microphone. RECORD. The performance began on the hillside while standing near the microphone, one man above it on the hill and one below it on the hill. While playing gravity was slowly pulling one musician down the hill and away from the partner and the microphone. Eventually the space between the two was so large that one could not see the other could still hear him, albeit with nearly half a seconds delay. At this point it was obvious that the initial call had really changed as the musicians became farther and farther apart. Instead of playing normally one would have to subconsciously adjust the calls and responses to be better interpreted over long distances. They did this by playing higher in the saxophones range because a high-pitched sound will carry farther than a low-pitched sound of the same volume. The character of the calls had changed from flowing together nicely to choppy bursts of tones reminiscent of Morse code. A musical venue was created that decidedly changed the way two musicians composed and performed on the fly. After the performance one could notice all of the different things that were different about this venue when compared to a traditional venue. Listening to the recordings once could also relate the changes in technique to specific changes in recording heard by the microphone.

Having recorded the experiment and having already found correlations between venue changes and technique changes, an analysis was begun. What set this call and response apart from a typical one? The fact that we were playing outdoors in a wooded area...the distance between the two performers...the high amount of ambient noise at the venue. Listening to the recording again, one could deduce that changing the distance between performers was the variable that could be manipulated the easiest and that would cause the most significant change to the music. At progressively higher distances, the speed of sound becomes a factor in the interpretation of the music for the performers. This delay in sound causes unintentional overlaps in the call and response, and forces a change the musicians thought processes about his current improvisational style.

Through the manipulation of this one specific property of sound, one could create situations that prompt a change in the composition and performance of a specific type of music. Due to the success of this idea, researching more aspects of sound seemed of utmost importance as these special instances would drive the thesis.

The research began with a further analysis of the speed of sound. The speed of sound through air at sea level is approximately 1,126 feet per second or 768 miles per hour, however it can be changed by altering by certain environmental factors. For instance, as ambient air temperatures rise, so does the rate at which sound waves travel. There is also a linear relationship between air density levels and the speed of sound. Sound can also travel through solids and liquids. Sound speed through solids and liquids is also related to density. Solids and liquids with high densities facilitate a high speed of sound. When moving through steel sound travels at 20,000 feet per second, and at 1904 feet per second when projected through glycerine. Low-density solids and liquids allow sound to travel at a slower velocity. The speed of sound through rubber is 130 feet per second, and is 985 feet per second through ether. By using different materials to transmit the sound signal, one could also control the speed of sound and hearing delay.

Reverberation times might be altered to produce performance-changing effectsas well. Reverberation time is the amount of time it takes for a sound to drop 60 decibels lower than its initial volume. In spaces that are acoustically reflective sound bounces around easier, and therefore longer. This is because the sound waves expend less energy when they bounce with less friction. Spaces with high reverberation times sound “live.” When sound waves encounter absorptive materials they expend more energy when they bounce because of the added friction. These type of spaces are said to sound “dead” and no echoes can be heard. This information would allow one to design spaces with reverberation times that varied from point to point within a space.

Specular diffusion is the process by which a sound is spread over a wide area. Typically, when a sound is produced it radiates outward from its source giving it a directional quality. Specular diffusion is achieved when sound is reflected off of a large amount of small panels all angled in different directions. These varying angles reflect sound in all possible directions relatively equally, and create a sound that is no longer directional but ambient. Through the careful placement of diffusers and reflectors sound could be focused to a point or spread over a wide area, allowing the opportunity to hold a performance that would sound different from all points of the room.

Every one has experienced a moment where they could see or hear something vibrating on a table or in a cupboard because of loud music. What you are seeing and hearing is the object vibrating at its Acoustic resonance frequency. All matter has an acoustic resonance frequency. This is the sound frequency at which a specific object begins to vibrate. This vibration can be felt and even seen by the human body. What’s most interesting though, is that because that sound energy is transforming into mechanical “work” it can no longer be heard but only felt. This property presents some interesting opportunities for the thesis; imagine different parts of a space vibrating in accordance with the changing tonality of the music. If the performer became familiar with the different vibrating areas of the space they could purposely cause them to resonate on command simply by playing the appropriate note on their instrument. This effect could be used to allow musicians to communicate indirectly with each other, and allow the audience and entire building to become part of the performance.

A series of pavilions could be designed that had their forms generated from these specific properties of sound, to see how they would influence the music. The first Pavilion: call and response pavilion that was based on the research into the speed of sound and delay. The design consisted of two pavilions facing each other on opposite ends of a 350 foot long path. One end was to be the call and the other was the response. The call was situated on the higher end of the line and the response was situated at the lower end, by the river. Sounds produced took 1/3 of a second to travel between the two buildings and would cause the overlapping of call and response as mentioned earlier.

The second design was driven by the research into sound reflection and absorption. It was a trio performance space the building is triangular in plan and a musician is seated in each corner. Due to the arrangement of the space, none of the musicians can see one another, and can only hear one other part of the trio clearly, in the case of bass performer the alto is also heard, the tenor also hears the alto, and the alto can only clearly hear the bass. This is achieved through the manipulation of the sound reflections inside the space, and the materials used to build the walls. Where sound is meant to be reflected the walls are built with hard reflective surfaces, and do not allow sound to be absorbed. Where reflections are not wanted the wall is filled with insulation, and has perforations to allow sound to become trapped inside. This assures that sound is directed clearly around its path.

The third sketch problem was focused on the research with organs. A wind-powered organ-like structure was placed adjacent to small building and its music was prominent on the inside. The organ is not played with keys in the traditional sense, but instead relies on wind speed to change the pitch of the music. At the sites average wind speed, ten miles per hour, the organ emits a specific series of tones. At progressively higher wind speeds, the pitch changes as pipes gradually began to resonate at higher overtones. This modulation in tonality would cause musicians to either perform in the current ambient key, or allow for the constant dissonance in their music or composition.

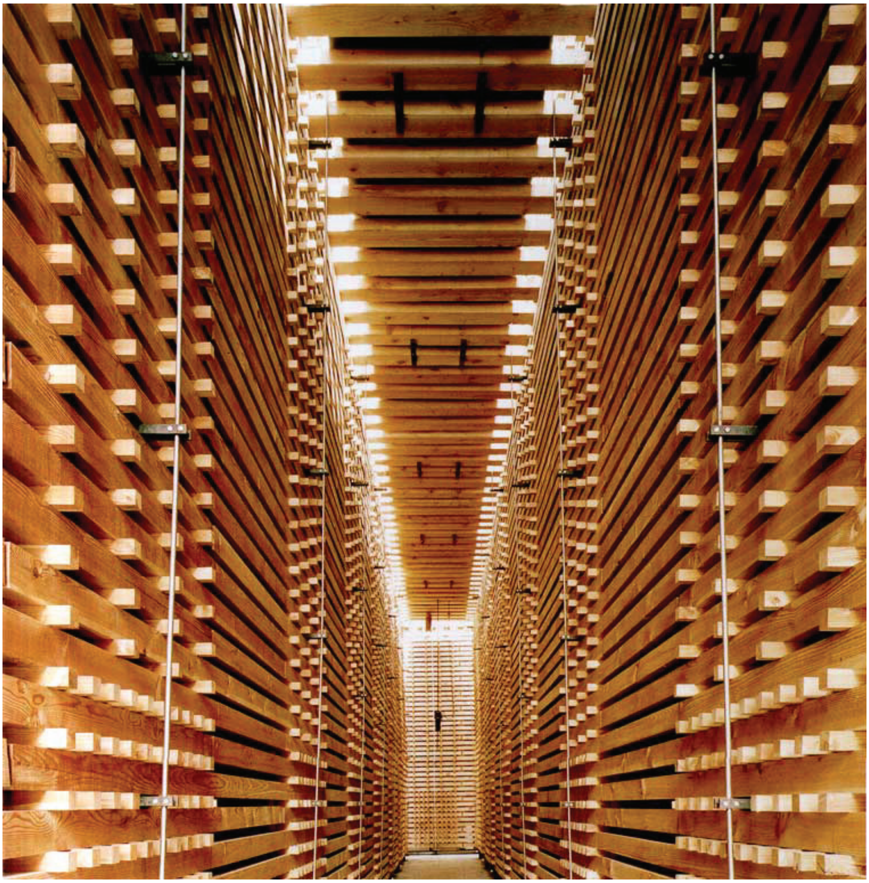
The last sketch problem dealt with the research on specular diffusion. The design consisted of a series of towers placed among the forest that would raise musicians up to the canopy to perform. With all of the leaves and branches reflecting sound, the direction from which it is coming is unclear. Also, depending on the density of the trees surrounding the performers certain frequencies of the sound would become muddied from mechanical resonance within the tree. High in the canopy, higher pitched sounds would be muffled. Lower where the limbs of the tree were more voluminous lower pitched sounds would be muffled.

*"The River Bends Center for Experimental Music" will serve as a haven for musicians and composers who are seeking to push the envelope of musical ideas. Here they can experience music like never before, and free themselves from the typical constraints and stresses placed on them by the public, and by the comissioners of large musical works. No longer will they feel like they are being judged by a misunderstanding public, no longer will they feel alone in times of writers block. Support from like-minded individuals will lead to collaboration and composition like never before. Experimental musical styles and performances are the norm at the Riverbends, and questioning traditions is what its all about.*

# Precedent Studies

## Swiss Sound Box

Peter Zumthor's Swiss sound box was a very useful case study. His design was for the swiss pavilion at the EXPO 2000. His design called for the building to be built entirely of stacked timber, specifically, European Larch and Fir. Over 40,000 timbers were stacked and held in place with a top-mounted clamping system. The larch timbers were stacked in an east-west orientation and the fir stacked north-south. This positioning caused the southern façade to darken to an almost black color, and left the northern façade to weather into a silvery-grey tone. (Zumthor, 150). The exploitation of the timbers natural properties had caused it to become perfectly seasoned while it served as a structure. During its time at the expo it served as a stage for musical performance of all types. Over 300 musicians were brought in from around the world to perform there. (Zumthor, 45). This combination of a new sensory environment, and a broad range of musical typologies yielded some interesting results. The construction of the building allowed sound to seep through the walls of the structure in many different ways, which caused the individual performances to meld together from the audience's perspective. However, this effect was not always noticed by the musicians. Musicians playing in the actual performance spaces did not hear the intrusive music of the performers wandering through the corridors. But, the corridor musicians had to adapt their music to compliment aspects of the larger performance that they could pick up on.



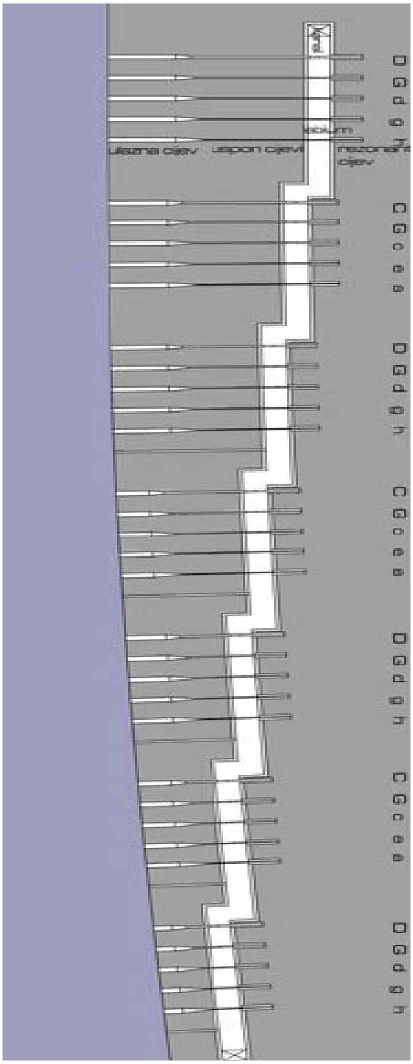
# Precedent Studies

## Singing, Ringing, Tree

The singing, ringing tree, is a musical structure that is placed atop a windy hill in the U.K. It is built of steel pipes that catch the wind and produce “Music” that is modulated through wind speed. (Birch, 1). The faster the wind blows, the higher pitched the ringing is. The sound is produced when wind blows across the various capped and uncapped pipes on the sculpture. As the air strikes the edge of the pipe it begins to vibrate. This vibrating pressure wave’s pitch is determined by the physical dimensions of the pipe.(Marsh, 6). This precedent provided some insight as to how careful site analysis really does drive the design of architecture. Without the proper site conditions this architectural sculpture would not produce sound at all. It was immediately apparent that a careful site selection and analysis would be crucial to design.

# Precedent Studies

## Sea Organ, Croatia



The Sea Organ, located in Zadar, Croatia is an experimental musical instrument that plays music using sea waves and tubes located underneath a set of large marble steps. As the waves pound into the seawall a cylinder of water travels inland via a special tube that runs under ground. This cylinder of water in turn pushes a volume of air through an organ pipe also buried below. Finally the sound produced in the pipes is allowed to exit the ground through vents in the steps leading to the sea wall. (Oddstrument, 1). The waves create random rythms, but the pitches were carefully chosen by architect Nikola Bašić. He broke the sea organ into seven ranks of five pipes each. Each rank is tuned to a specific chord. The ranks are tuned to for octaves of D and three octaves of C.

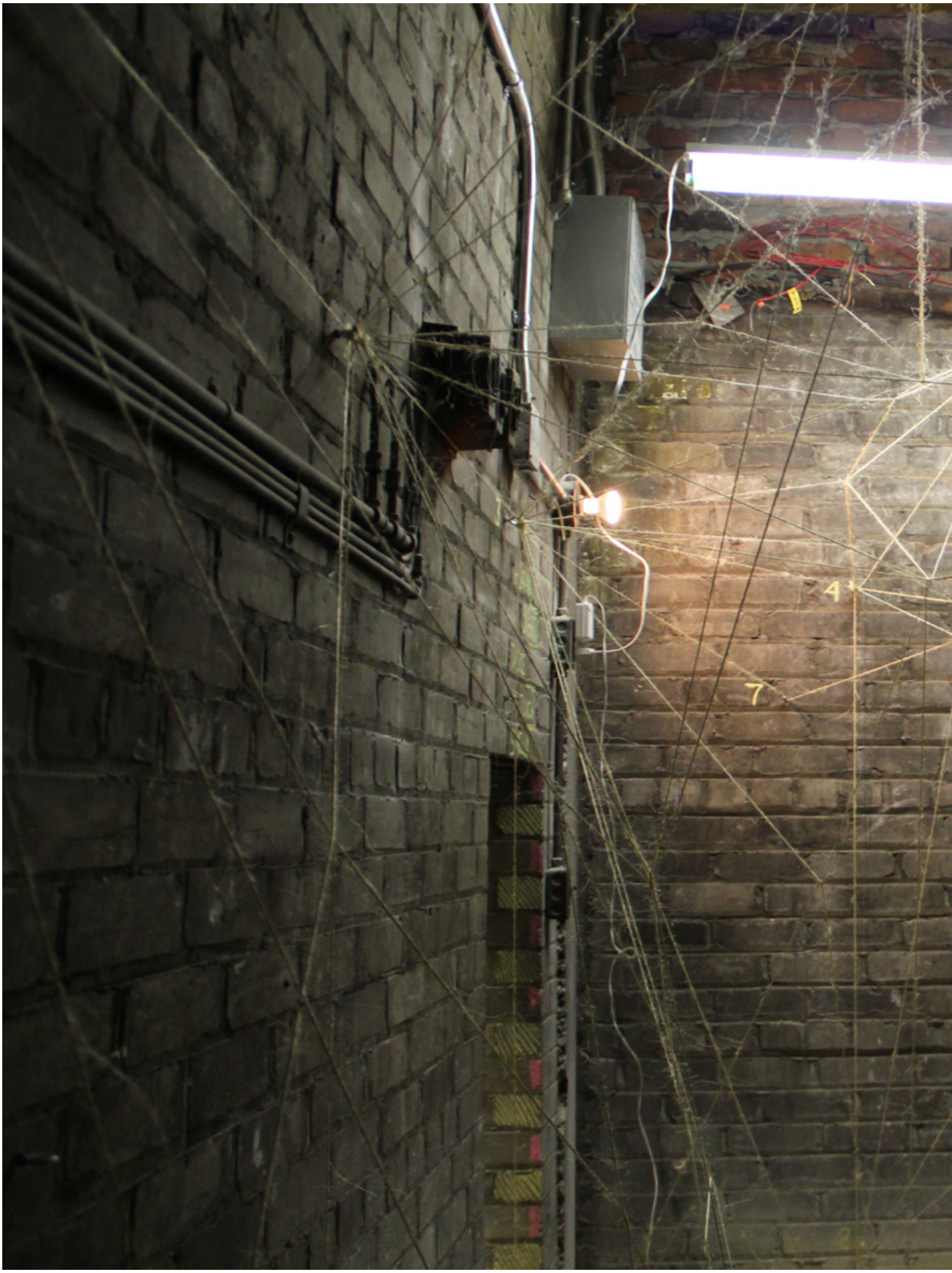
Photo showing white marbles steps of the Sea Orgsn disappearing into the sea.

Detail view of the vents cut into the risers of the steps to allow the organ pipes to breathe.

# Installations

## Sensory Room

The goal for this space was to create a place where someone could perform or compose music while dealing with sounds that were not necessarily consistent with music type. The room was approximately 10’ wide by 16’ deep and had a relatively low ceiling, except for a portion near the front of the room that angled sharply upward. The first part of the process was to alter the space in which a musician could inhabit. Using a pre existing grid of eyebolts, a web of sisal rope was connected to the ceiling, walls, and floor. This  web inhabited a percentage of the volume and redefined where users could actually move. Secondly a bench was built in the back corner of the room, that when used, placed musicians in proximity to a mechanical room that constantly produced a droning noise. Along with the noise produced, a vacuum was generated. The vacuum sucked air from door toward the opening in the back of the room. After an extended period in the room one noticed that the mechanical sounds were not constant. Around 6pm every day the mechanical room goes silent, and the room takes on a much different character. It has transformed into a quiet space that no longer competes for aural dominance. The wind that was present earlier is also gone and the door to the room is no longer vacuum-sealed, which makes access to the room easier. Its as if the room has a dormant state and an active state. Like the swiss sound box, my room allowed the interplay between the sounds produced by the musician, and the sounds produced by the environment causing the performer, to alter playing style to suit the ever present sounds of the room.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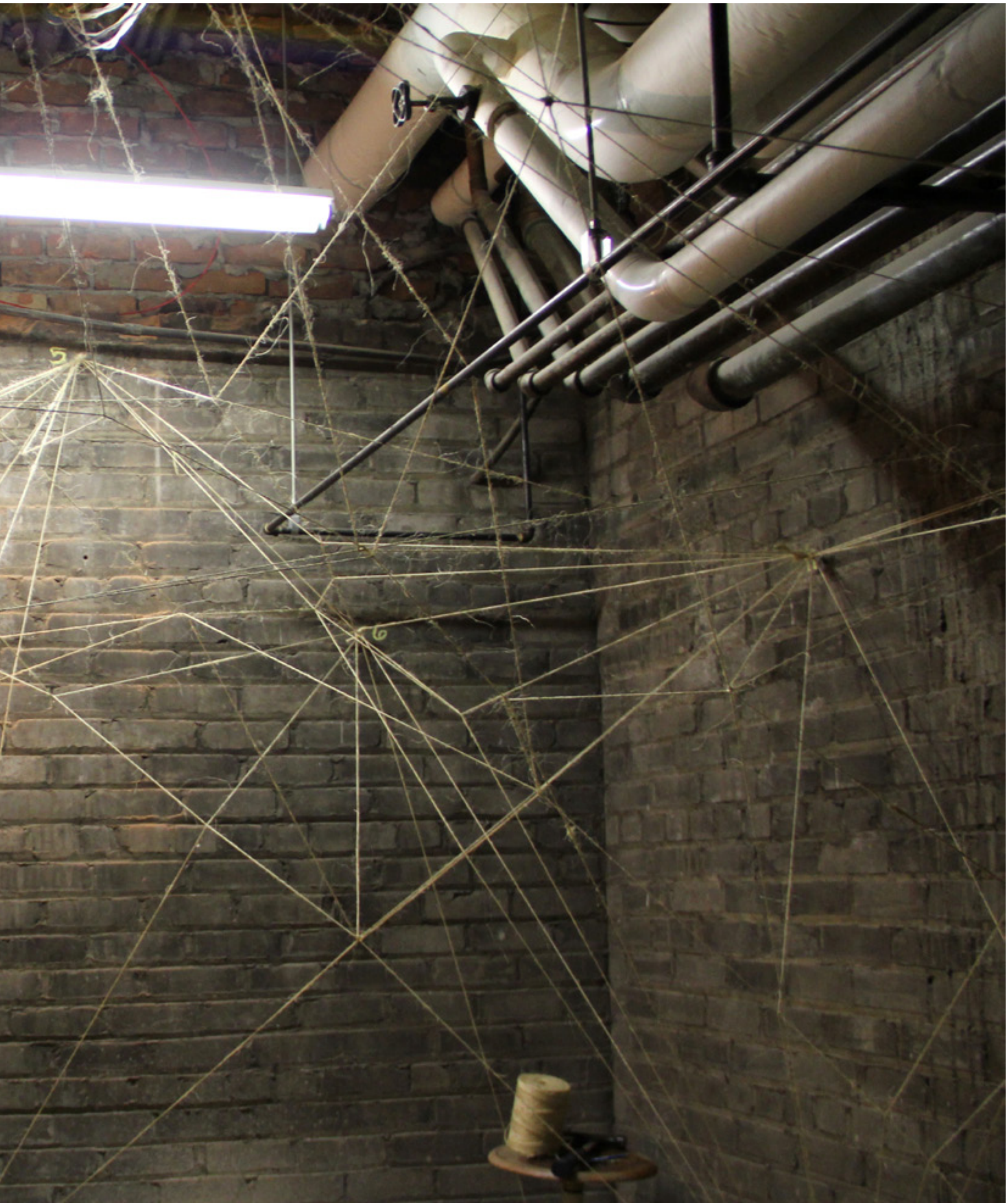
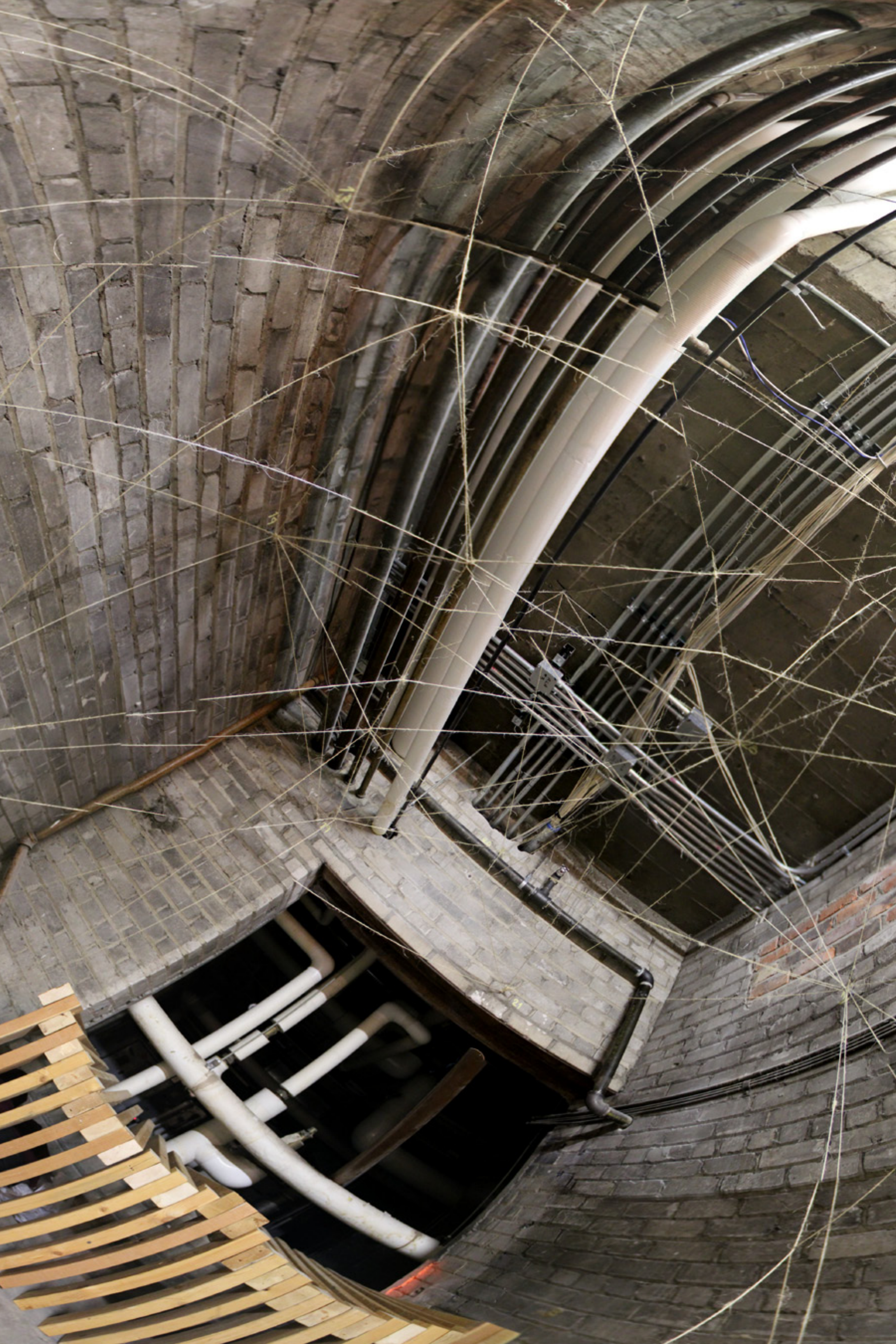


An irregularly shaped twine structure existing within the room restrains the upper portion of the body only, foot traffic is not impeded however




Fisheye view of the sensory room looking upward toward the ceiling.
Entrance shown on the right with the bench installation on the left

# Research

## Call And Response Performance

On Sunday, October 24th, a fellow student and I went to the site to test out my thesis on a very basic level. Would the way we composed our call and response performance be altered in any distinguishable way because of our surroundings? The experiment was also documented with the use of sound recording equipment, so that others could experience the performance, and so that I could see if any noticable things from the live performance made it into the recording.

The two different recordings feature:
Alto Saxophone
Didgeridoo
Snare Drum
French Horn
Violin

Being a jazz musician, I really enjoy call and response type improvisation, and I wanted to design a sketch problem around this type of performance and a particular scientific property of sound. In a call-and-response performance, one musician plays a few bars of improvisational music and then stops. A second musician then repeats what was played to them with their own personal twist. This process is continued, and the initial musical idea changes over time. I started this design process by visiting the site with a friend and recording our own call and response experience. In order to properly record the experience I used a diesel generator on site to power a computer and a digital interface for a microphone. The microphone was set up between both musicians and recorded the call and response performance. Some sheets of plywood were used as rudimentary structure in an attempt to create surfaces off of which sound could be more easily collected.

The speed of sound at sea level is 340m/s (Marsh, 1), which means that sounds produced by me take some amount of time to travel from musician to musician.

This experience showed me that I could effectively control how long it took for the musicians to hear each other's message. I learned that by separating the places where the two musicians were located this distance might prompt a response that comes before a call is even finished.

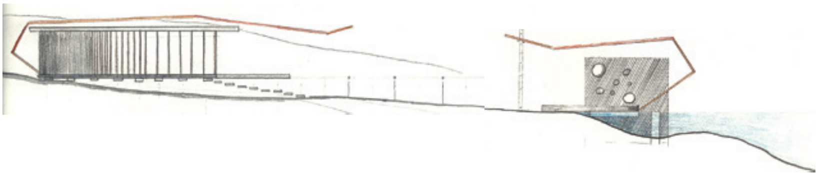
# Sketch Design

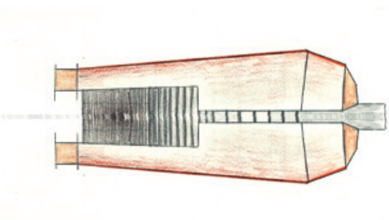
## Call and Response Pavilions

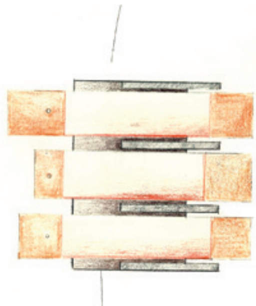
The first design problem was a set of pavilions that would be used for call-and-response musical performance. My research into the speed of sound, as it relates to both the behavior of certain musical instruments and the behavior of sound in space, was the driving force behind this design

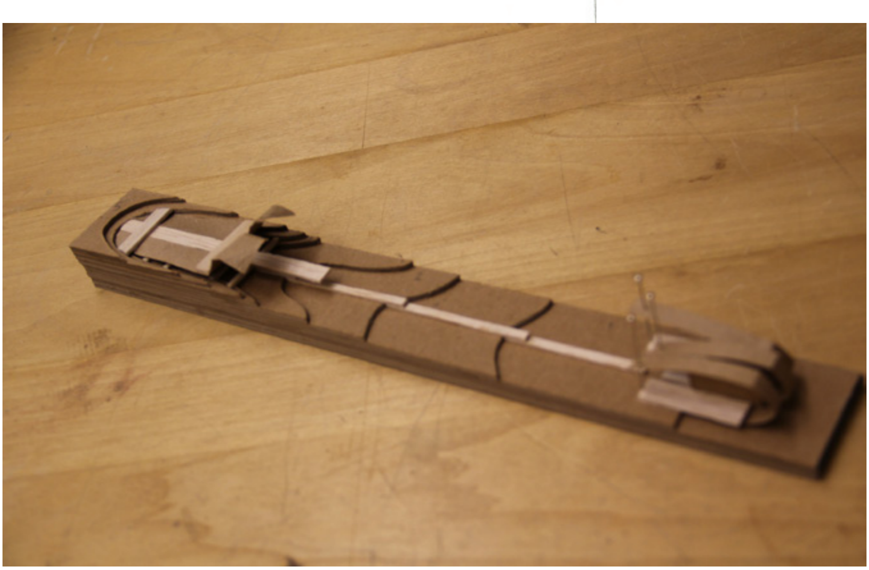
One pavilion was situated at the Upper end of the escarpment and the other was located 350' lower, near the river. This distance between the pavilions causes aproximately a half second delay from sound production in the call pavilion and sound reception in the response pavilion. The call pavilion is concave in section and plan so that sounds are focused as they leave the building and travel to the other building more clearly. (Marsh, 12).Also, by skinning the interior of the space in a dense hardwood, sounds do not becomed absorbed by the pavilion but rather reflected. (Marsh, 1).

The model shows the linear orientation of the pavilions on the site. The upper building is placed in a smaller valley on the hillside so that sound produced there is directed toward the lower pavilion. You can also notice that the lower pavilion is partially placed over the river. This is done so that the moving water produces sound as it flows past the supports that run into the riverbed so in this case the surrounding environment is also contributing to the soundscape. This detail model shows a typical dividing wall construction at the lower pavilion.







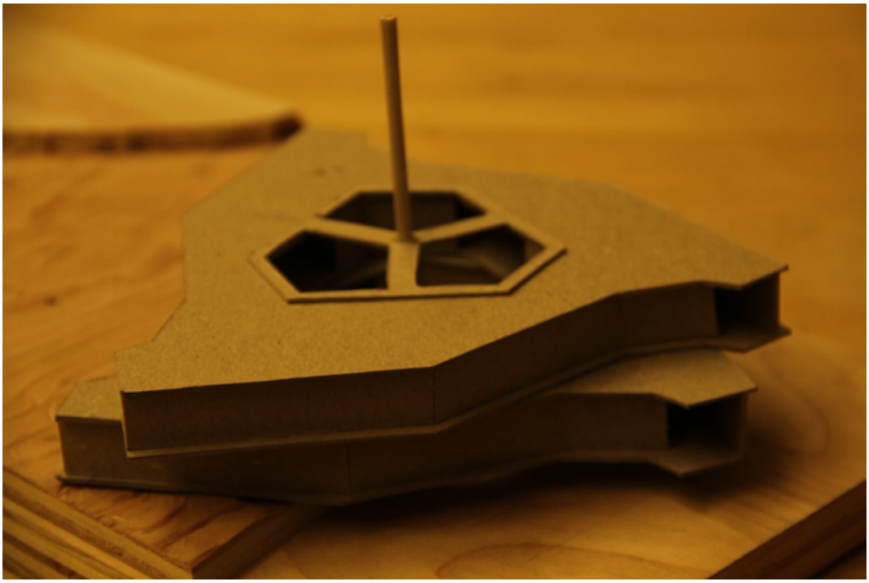


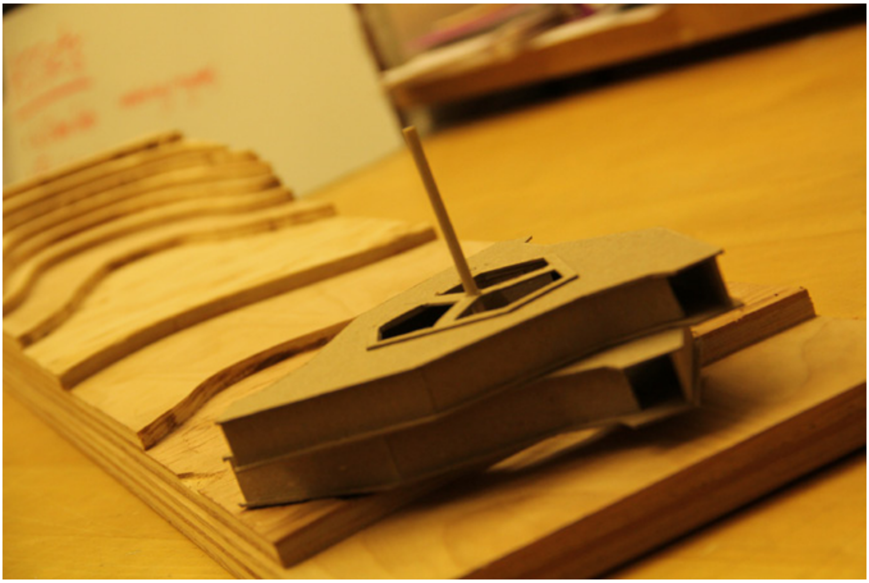
Fenestrations in the finish allow sound be filtered through the wall and heard differently on the other side. This design sketch was important because it showed that specific sound delays could be created by altering the distance between source and reciever. This new information would be extremely valuable when planning the remaining buildings on the campus, as sounds are able to freely travel around the site.

# Sketch Design

## Trio Performance

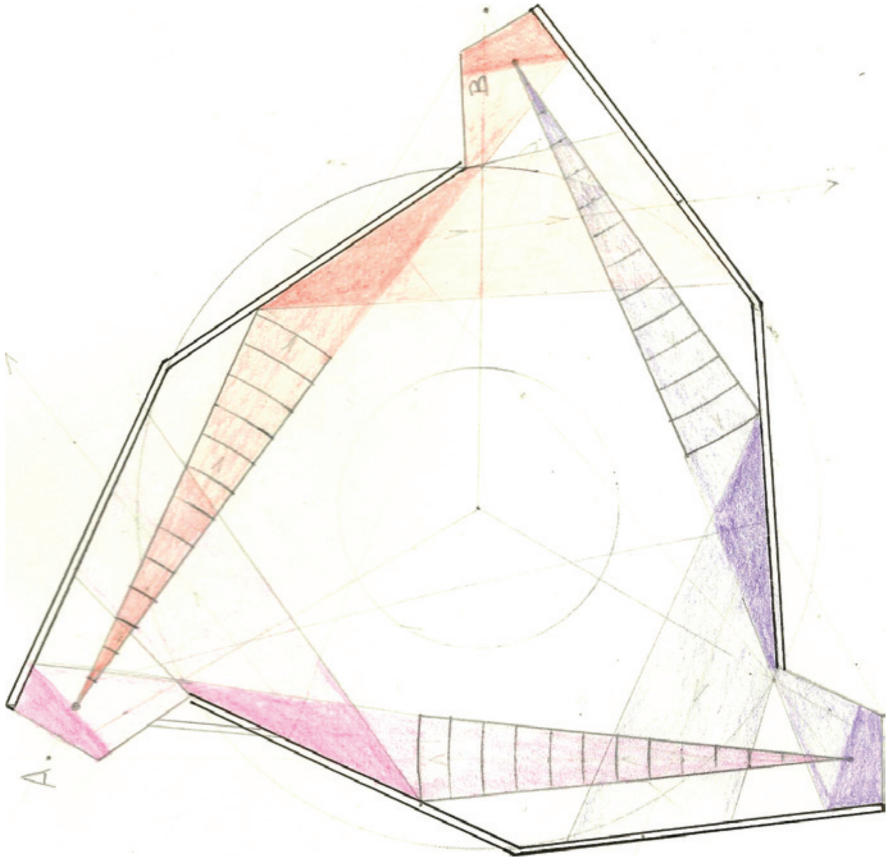
The second sketch problem was a designed for trio performance. The building is triangular in plan and a musician is seated in each corner. Due to the arrangement of the space, none of the musicians can see one another, and can only hear one other part of the trio clearly, in the case of bass performer, the tenor is heard, the tenor hears the alto, and the alto can only clearly hear the bass. This is achieved through the manipulation of the sound reflections inside the space, and the materials used to build the walls. Where sound is meant to be reflected the walls are built with hard reflective surfaces, and do not allow sound to be absorbed. Where reflections are not wanted the wall is filled with insulation, and has perforations to allow sound to become trapped inside.

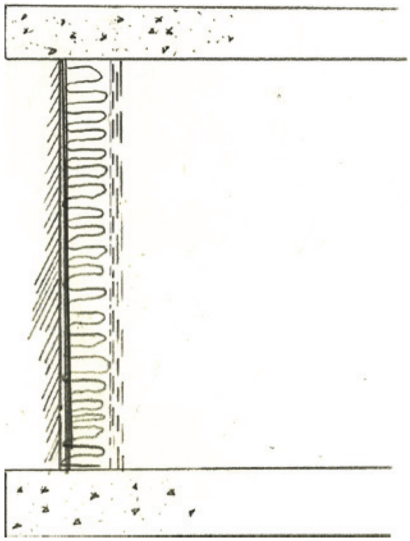




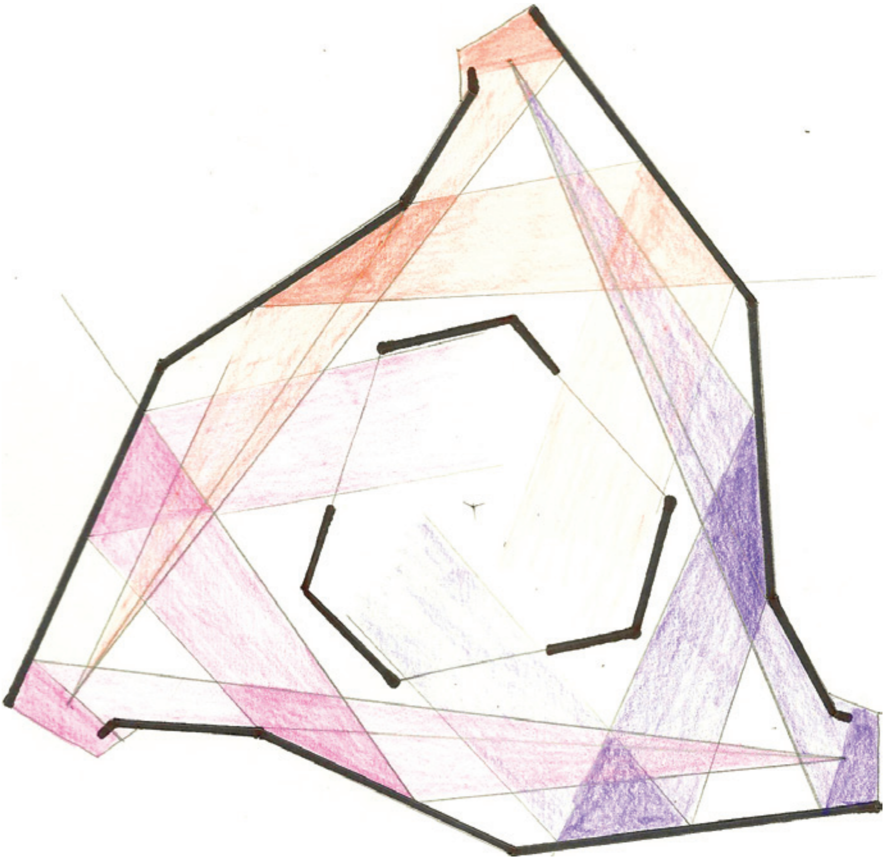
This assures that sound is directed clearly around its path. (Marsh, 12).

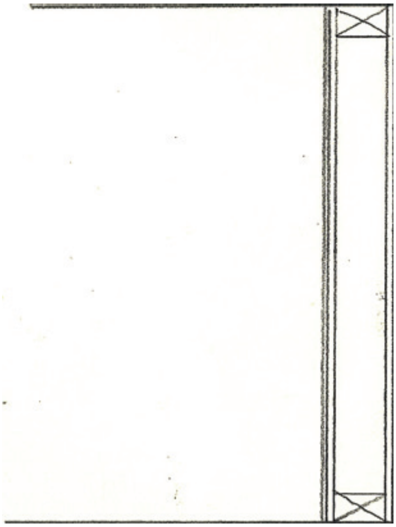
This model shows the placement of the building on a portion of the site. It is also located on the river, albeit for different reasons. This design decision was made to  allow the building to make one river-powered rotation per day. In doing so, different parts of the trio performance are projected onto the surrounding site throughout the day.



Above: conceptual interior sound reflection diagram
Left: section drawing showing typical sound insulating wall section





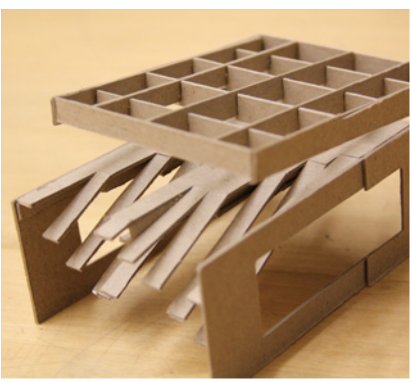
Above: floor plan showing sound absorbing walls in the center of the space, essential for proper program function
Left: section drawing showing typical sound reflecting wall section

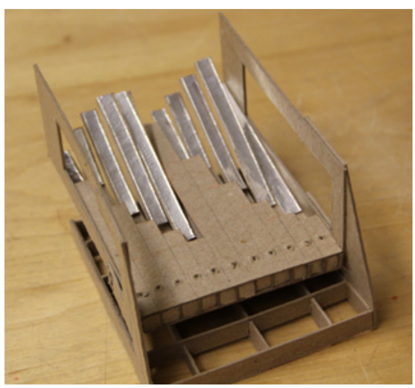
# Sketch Design

## Wind Organ

The third sketch problem was focused on organs, primarily those that are powered by nature. In this design a wind-powered organ was used as a roof foor a small building. This model shows the integration of the organ to the structure of the pavilion. By placing the organ on the roof we are able to capture higher wind speeds than can be captured at ground level. The overhang above the organ is the method for collecting wind and directing it into the ends of the organ pipes.

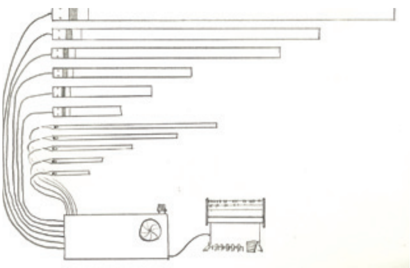
The organ is not played with keys in the traditional sense, but instead relies on wind speed to change the pitch of the music. At the sites' average wind speed of ten miles per hour, the organ emits a specific series of tones. At progressively higher wind speeds the pitch changes as pipes gradually begin to resonate at higher



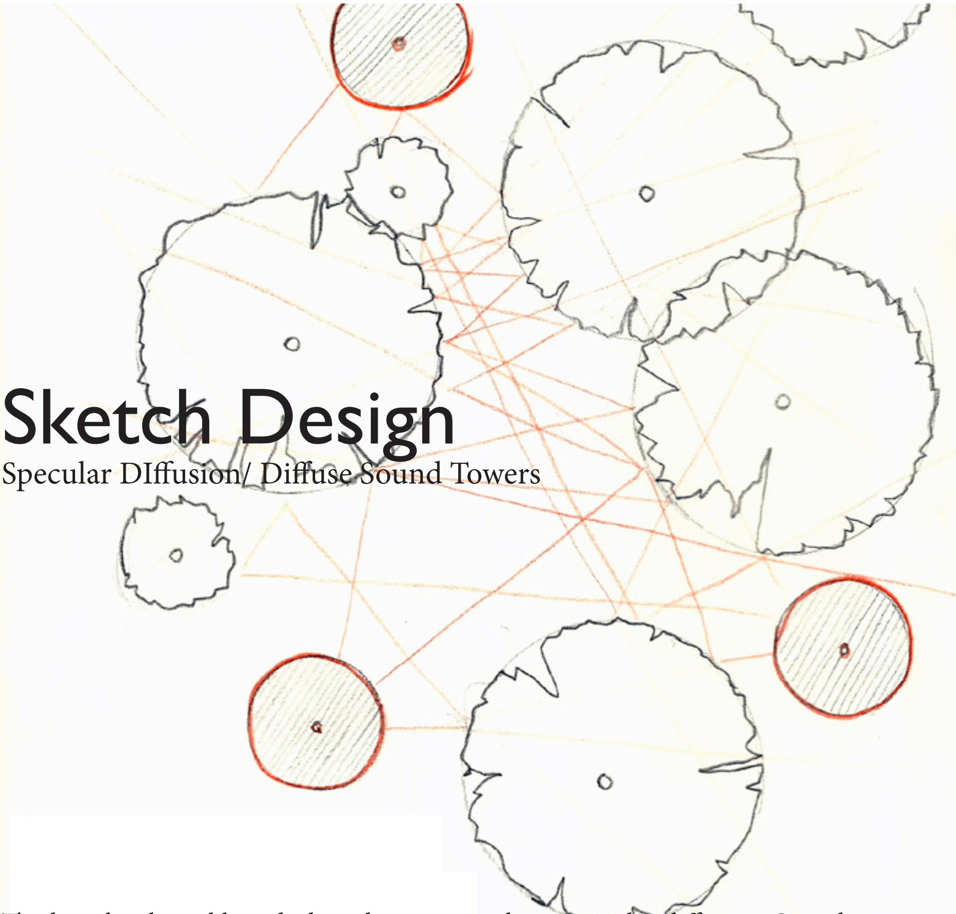


overtones. This modulation in tonality would cause musicians to either perform in the current ambient key, or allow for the constant dissonance in their music or composition. The next few models were studies as to how a organ pipe was built and how the sound was produced by it. The first few attempts at creating a functioning pipe were failures, but after stepping up  to a larger pipe size, a pipe that functioned exactly as predicted was created.

Below: Organ pipe reed assembly cross-section showing wind sheet thickness and conceptual organ schematic



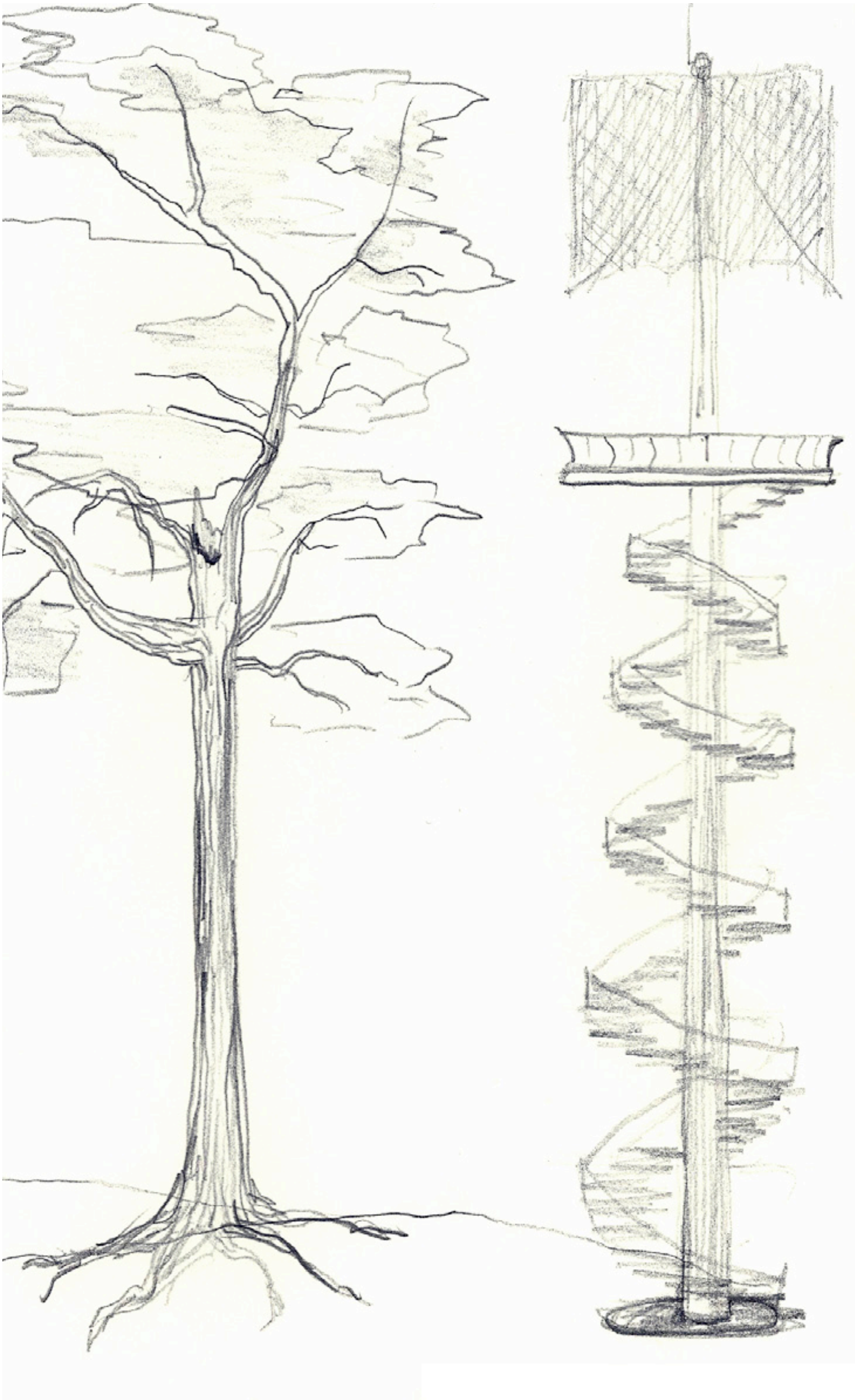
Above: detail of the reed portion of my homemade organ pipe.
Below: Functioning organ pipe tuned to A=440hz.



# Sketch Design

Specular DIffusion/ Diffuse Sound Towers

The last sketch problem dealt with my research on specular diffusion. Specular diffusion refers to a situation where sounds are distributed widely over a large area. The design consisted of a series of towers placed among the forest that would raise musicians up to the canopy to perform. With all of the leaves and branches reflecting sound, the direction from which sounds are originally emenating is unclear. Also, depending on the density of the trees surrounding the performers certain frequencies of the sound would become muddied from mechanical resonance within the tree. High in the canopy, higher pitched sounds would be muffled. Lower where the limbs of the tree were more voluminous, lower pitched sounds would be muffled. (Marsh, 5). These interesting properties would create a musical environment that was very passive. It creates an situation where listeners are not bound by the conventional rules of a musical performance. People can come and go as they please, and can change their aural perspective at will.



# Site

## Shelby Twp. River Bends Park

Before selecting a site for it was necessary to develop a criteria on which to base the decision. Due to the size of programmatic requirements a large, uninterrupted site would be necessary. And, with the focus of the project being on sound, a site that was in an urban/suburban context would inherently come with a set of sounds that would always interfere with the music on the site, like the constant flow of noisy traffic that would alter spaces in ways that were semi-unpredictable.

The nature of the sketch designs also contributed to the selection of site, and in order for all of them to function properly; trees, wind, and flowing water would be required. This realization made it apparant that the site might have to be in a rural context and that it must be forested, have a river running through it, and have areas where winds blow quite forcefully. With many of the proposed spaces being performance based, areas with hilly topography would be favored as they could provide a pre-sloped seating surface, eliminating the need for highly intrusive excavations and constructions.

A purely rural context would pose problems however. For instance, how far from the site is the nearest freeway, or airport? If musicians and guests are coming here from around the country or even the world, how will they get to the site? Where can they go to remove themselves from the musical environment if they tire of it?

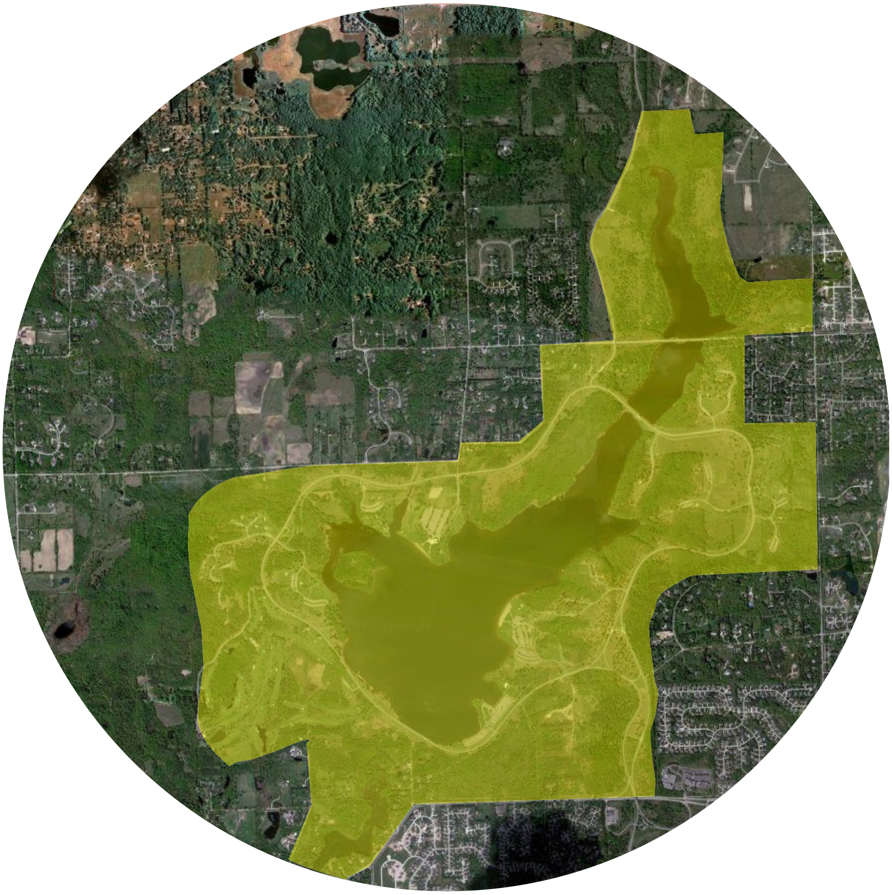

S H E L
Gravel Pit
Ewell Sch
23 MILE
BM 691
702
700
WT
Sewage Disposal
PROVING GROUND
21
Gravel Pit
BM 688
Gravel Pit
STATE
RECREATION
AREA
20
OLD
680
650
590
694
CANAL
SHELBY
Picnic Area
ROAD
ROAD
CONRAIL
28
29
WT
Picnic Area
RYAN
CLINTON
RIVER
Utica High Sch
BM 704
Gravel Pit
32
33
St Lawrence Cem
West Utica Sch
ROAD
GREENS
UTICA
WEST
DITCH
679
670
59

Instead of a purely rural site, a site that had quick access to major roads and freeways would be advantageous. The site could be a public park ... a park that was large, wooded, contained a river, and had decent access to the transportation system. There are only four parks in the metro-detroit area that fit these criteria: Wolcott Mill Metropark, Stoney Creek, Metro Beach, and River Bends. These parks all contain the attributes that were necessary to fit the criteria, but only one had an area where all requirements were met simulteanously.


2625 acres

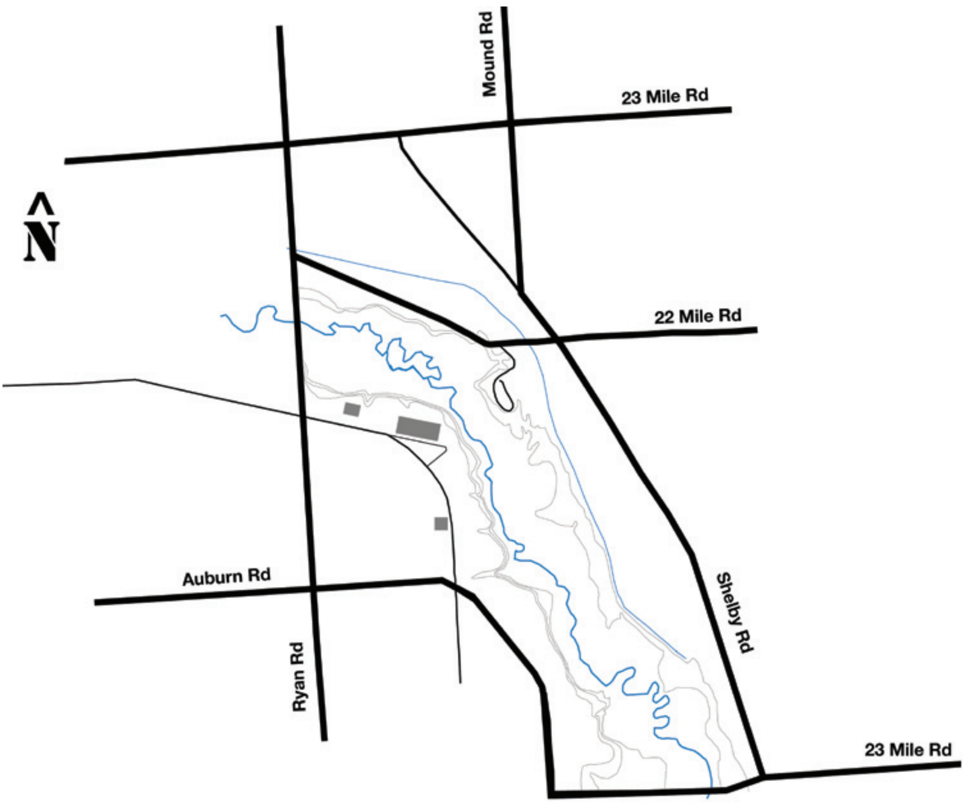
# Wolcott Mill

# Stoney Creek
4461 acres

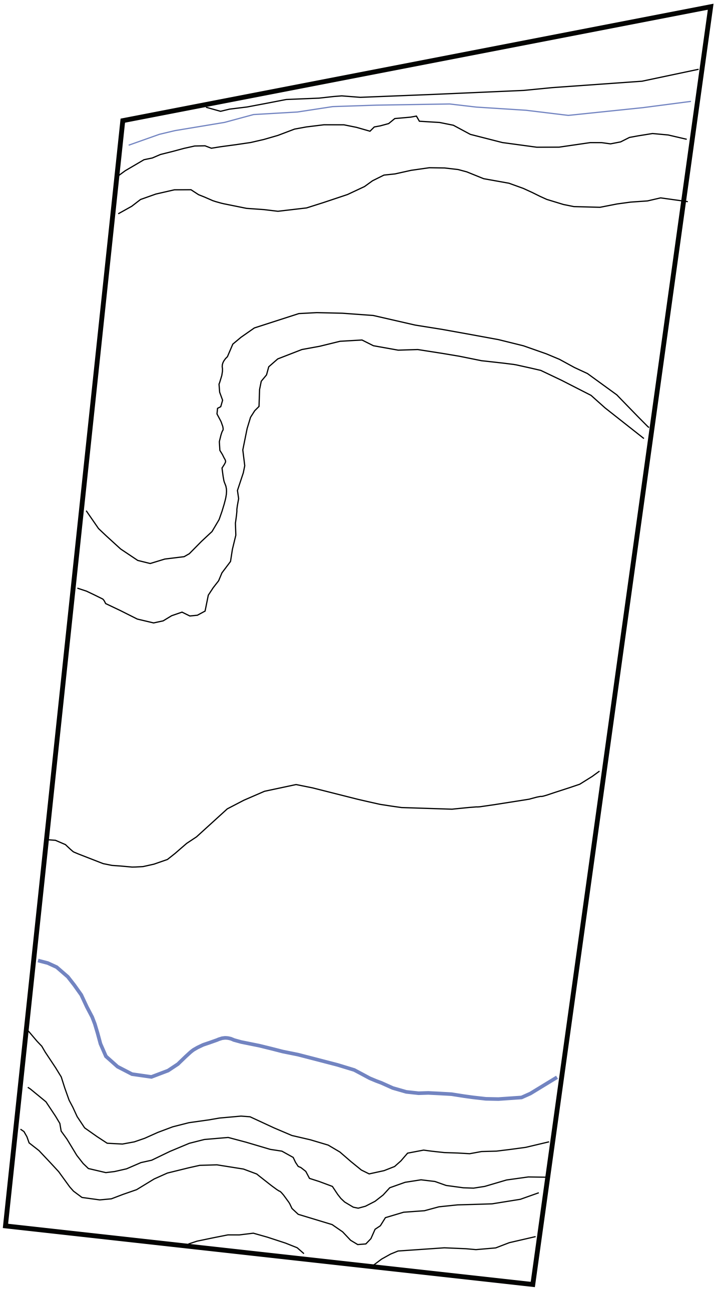


# Metro Beach
770 acres

# River Bends Park
838 acres




River Bends Park is the third largest public park in the tri-county area, covering a massive 838 acres. The RBP Center for Experimental Music will be located directly in the center of the park deep within a heavily wooded area with access to the clinton river The interesting topography in this area is caused by the ever-changing Clinton River. The river rises and falls with the changing seasons and is currently in the process of forming a small island with proximity to the proposed site. RBP is home to thousands of different plants and animals, each contributing to the diversity of the forest.



site boundaries: clinton river shown in blue near the bottom of the image and the clinton-kalamazoo canal showin in blue at the top.

# Wildlife

**Trees and Shrubs**

| | |
|---|---|
| Tamarack | Large Tooth Aspen |
| Ironwood | White Cedar |
| Spice Bush | Red Maple |
| Red Elm | Black Raspberry |
| Basswood | White Ash |
| Gooseberry | Black Cherry |
| Choke Cherry | Red Oak |
| White Oak | Black Oak |
| Burr Oak | Shadbush |
| Witch Hazel | Hawthorn |
| Hackberry | Yellow Birch |
| Red Mulberry | Sugar Maple |
| White Elm | Red Raspberry |
| Black Maple | Black Ash |
| Common Elder | Bitternut Hickory |
| Prickly Ash | White Pine |
| Canada Yew | Willow |
| Honeysuckle | Narrowleaf Willow |
| Poison Ivy | Bladdernut |
| Pussy Willow | Cottonwood |
| Poison Sumac | Aromatic Sumac |
| Gray Dogwood | Tulip Tree |
| Blue Beach | Sycamore |
| Dogwood | F. Dogwood |

**Animals**

| | |
|---|---|
| Whitetail Deer | Coyote |
| Fox | Raccoon |
| Oppossum | Skunk |
| Squirrel | Badger |
| Beaver | Muskrat |
| Mink | Chipmunk |
| Wood Duck | Gopher |
| Mice | Cottontail Rabbit |

Above: Colorful leaves provide a dramatic backdrop during fall months

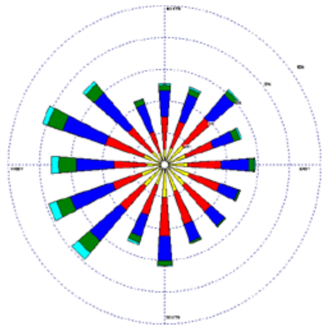
## *Wind Analysis*

Wind analysis of the proposed site shows that little wind is felt on the escarpment of the valley due to the tree cover and slope that shield it from the southwestern prevailing winds. Wind IS however present among the canopy and in the flat flood plain to the east of the river. By placing buildings into the escarpment rather than on top of it, the sounds produced in outdoor amphitheaters will be shielded from gusts that disrupt the transmission of sound waves. Certain performance venues may appreciate the wind however. The call and response pavillions spacing allows for the effects of wind gusts to be incorporated into the musical composition. Wind blowing toward the sound source will cause the sound to travel slower than normal, and wind blowing with the direction of the sound will increase the rate at which it moves through the air.

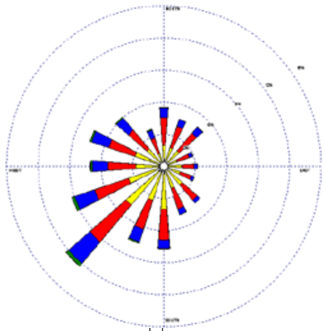
## *Sound analysis*

This model shows the various sound pathways on the site. Each satellite pin represents a sound source that can be heard from the main pin. The larger spaces are placed on the escarpment to take advantage of the sloped surface for natural auditorium style seating.

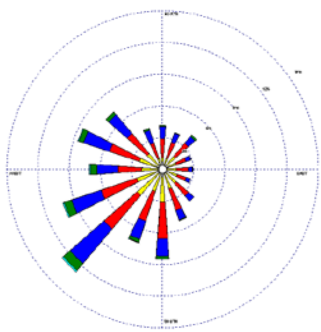
Wind Rose: Shelby Twp. Michigan



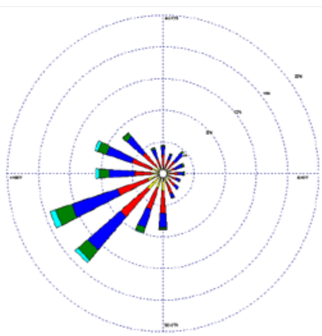
April



July



October

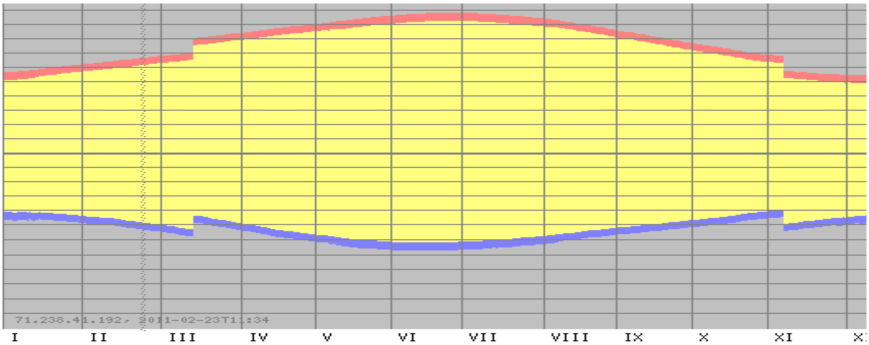


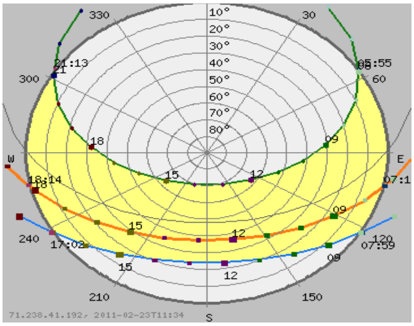
January

The smaller sized spaces are placed on the eastern side of the site where the forest is more dense. These denser forests would allow more specular diffusion to occur when and where it is needed. In the end each proposed sub site allows its respective building to take full advantage of the natural environment around it.

### *Sun Analysis*

A sun analysis of the site reveals that despite the varied topography and tree cover, much of the valley is bathed in sunlight from 6:30am until 8:00pm during the summer months.




Above: Sunrise and Sunset times on site.
Left: Diagram describing the suns path through the sky throughout the year


Mid-August 5:00 a.m.


Mid-August 6:30 a.m.


Mid-August 8:00 a.m.


Mid-August10:30 a.m.

Mid-August 1:00 p.m.

Mid-August 4:00 p.m.

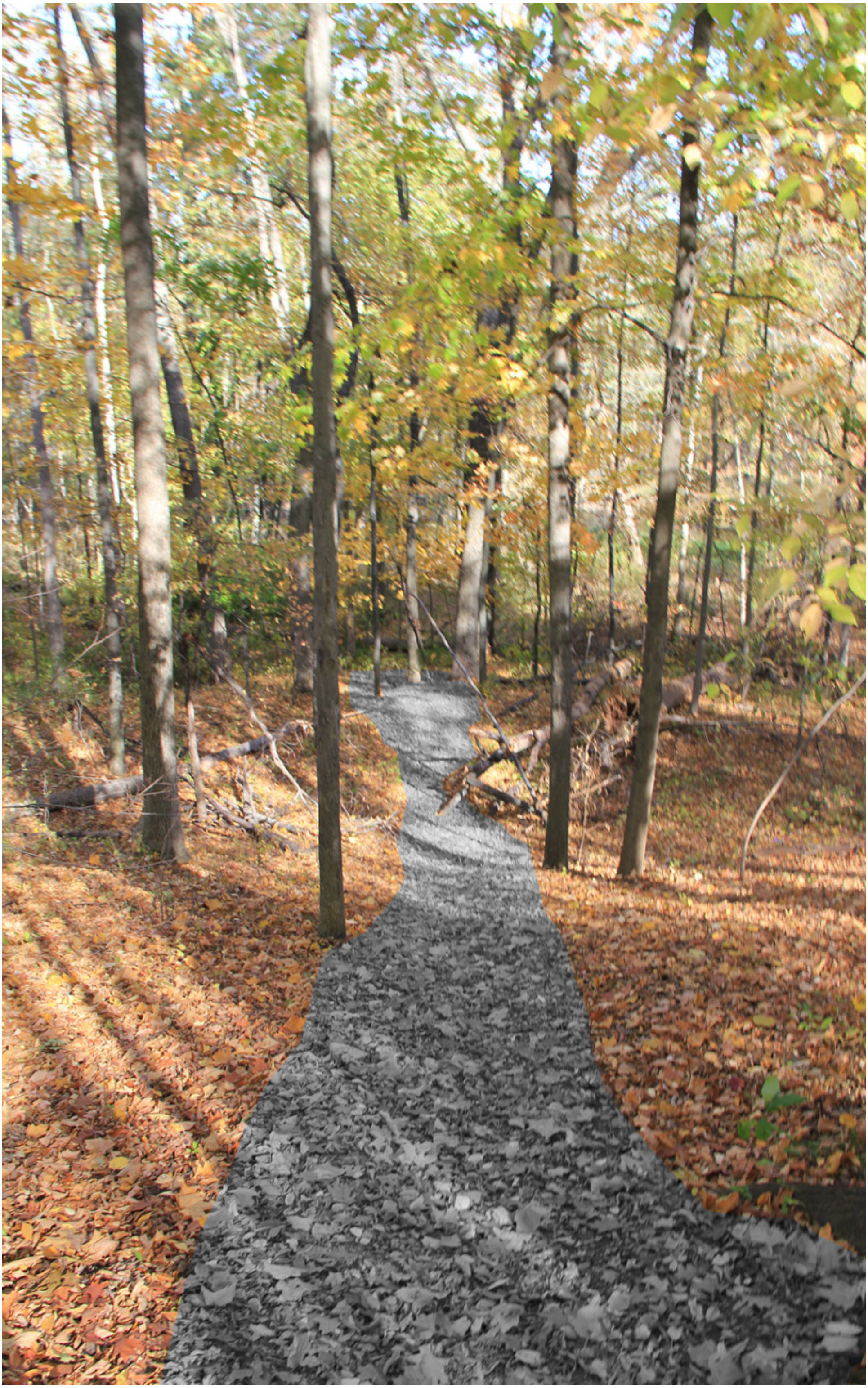
Mid-August 6:00 p.m.

Mid-August 7:30 p.m.

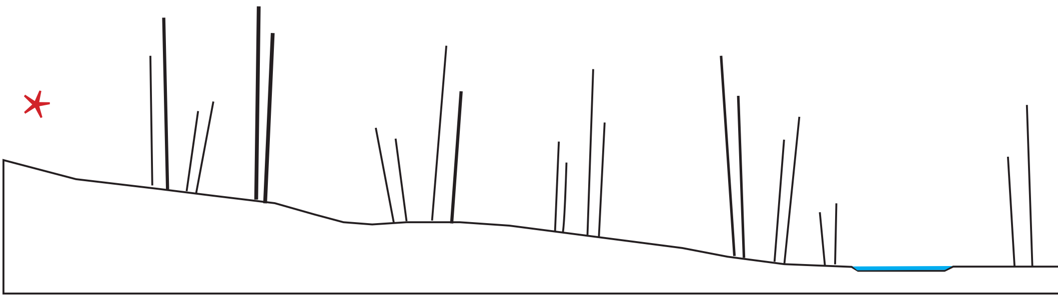
# Site

## Pathway through the valley

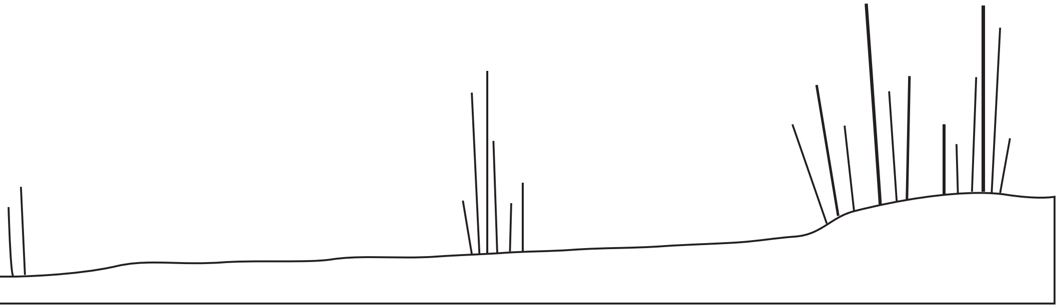
The next twenty pages show the main pathway used to access the site. In the images the desired path is desaturated so that it stands out easily against the colorful forest. By flipping through these pages, you begin to understand how expansive the site is, and also are able to get a grasp on the topographic features.



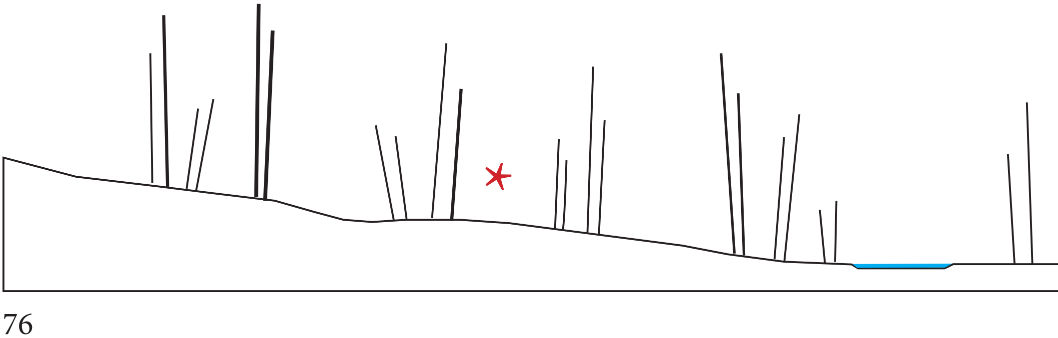
# Panorama I



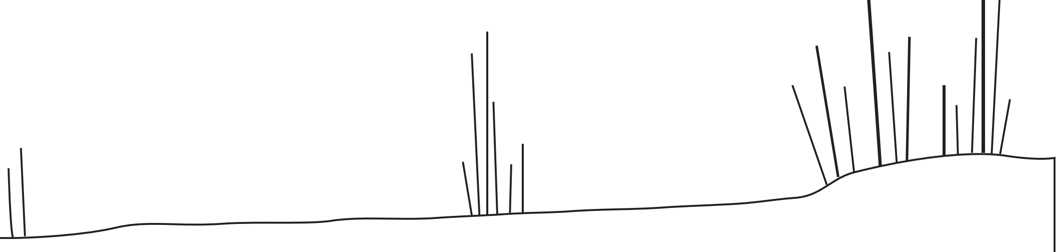
This 360* panorama is taken at thetop of the point of view path, this is the highest part of the site. Also the area with access to the parking lot and street



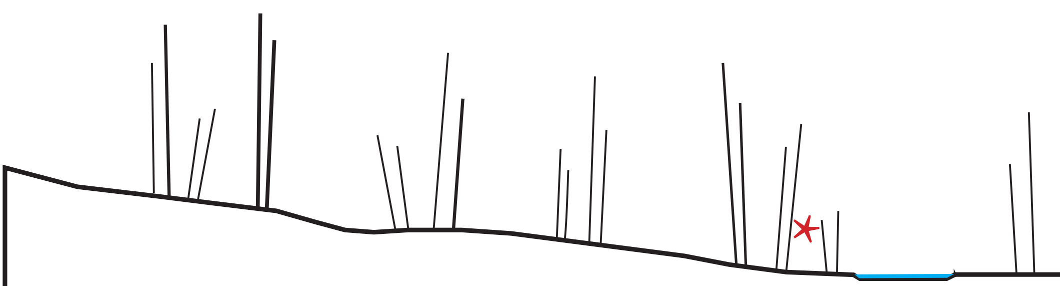
# Panorama 2



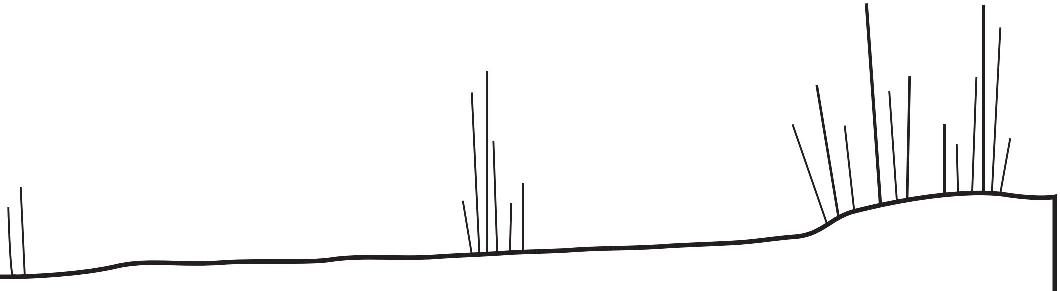
.This 360* panorama is taken along the point of view path, at the point where the topography becomes the most varied.



# Panorama 3



This 360* panorama is taken at the bottom of the point of view path, this is where the terrain becomes flat and is divided by the clinton river. It is the lowest area on the site



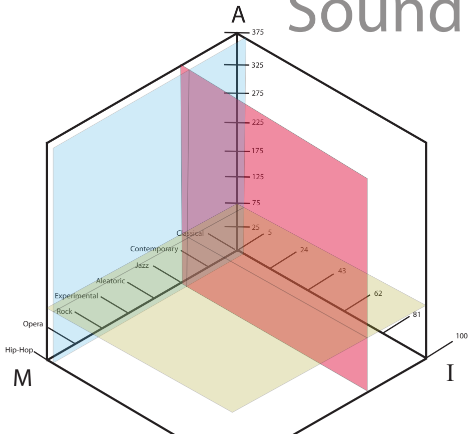
# Research

## Musical Scenarios

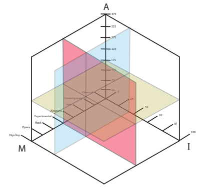
This series of diagrams was used to begin to define a logic behind the scale and style of spaces that should be considered. Along one axis of the diagram is an indication of audience size, along another number of musicians is indicated. The last axis shows genres or musical types. After 20 preferable musical situations were defined, they were plotted in the graph. Following their analysis, relationships were drawn between the different situations. Five distinct venue sizes were noticed, and several consistent ratios of performers to audience were also observed.

Despite the sketch problems tendency to focus on the relationship of performer to performer, spaces intended for public performance will also be very important to the project. Doing this will call the traditional role of the performance audience into question, and could possibly foster the beginnings of a new compositional archetype. With the favorable musical situations identified, the program could begin to be based around their relatedness. There will of course be other spaces in the building or buildings, to accommodate private practice, classrooms, libraries, composition studios, offices, support spaces for the larger venues such as lobbies, etc. as well as the residential component that I mentioned.

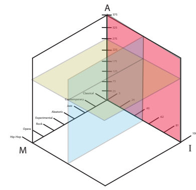
# Sound Diagram



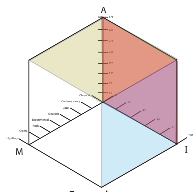

Jazz Combo Performance



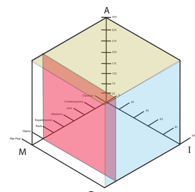

Experimental Performance



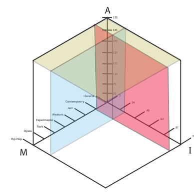

Chamber Ensemble



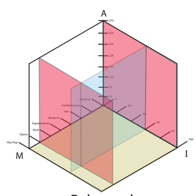

Symphony



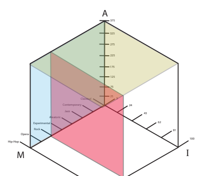

Opera



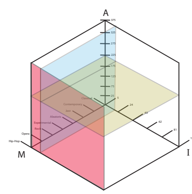

Percussion Ensemble



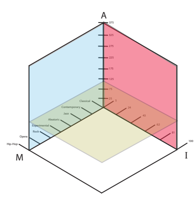

Rehearsal



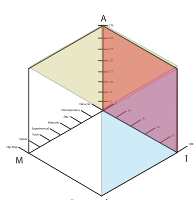

Rock Concert



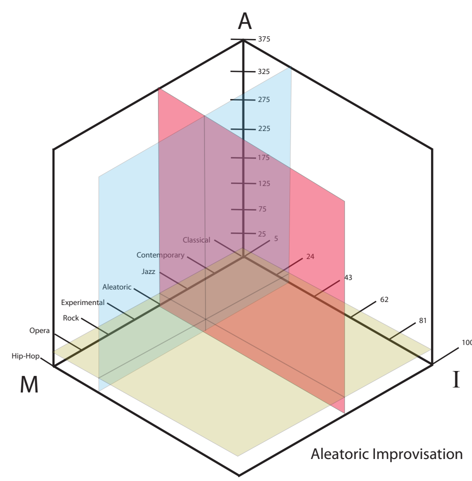

Rap-Hop Show




Organ Performance




Symphony




Aleatoric Improvisation

| | | | | |
|---|---|---|---|---|
| Jazz Combo Performance | 5:75 | 1:15 | C | E |
| Experimental Performance | 30:175 | 1:5.8 | D | B |
| Chanber Ensemble | 50:275 | 1:5.5 | E | B |
| Percussion Ensemble | 27:375 | 1:14 | F | D |
| Opera | 100:400 | 1:4 | F | B |
| Symphony | 100:400 | 1:4 | F | B |
| Rap-Hop Show | 18:125 | 1:12.5 | E | D |
| Rock Concert | 5:400 | 1:80 | F | H |
| Rehearsal | 62:0 | 62:0 | A | X |
| Organ Performance | 1:125 | 1:125 | C | H |

| | | | | |
|---|---|---|---|---|
| Aletoric Performance | 26:10 | 2.6:1 | A | X |
| DJ Set | 1:100 | 1:100 | C | H |
| Prepared Piano Performance | 2:50 | 1:25 | B | F |
| Participatory Performance | 26:25 | 1.04:1 | A | A |
| Listening Experience | 0:30 | 0:30 | B | X |
| Choir/Chorale Performance | 50:150 | 1:3 | D | A |
| Musical Theatre | 20:150 | 1:7.5 | D | C |
| Jam Session | 8:16 | 1:2 | A | A |
| Acoustic  Performance | 5:50 | 1:10 | B | C |
| Childrens/Student Performance | 10:50 | 1:5 | B | B |

# Schematic Design

The six sketches on the right are program diagrams of the selected building types, and their interaction with the specific acoustic principles to be utilized there. Each sketch shows an interpretation of how these typologies are able to individually or collectively exploit the acoustic properties being exercised. These were used to infom myself about the possible ways that the various performances can be combined.

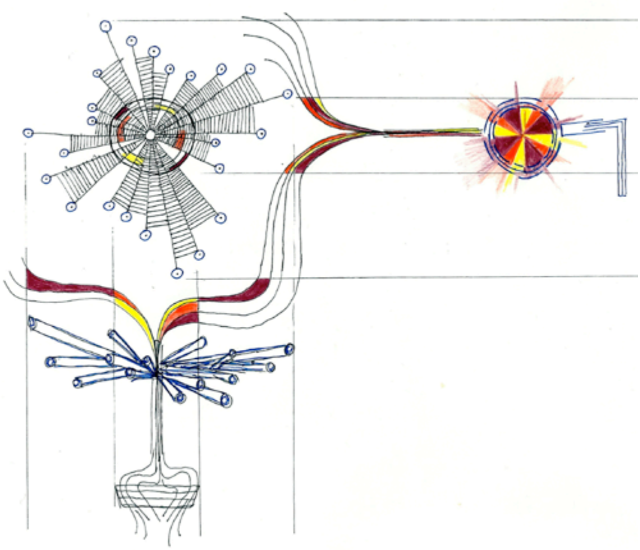
1. Rehearsal spaces/practice rooms are generally small and personal. They provide musicians with a ample light and space to get work done. It was for these reasons that the practice spaces became standalone towers that dot the campus.

2. This sketch was influenced heavily by the listening experience program and the reflection space program. The illustration shows a small, roofless structure that lets sounds pass right through its walls. The wall system also provides acoustic reflectivity when sounds are projected from the stage area toward the back of the space.

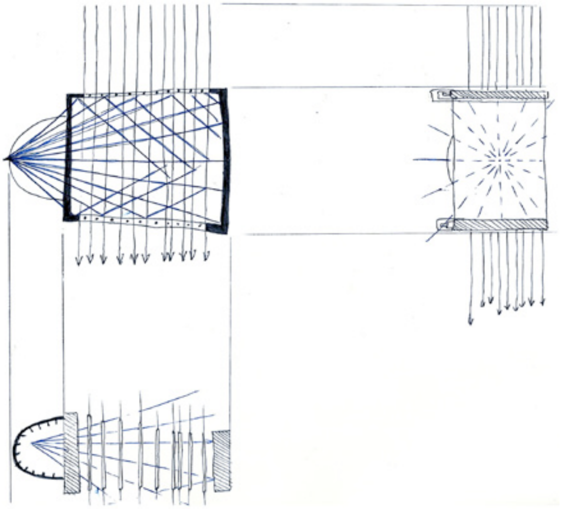
3. This sketch shows a space that operates like an instrument. Wind and water are directed into the building. As it passes through it is processed and turned into sounds that can be heard in and around the building.

4. The red and blue areas indicate two seperate sound sources being projected onto a common audience. This concept is the basis for binaural sound

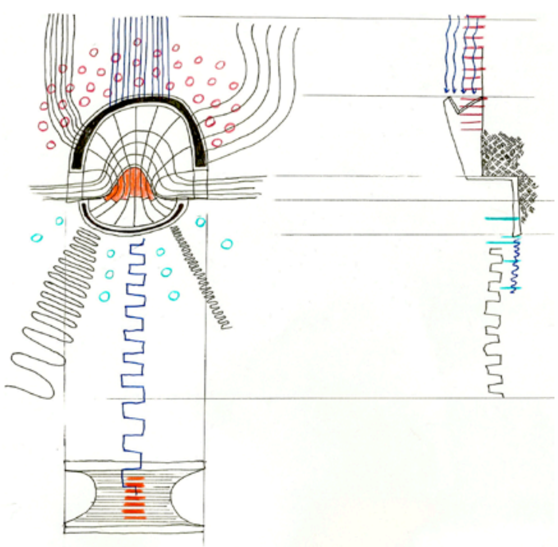
5. A large scale space is shown in this sketch for the main auditorium. As the only non-acoustically active performance space in the project it must provide large orchestras and symphonies with a performance space that is "perfect."



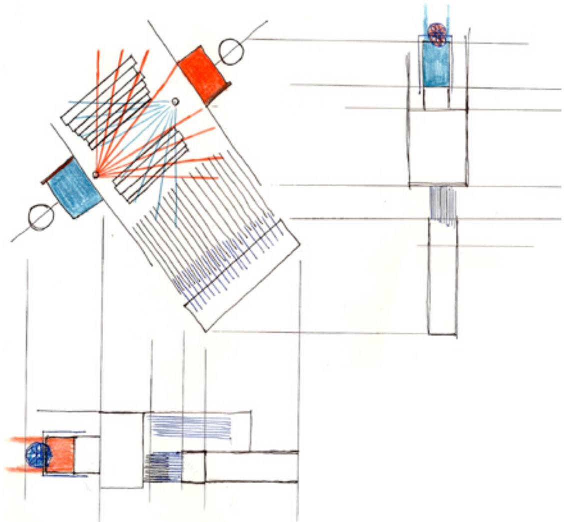
1. Rehearsal space, Participatory Performance, Jam Session, Aletoric Performance



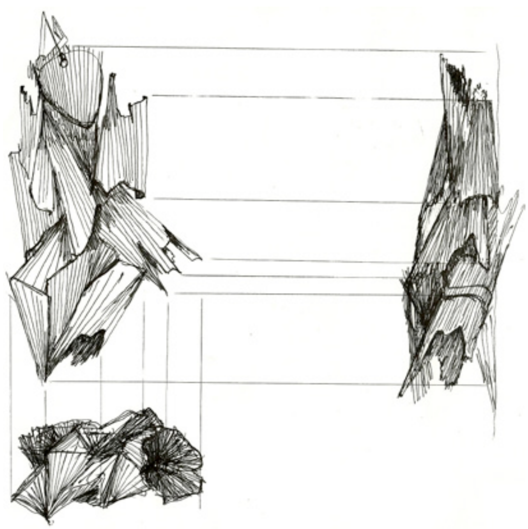
2. Listening Experience, Childrens Performance, Reflection Space



3. Acoustic Instrument Performance, Prepared Piano Performance



4. Experimental Performance, Choir/Chorale, Musical Theater



5. Opera, Chamber Ensemble, Symphony

# Program Development

RBP Center for Experimental Music

***Main Auditorium Building:***

Including green room, musician bathrooms, audience bathrooms, elevators, storage, mechanical rooms, sound booth, full lighting, catwalk, and ballroom. Will also include a small store that sells basic music supplies (reeds, valve oil, cork grease, manuscript paper, etc.); and a cafe with coffee and pastries. A cafe and dining room are also a part of the structure.

Sound reflection: return of sound after it strikes an object.

The main auditorium is a two-level auditorium that seats approximately 700 people. An unconventional seating arrangement on the ground floor allows more interesting views of the musicians and the sections they belong to. This helps the audience identify which instruments make what sounds. The main auditorium also has a large, deep stage that facilitates theatrical performances. Multiple backdrops at different depths create a dynamic visual experience to compliment the music. A green room is also located directly adjacent to backstage and has an access point outside of the auditorium. This area is where large instruments and stage equipment can be loaded directly from a truck onto a stage-level platform.

***Diffusion Towers:***

Specular diffusion: The spreading of a sound source over a wide area.

Sound always travels in a predictible fashion. It travels away from the source hemispherically in a straight line toward the listener. This law of acoustics makes it easy to determine where a sound is coming from, and where it will head to. The specular diffusion towers challenge these norms by placing musicians and listeners up into the canopies of trees during musical performance. Ranging in size from 5 feet to 20 feet in diameter, and raised 0-60 feet in the air, even large groups of people can be accomodated. these in As sound waves travel outward from the source, they collide with millions of tiny leaves, and each of these tiny leaves reflects the sound in a different direction. The specular diffusion of the sound will make it difficult for the listeners and even other performers to identify where specific sounds are coming from, creating a very diverse soundscape on the site.

***Call and Response Pavilions:***

Including one space to accomodate 1-20 musicians, while also acting as the beginning of the axial pathway that allows access to the lower portion of the site near the river. Also including four Response Pavilions spaced at 100' intervals along the axis heading in the direction of the river. Each of these pavilions will primarily be a small open-air structure that allows an intimate connection with the surrounding environment. However, these rooms will also be able to close in incliment weather, or for storage purposes. These pavillions can be used to relay messages  across campus quickly

Call and Response: In music, a call and response is a succession of two distinct phrases usually played by different musicians, where the second phrase is heard as a direct commentary on or response to the first.

The four call and response pavillions take this principle and elaborate on it. The speed of sound through air is 1,125 feet per second. This number was important when laying out the pavilions on the site because as the distance between the pavilions changed, so did the time it takes for a sound to travel from source to listener. In my design sound takes approximately one half of a second to be heard after it is produced. This might prompt an early response from the second and fourth musicians, causing the music to be changed on the fly.

***Organ Performance:***

Another, smaller-scale performance venue with built-in hybrid organ. Seating for 2-250 individuals would be provided by a gently sloped platform (2-3degrees), that has pew style seating that pulls up from the floor. When appropriate, the seats can be depresssed back into the floor to create a dance floor for 300 people. An antechamber houses bathrooms, simple storage, and mechanical systems rooms.

Hydraulophone: A hydraulophone is a tonal acoustic musical instrument where sound is generated or affected hydraulically.

Organ: a musical instrument consisting of one or more sets of pipes sounded by means of compressed air, played by means of one or more keyboards, and capable of producing a wide range of musical effects.

The organ performance building is located directly on the clinton river as it uses water pressure to sound the main ranks of the organ inside the building. Supplemental ranks of tuned pipes are carefully positioned on the roof to catch the wind and sound when wind speeds exceed eight miles per hour. Seating in this building consists of pew-style benches that can be stowed in the floor to allow more open space in the main performance room.

***Binaural Auditorium:***

A fully-functioning performance venue seating around 4-500 people. Including a green room, storage facilities, bathrooms, mechanical room, sound booth, several precisely sized and tuned performance boxes (incorporated into stage).

Binaural sound: sound that is transmitted through two different channels from two original sources.

This auditorium is designed in such a way that the audience experiences an acoustic beating during the entirety of the musical performance. This sensation is best described as same sound you experience when you strum two guitar strings that are slightly out of tune. The beating will occur because the audience is actually listening to two seperate bands performing at the same time; one band performs on stage in the traditional sense, while the other is hidden away in specially tuned, large-scale speaker enclosures. These enclosures increse the audiences percieved volume and in turn pitch of those musicians.

***Ambient Sound Space/Ballroom:***

One to two rooms and some corridors that are built primarily so that sound may be carefully observed by all. One of the rooms will have a dished floor to encourage lounging and staying a while. An adjustable oculus will frame views of the changing colors of the canopy and block out wind and snow. Corridors will be skinned on at least one side by a wall condition that allows the transmission of sounds, both altered and unaltered. While proceeding down these types of hallways aural signals are changing with every step, causing a unique cadence of melodics and rythyms to be experienced.

***Administrative Spaces:***

Including five offices, a copy/supply/break room, welcome center/lobby, bathrooms, and mechanical spaces.

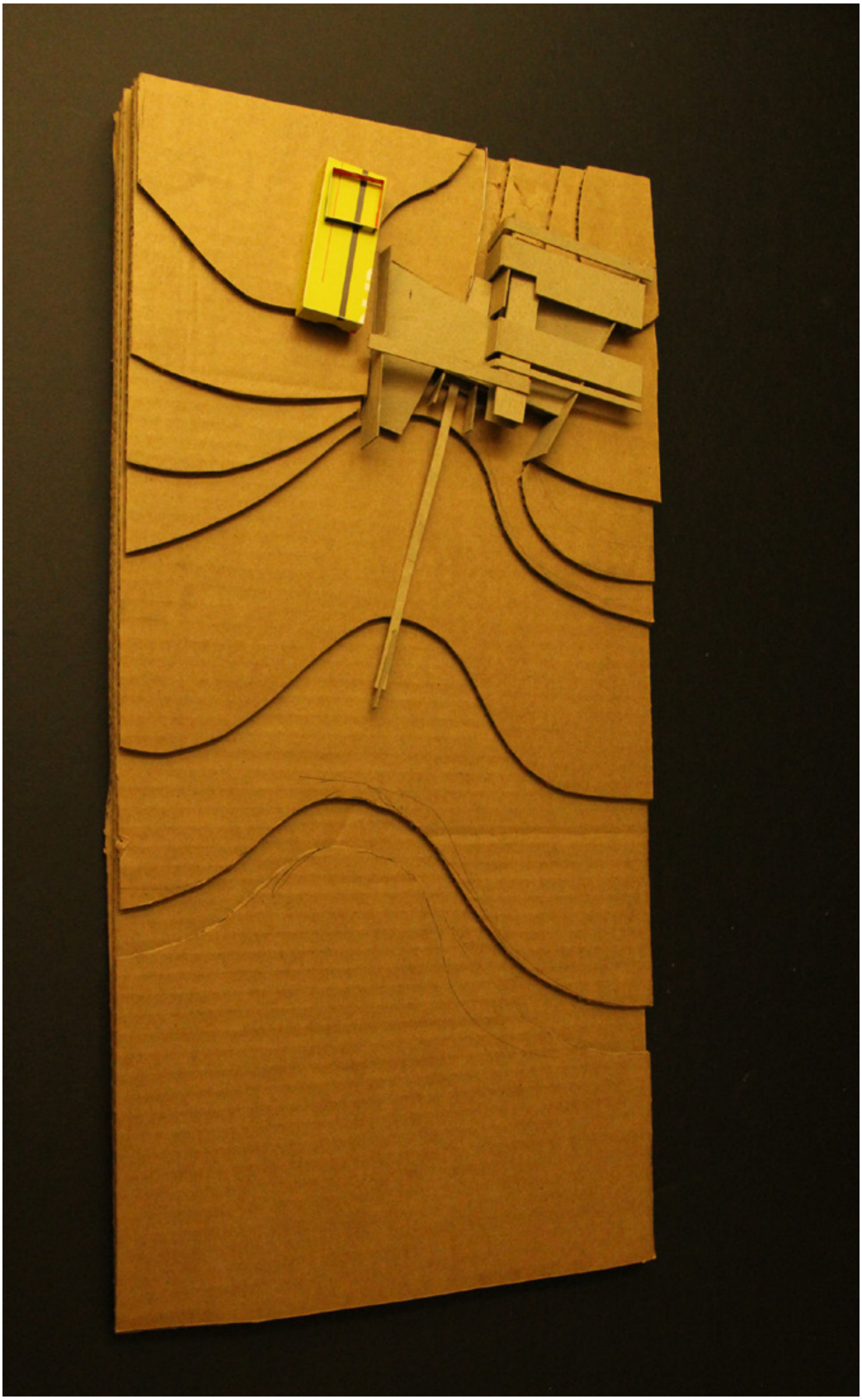
***Residential:***

Two different housing styles provide shelter for a maximum of 75 people in the summer months. Approximately 2/3 of the housing will cabin style units. In these units two bedrooms will share a common living room but all bath facilities will be contained in a seperate communal building. Meals for people staying in these units would be provided through the center's dining services contained in the main building . The remaining 1/3 of the housing will be studio lofts. These buildings will be primarily for professionals who are teaching workshops at the center, or are on sabbatical. They will have small kitchens and living spaces on the first floor, with lofted office and bedroom space.

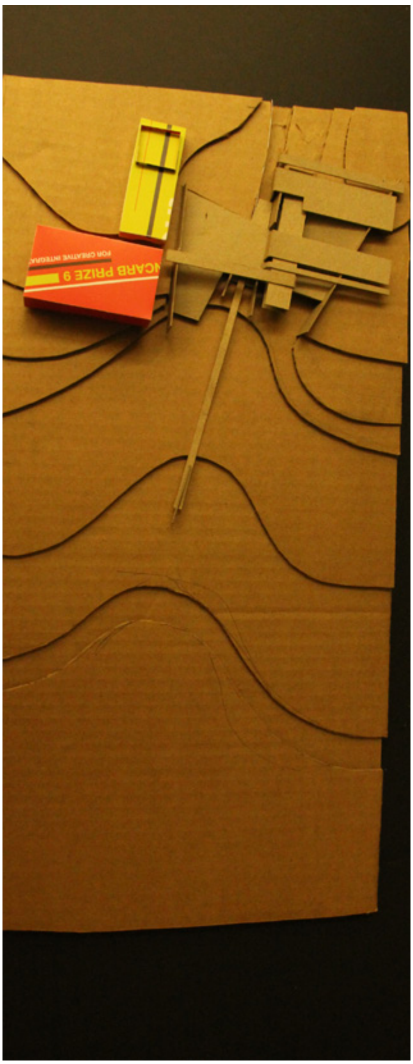
# Site Development

With a site selected, and some general ideas about performance space sizing, the buildings could now be layed out on the site in a way that would reflect my design intentions. In an effort to keep the overall number of standalone buildings relatively low and to place a hierarchy on the spaces to be designed in the future,

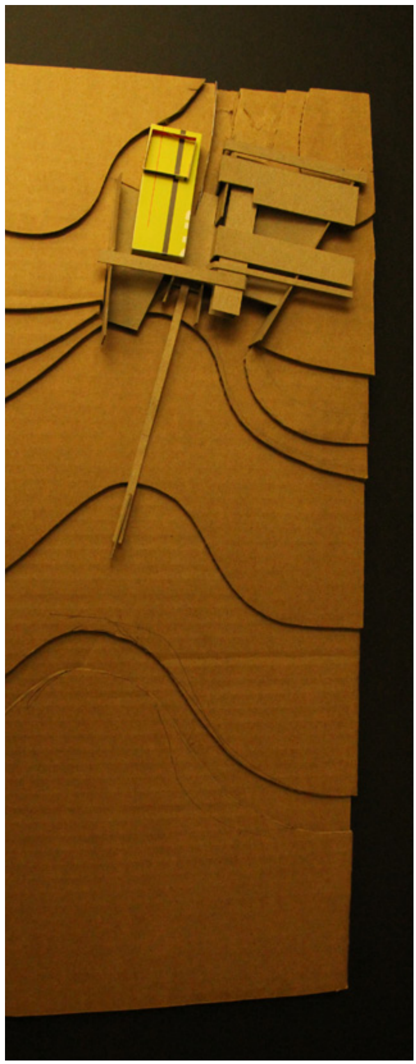
The first site model sets  precedence by placing the call and response pavilions into a depression on the escarpment and laying out the initial axis on which all the other buildings will be placed. The chipboard model on the right is a massing model of the main auditorium and its necessary supportive spaces. The colorful building is a smaller structure, the organ performance building. By pulling the two buildings apart, the natural walkway into the site is preserved. This pulling also creates the oppurtunity for a hardscaped congregation area between the two performance venues where patrons can socialize during intermissions and listen for other musicians performing around the site.


Site Model 1.

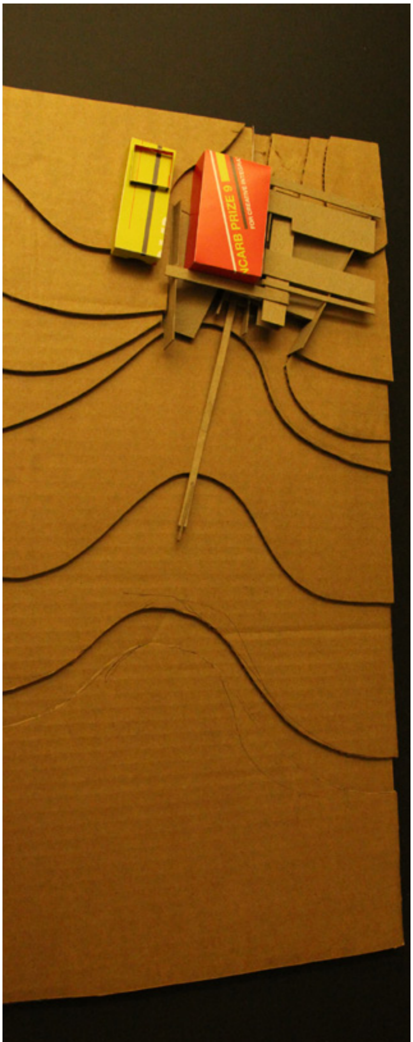
Site model 2. showing the placement of secondary buildings in a way that creates a longer, axial courtyard



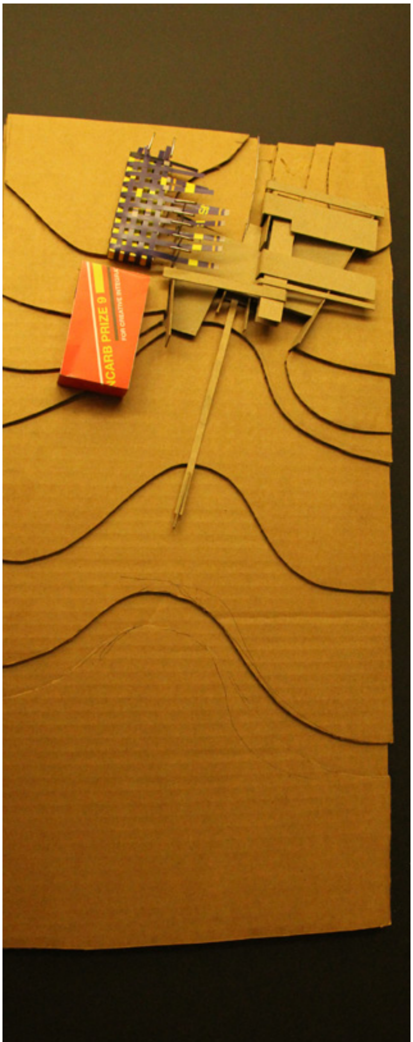
Site model 3. By pushing the organ building closer to the main auditorium, the courtyard becomes a narrow thouroughfare that directs visitors down into the site along the call and response axis.

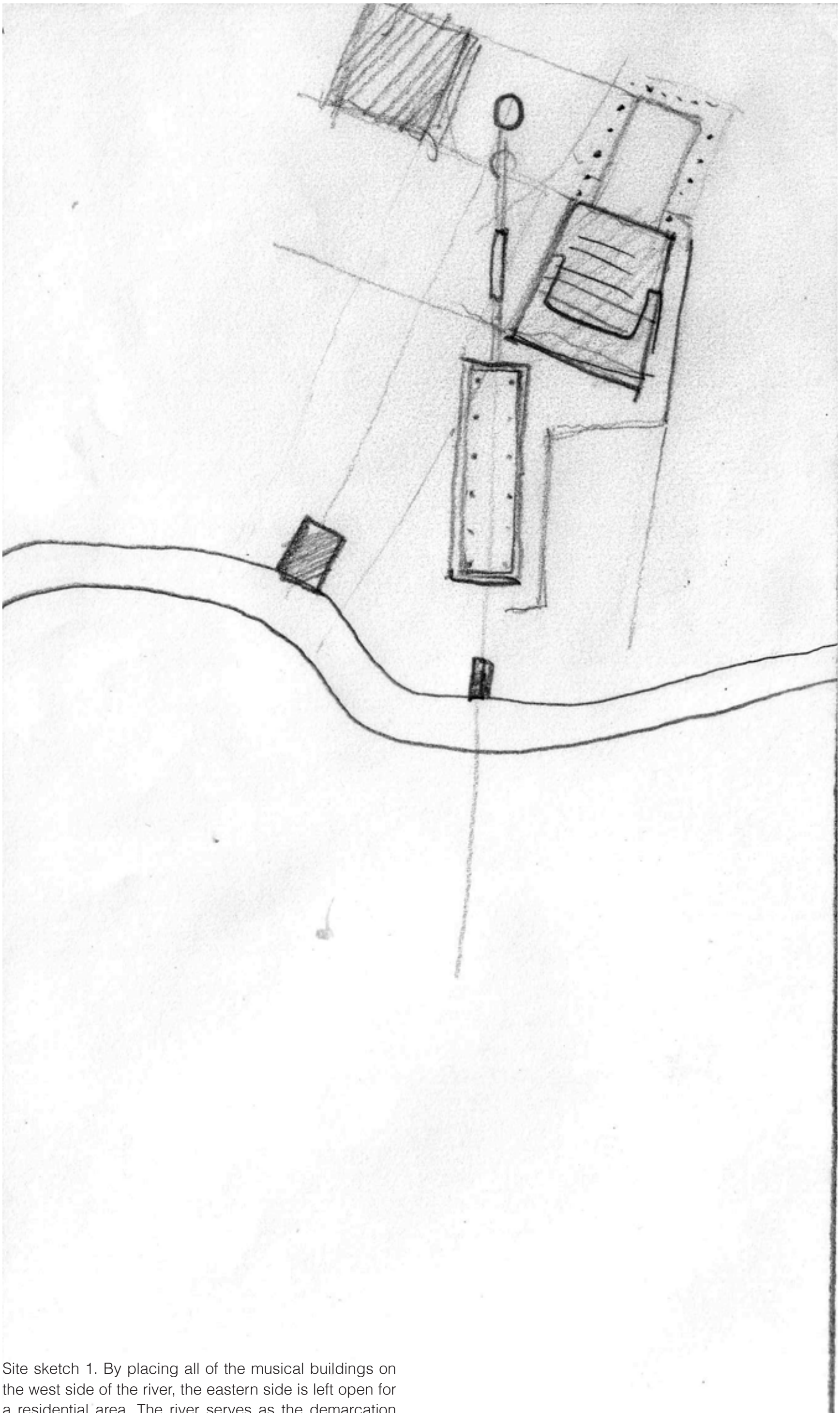


Site model 4. Administrative offices are placed between the organ performance building and the main auditorium. While reducing the overall footprint of the design seemed sensible at first, it quickly became apparent that this iteration severely limited the transmission of sound and visitors through to the east end of the site and also would cover some of the most interesting topography on the site.

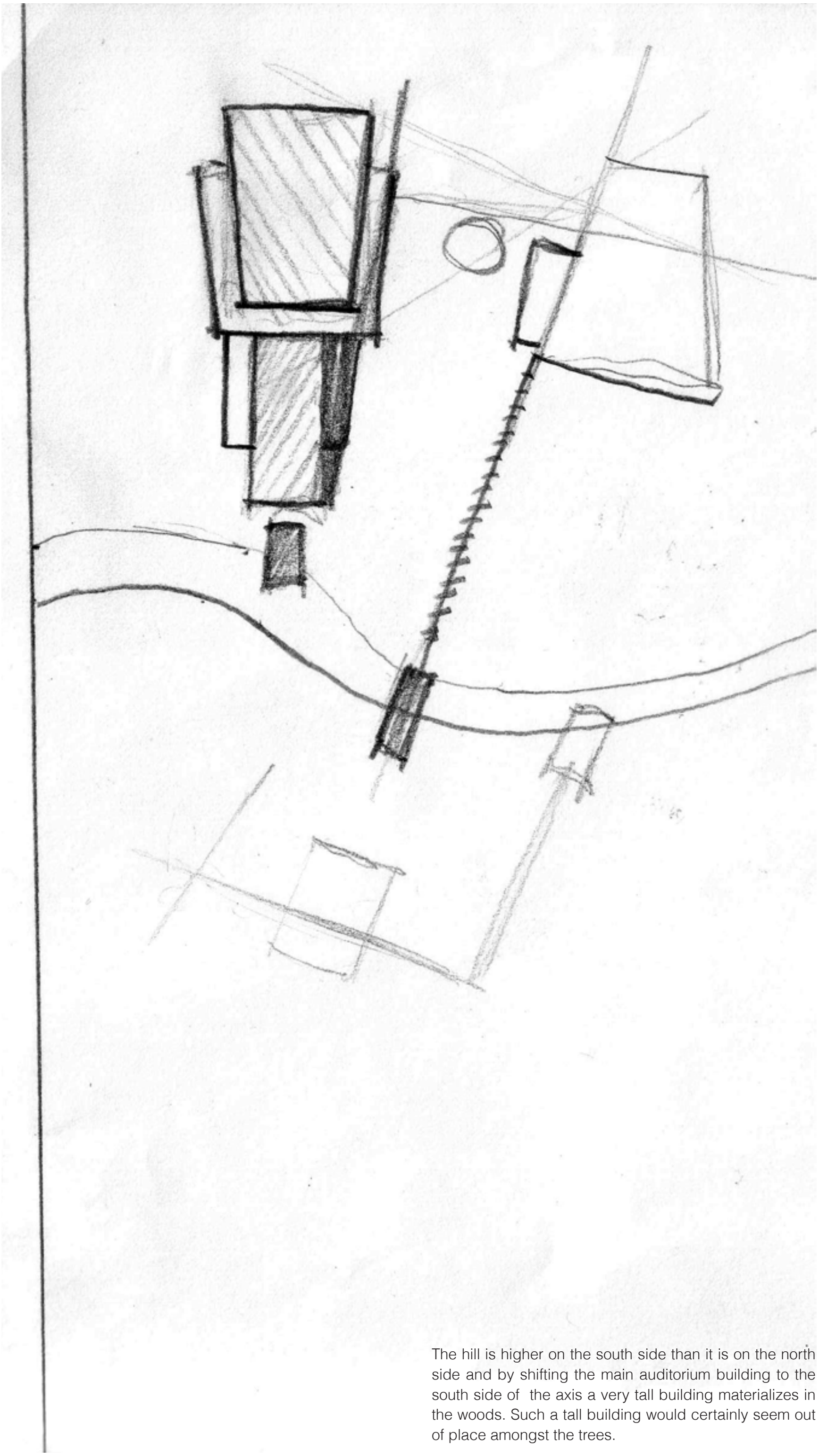



Site model 5. Courtyard concept is solidified. A series of terraced decks will descend into the site and provide a means of entry and transit throughout the site.

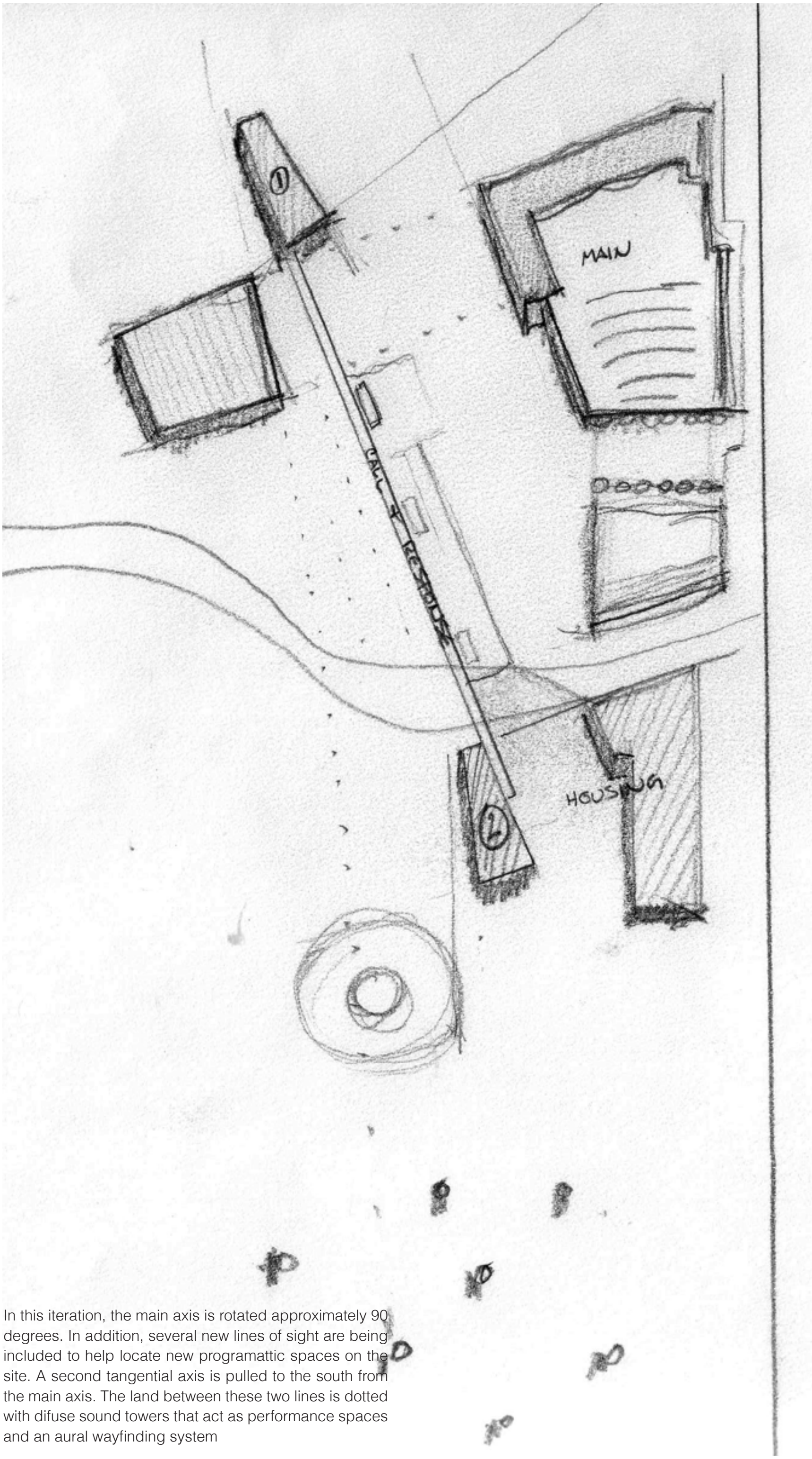




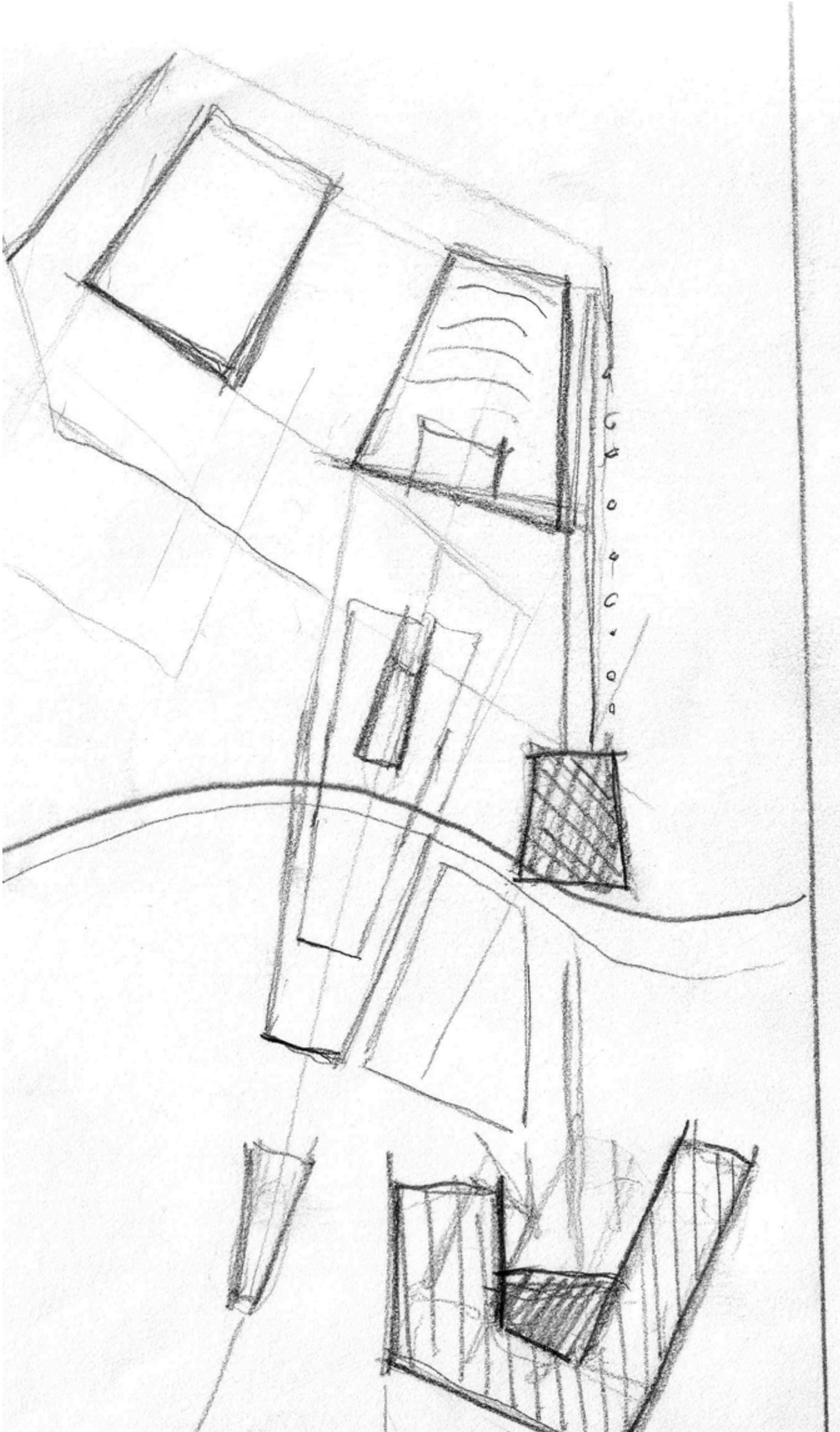
Site sketch 1. By placing all of the musical buildings on the west side of the river, the eastern side is left open for a residential area. The river serves as the demarcation between the public and private sectors within the campus. The organ building is now on the water and powers the instrument through a water driven air column.

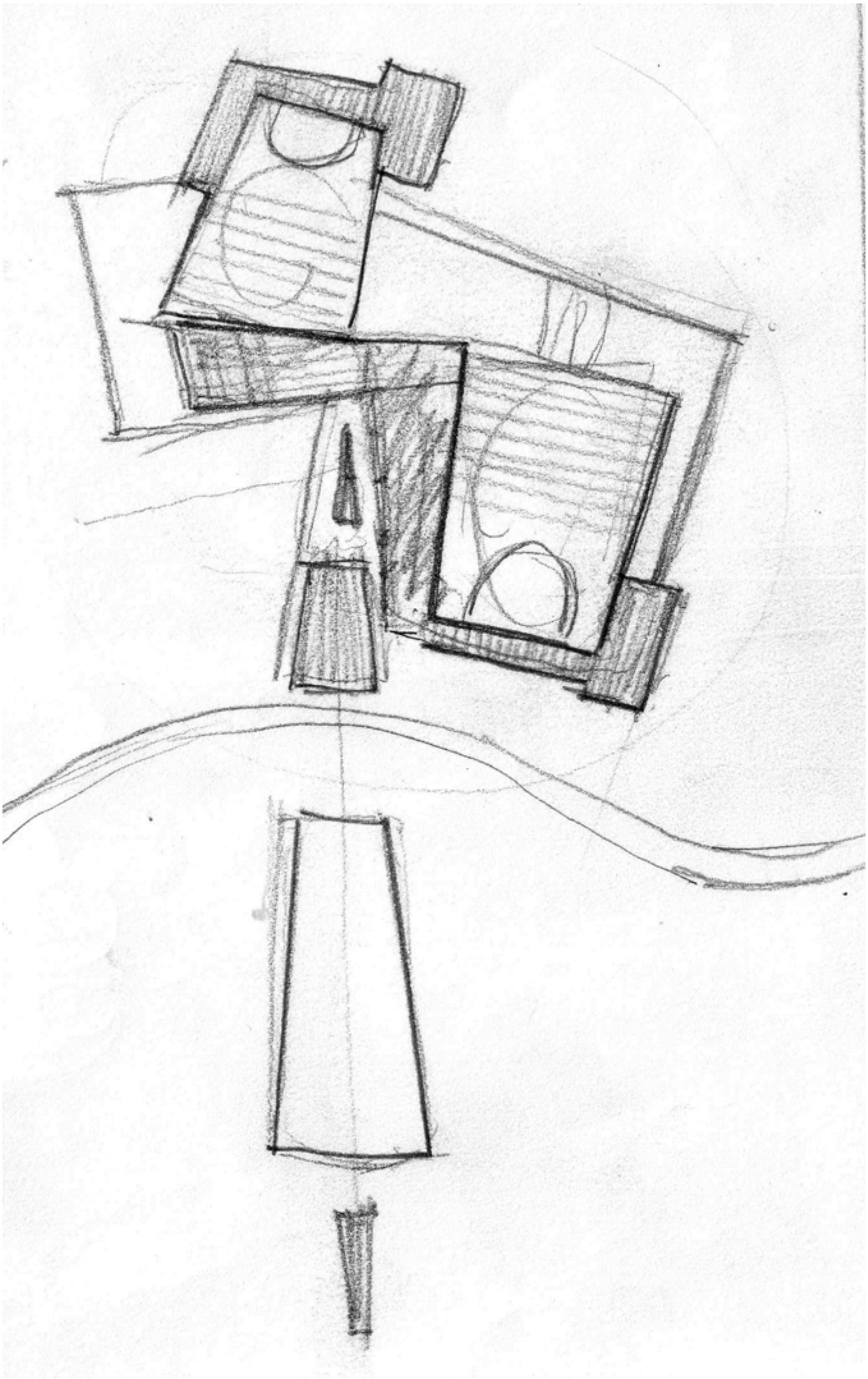


The hill is higher on the south side than it is on the north side and by shifting the main auditorium building to the south side of  the axis a very tall building materializes in the woods. Such a tall building would certainly seem out of place amongst the trees.

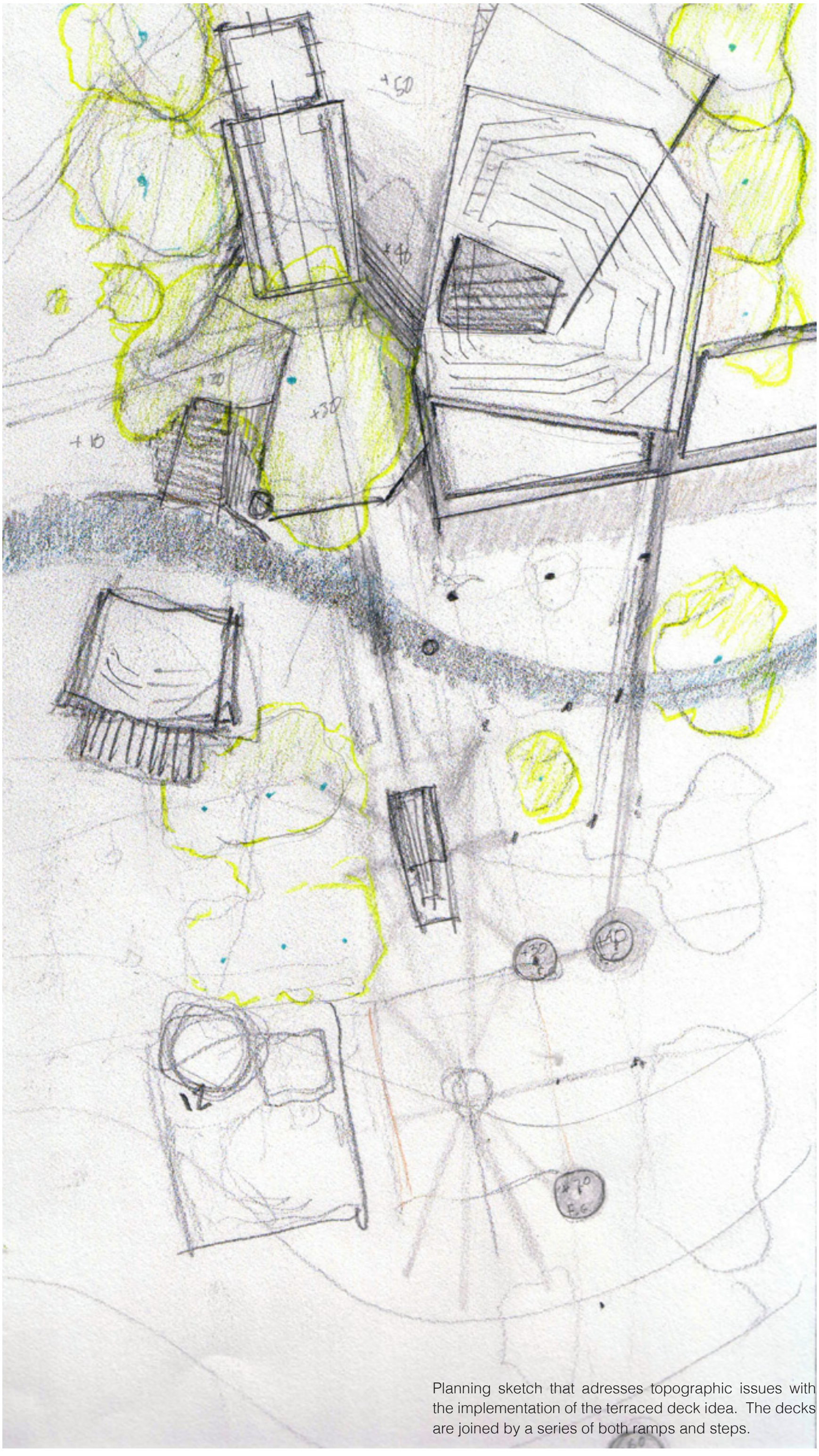



In this iteration, the main axis is rotated approximately 90 degrees. In addition, several new lines of sight are being included to help locate new programattic spaces on the site. A second tangential axis is pulled to the south from the main axis. The land between these two lines is dotted with difuse sound towers that act as performance spaces and an aural wayfinding system


Progression of the multi-axis idea.



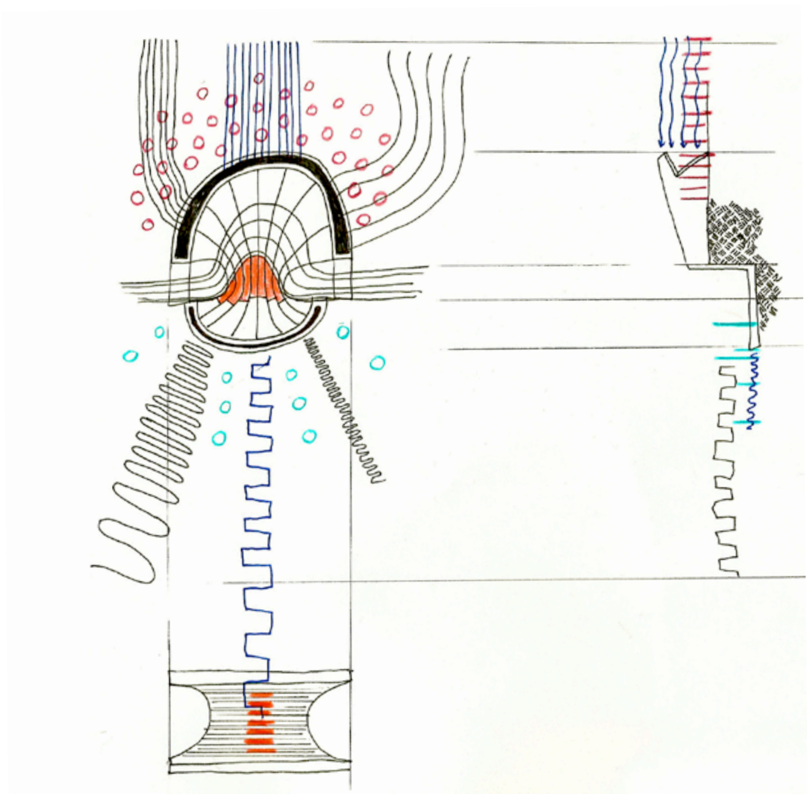
First sketch experimenting with multiple venues within the same structure. Here, the binaural auditorium is combined with the main auditorium.

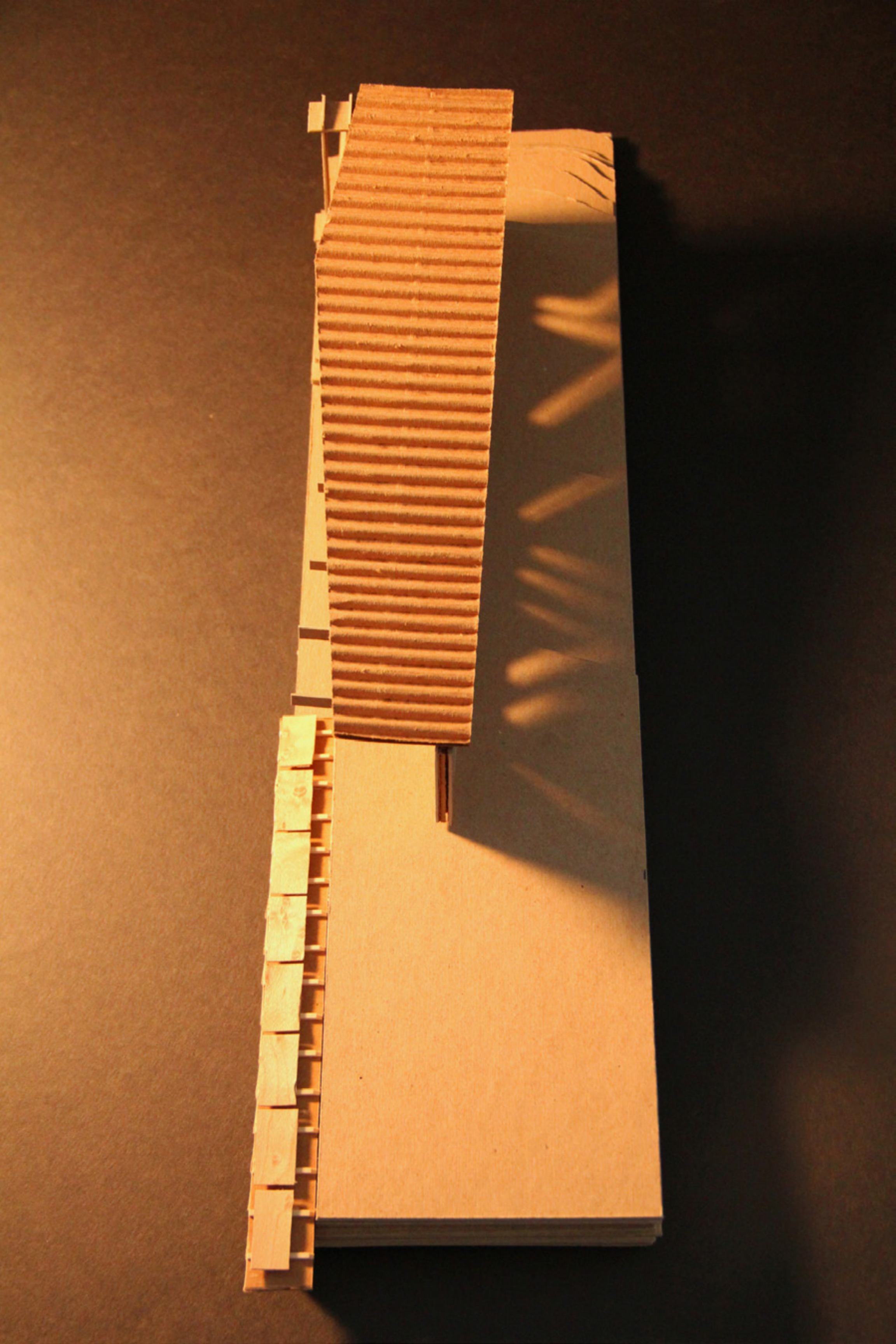


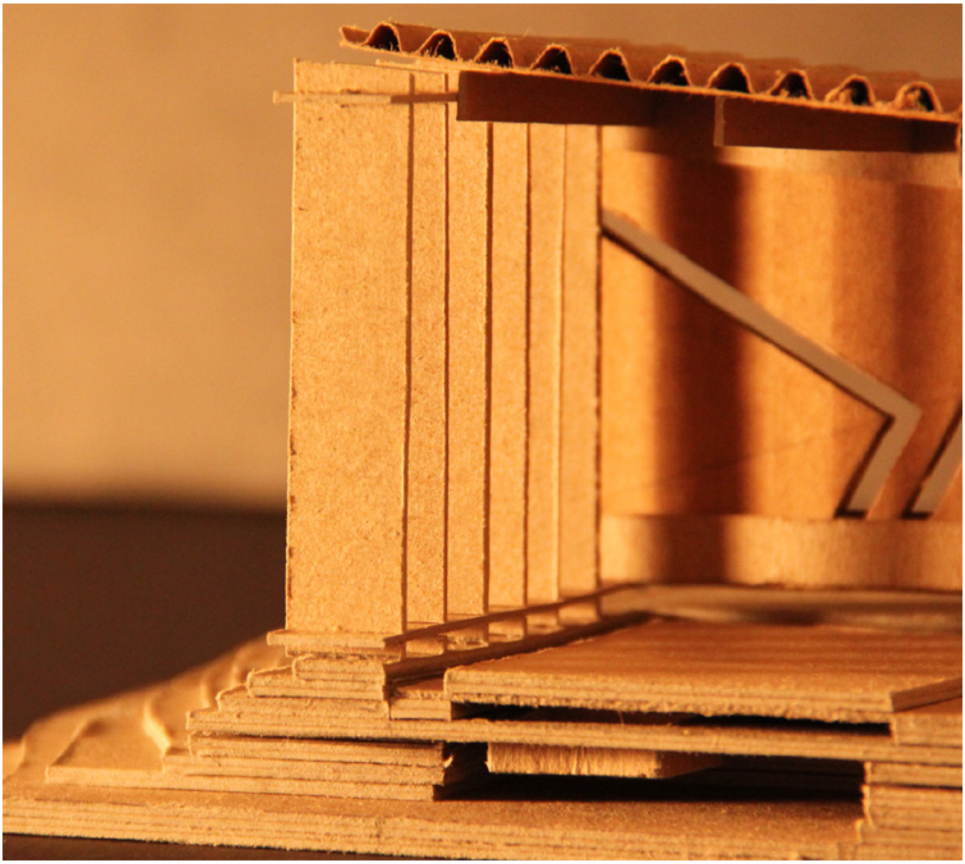

Planning sketch that adresses topographic issues with the implementation of the terraced deck idea. The decks are joined by a series of both ramps and steps.

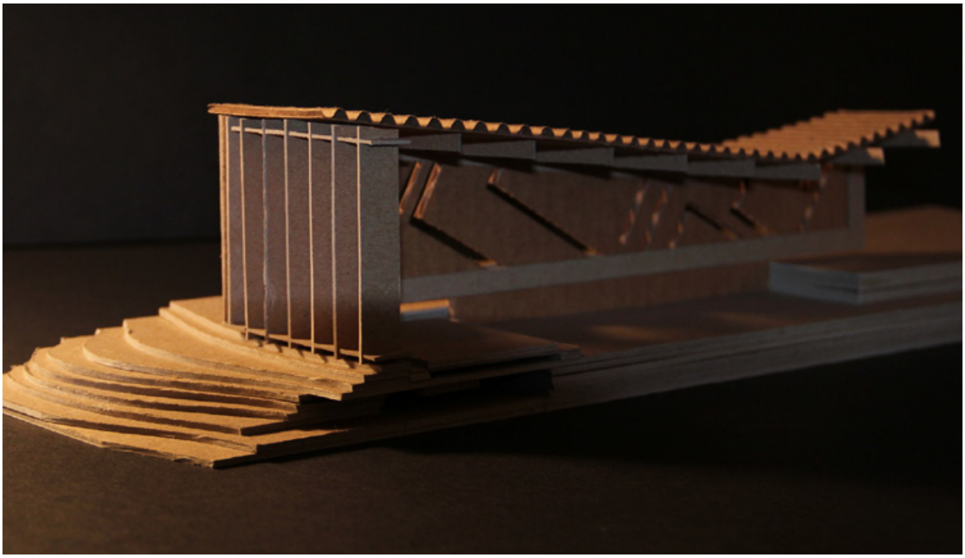
# Design Development

Organ Performance~ environmentally powered instruments



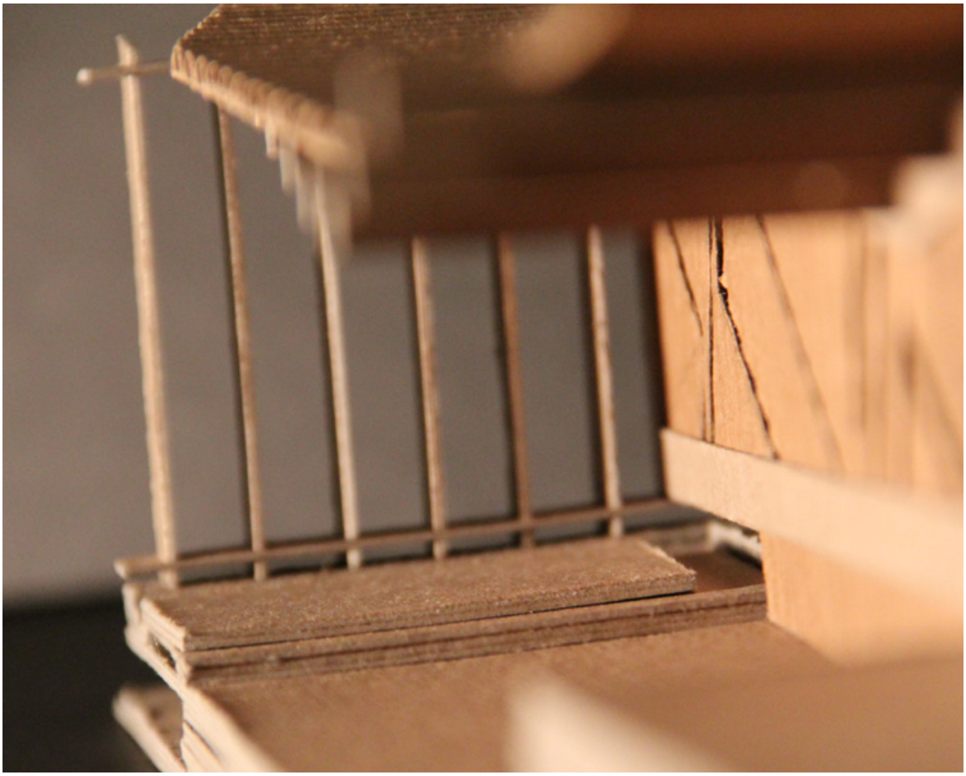


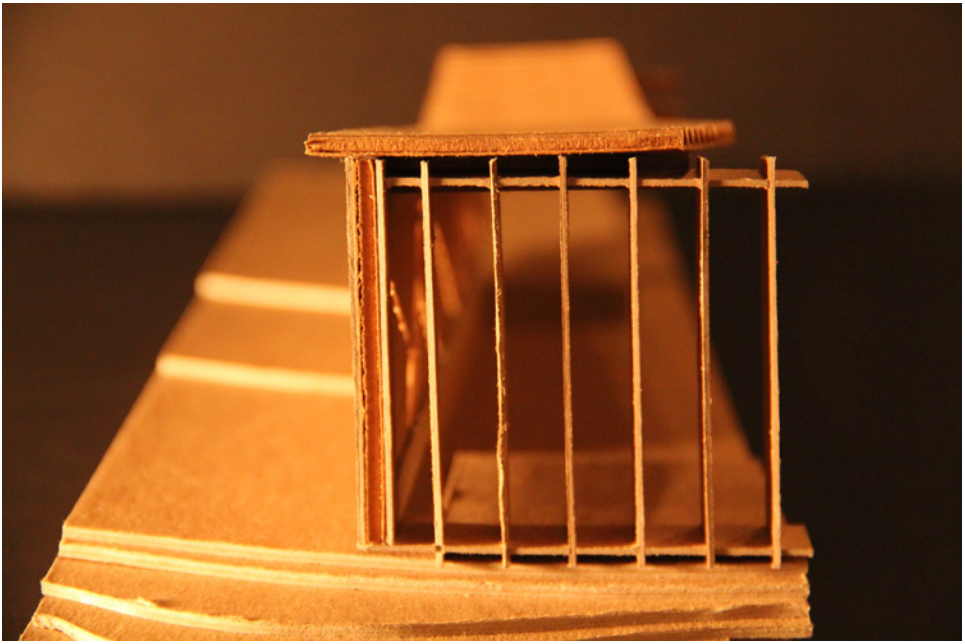




Top: Section showing the design of the water driven organ pump

Above: Lighting study showing proper sun altitude and azimuth for anearly spring morning

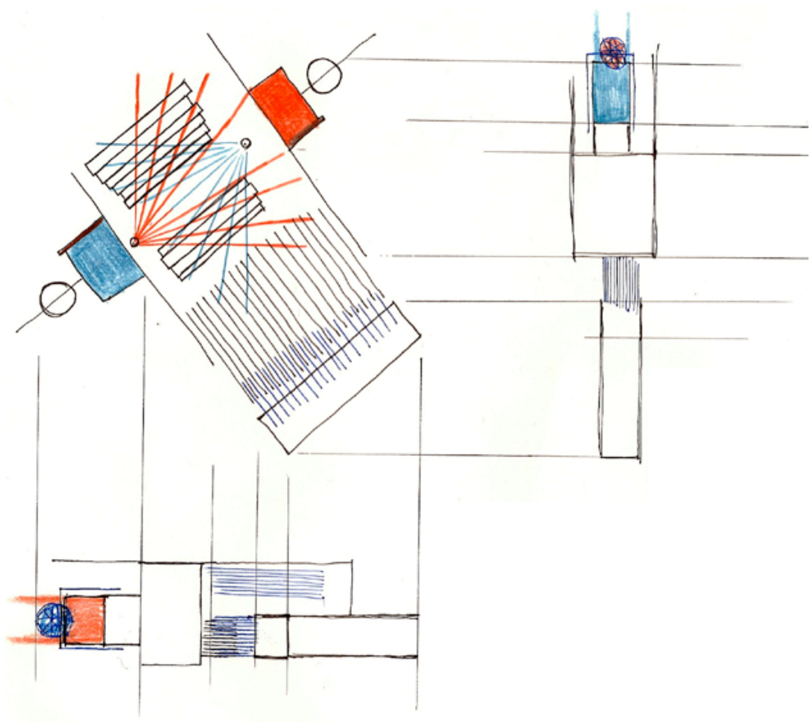


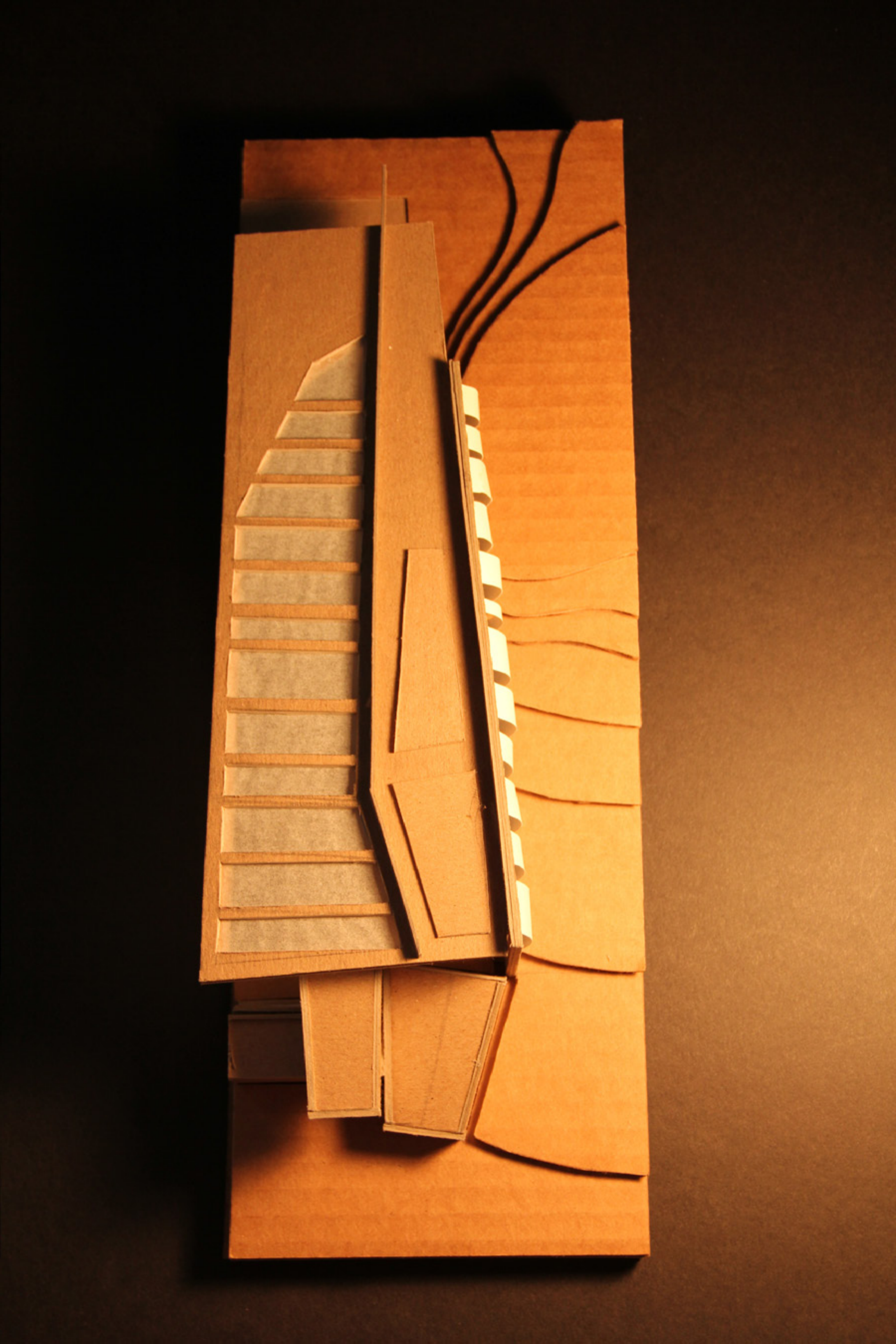


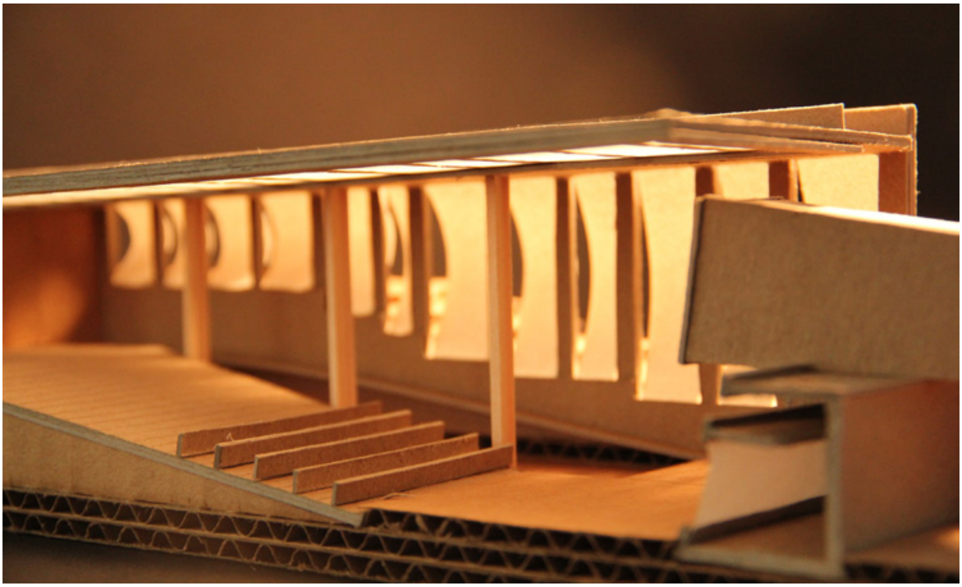
Perspective from entrance, straight through the building

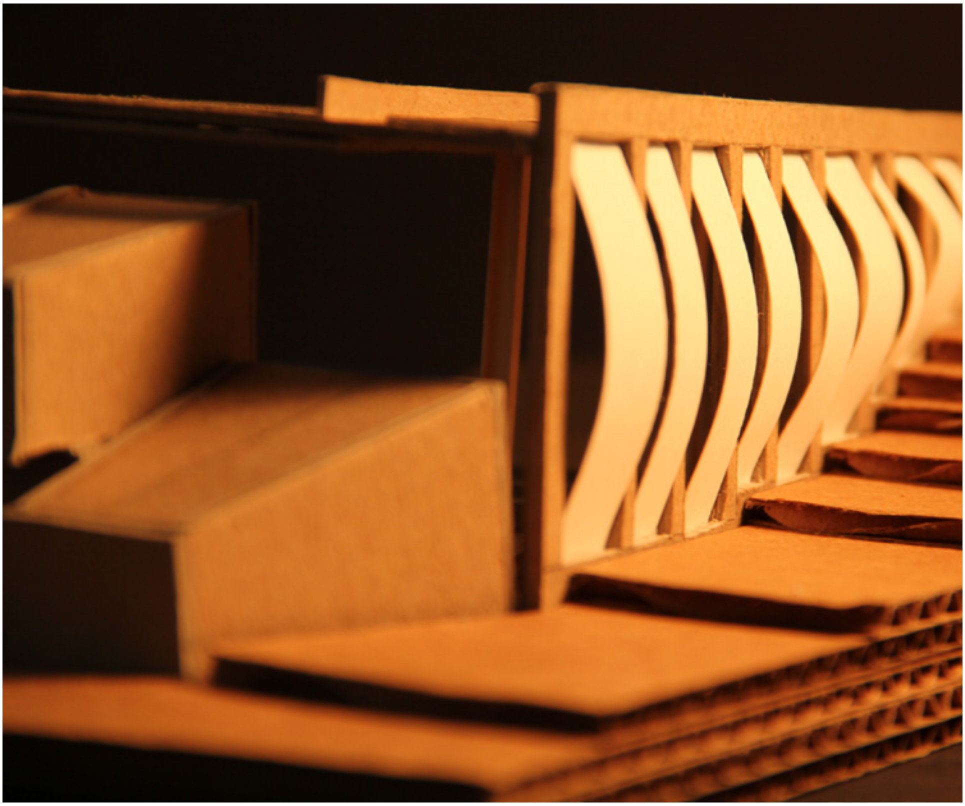
View into the auditorium from the river, looking north/north-west

# Design Development
Binaural Auditorium

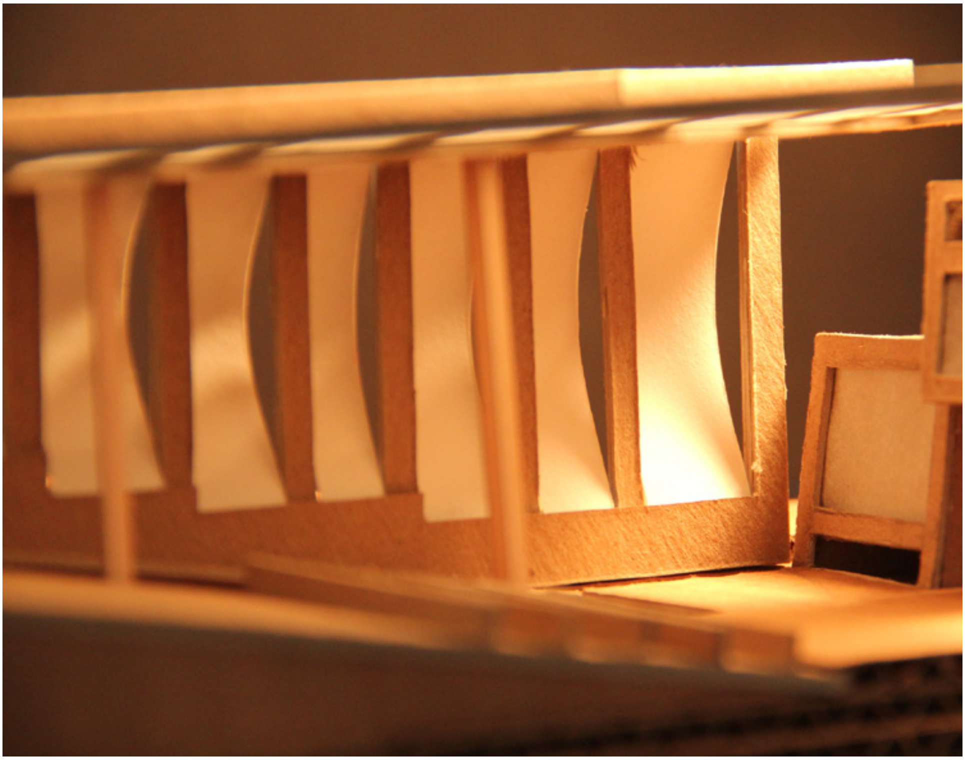






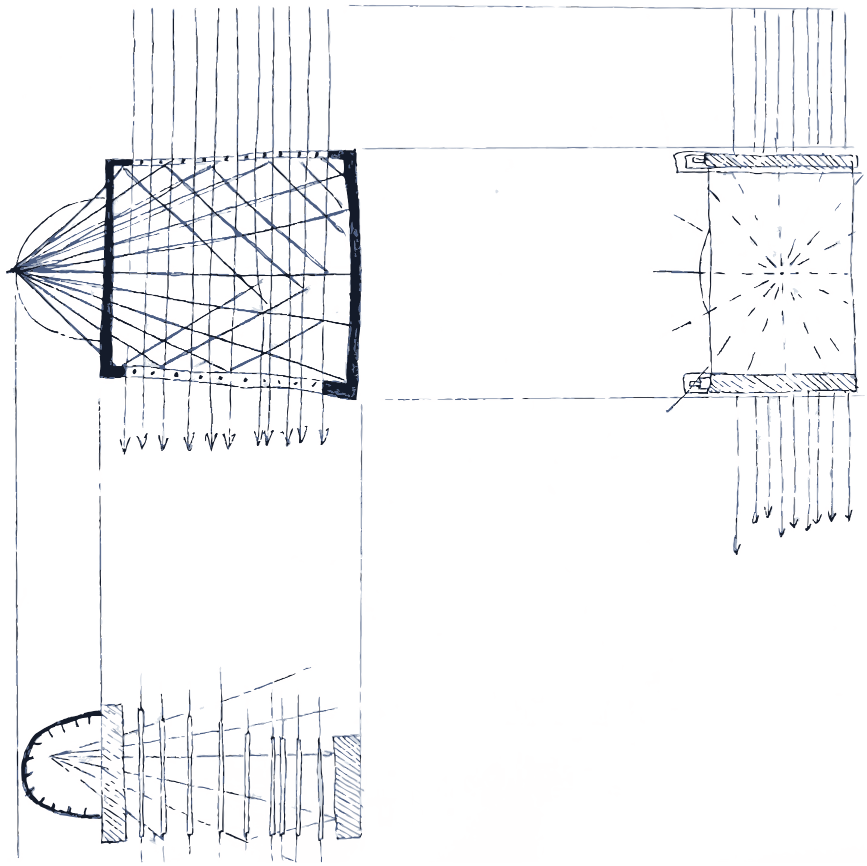


Top: section showing the construction and scale of the speakerboxes
Above: view showing how the sloped seating is incorporated into the natural grade on the site



# Design Development

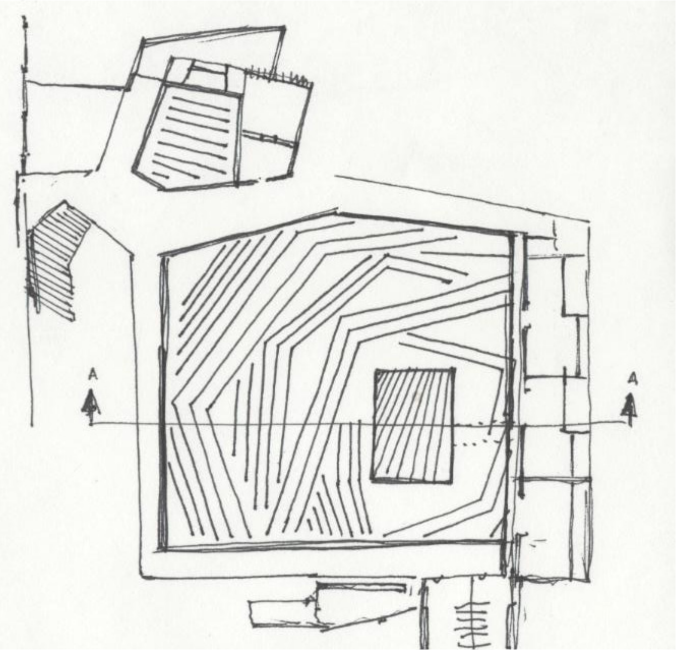
Ambient Sound Chamber

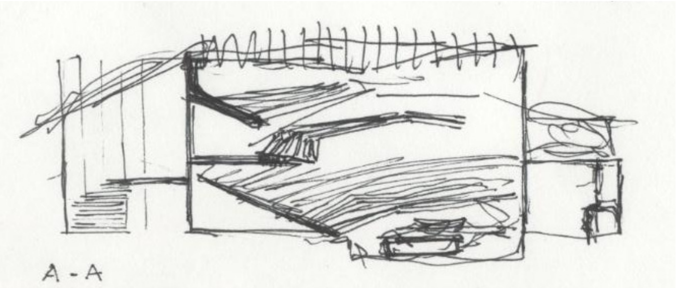


# Final Design

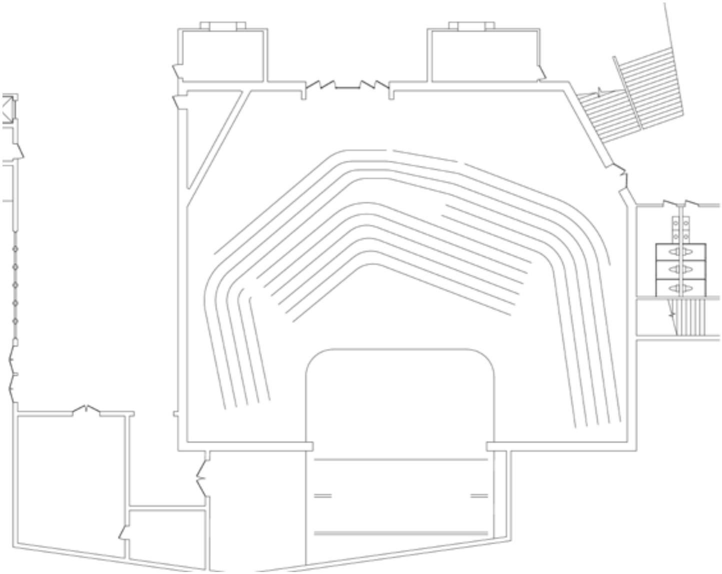
## Main Auditorium

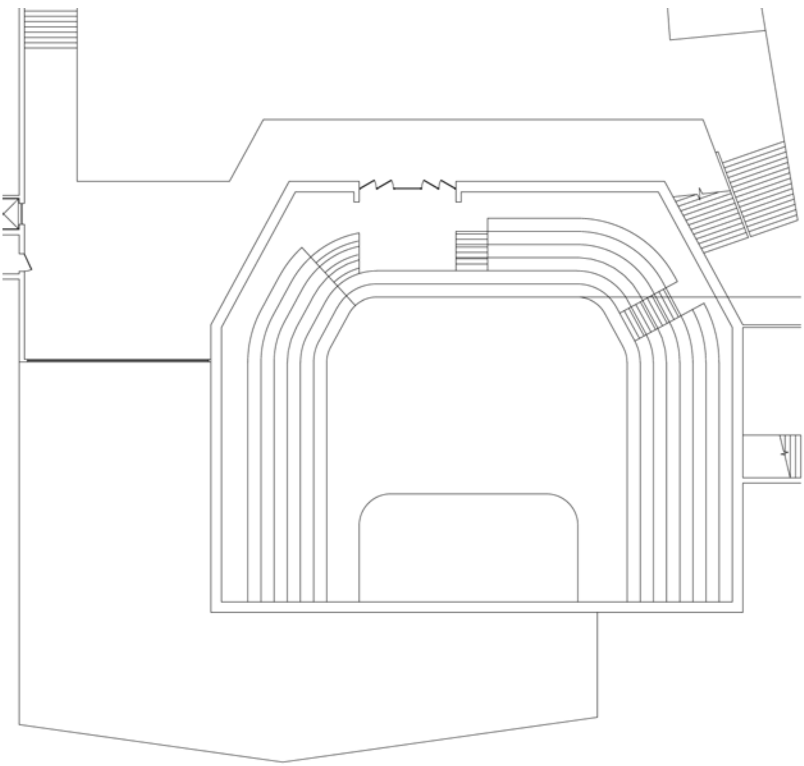
The main auditorium, as stated before, is a 700 seat auditorium. This auditorium would be the only performance space in the RBP Center for Experimental Music that does not seek to alter music through the exploitation of a specific acoustic property. Instead, it serves as a clean backdrop for musical performance of all types and focuses its enegry on enhancing the relationship between performer and listener. This space is designed in a way that allows the audience members to be positioned at an unparalleled proximity to the stage. By doing this, a more intimate relationship is formed between the audience and the musicians. This relationship is important because without it there is never a true realization of the full potential of the music. A group of musicians can perform a song indefinitely, but without the reaction and interpretation of the audience, it is merely an excercise or a rehearsal, not a concert. The seating arrangement also challenges the normal linear arrangement of seats facing the stage. Instead of straight lines of seats, arched rows of seats encircle the stage. This allows the audience to interpret the music, but also allows them to see how other audience members feel about the performance. Emotion conveyed by eyes of one can now lead to the transmission of these feelings to the entire audience, creating a more empathetic experience for everyone.



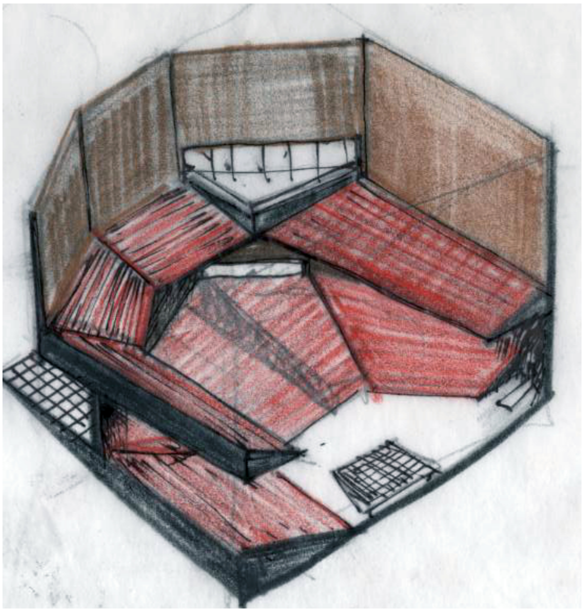



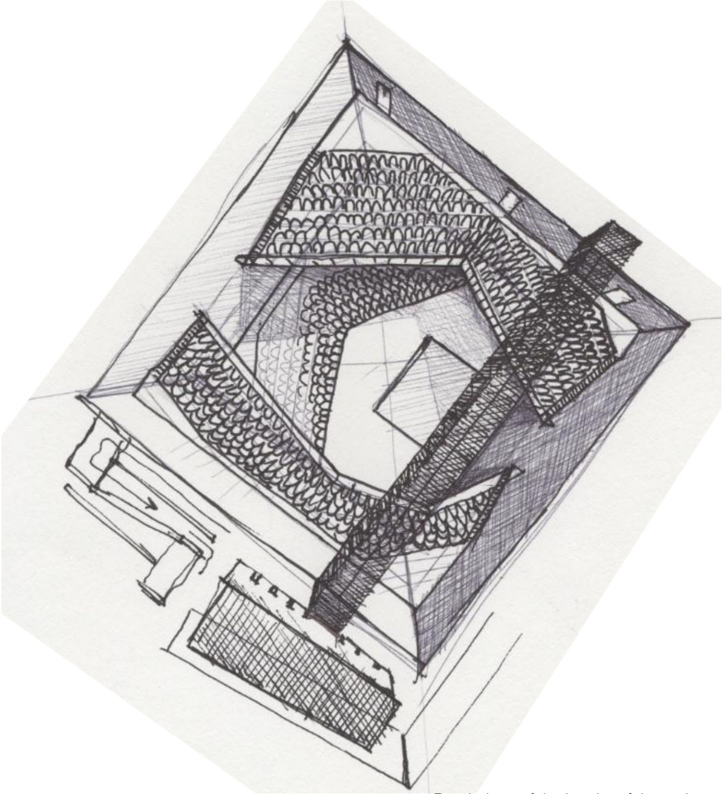

preliminary sketches showing both plan and section of the main auditorium





Final first and second floor plans of the main auditorium





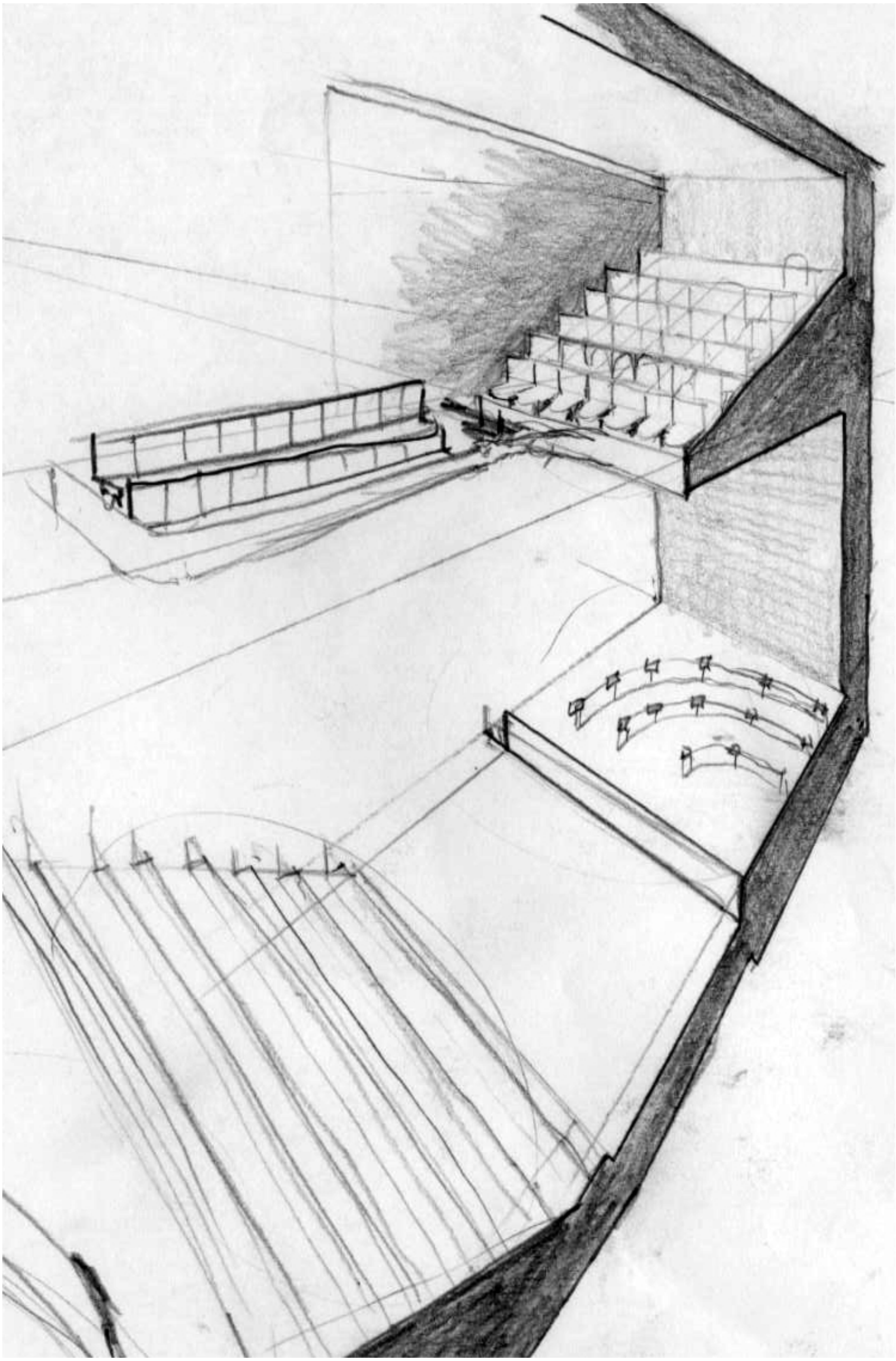
Renderings of the interior of the main auditorium showing
the unconventional seating arrangement

# Final Design

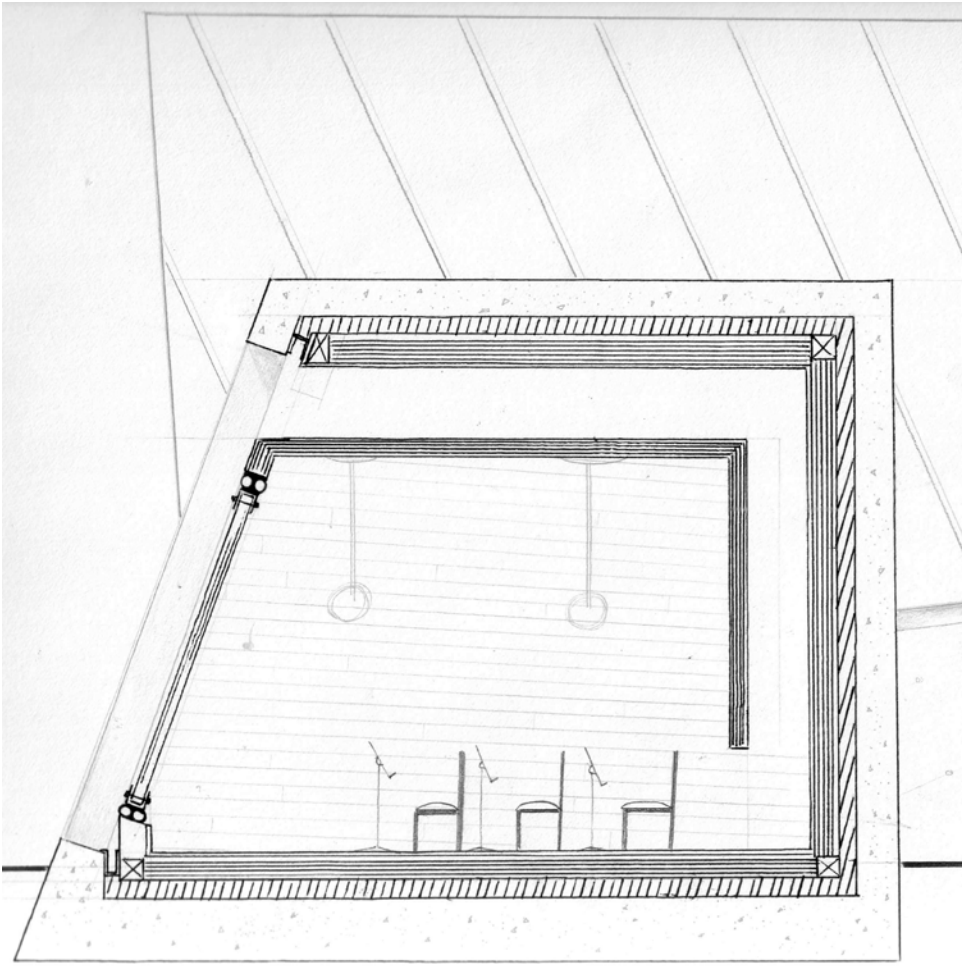
## Binaural Auditorium

The binaural auditorium is a 350 seat, single-level, performance space that uses binaural sounds to change the way that listeners hear music. Binaural literally means "using both ears" and the purpose of this space is to make both the audience and performers more aware of how each ear on the human head hears independently, but converts the signals into a composite set of sounds that can be understood more easily. Listening to two different songs simultaneously would be quite unpleasant, so a less straightforward approach had to be implemented. So instead of listening to two different songs, the performers play one song, albeit at different pitches. The slight difference in pitch will create a pusling sound in the listeners ears while the music is being performed. This pulsing can best be likened to the sound of vibrato in a musical instrument or voice.

The only way to create this effect is to change the audiences perceived pitch of half of the music. Changing percieved pitch can be achieved through a modulation in actual tonality, through the use of the doppler effect, or through the use of modulated sound amplitude or volume. Asking half of the orchestra to play slightly sharper did not seem like a viable option, becasue this meant that the musicians were responsible for the change, not the architecture as was the intention. The use of the doppler effect was also ruled out, because it would require the audience, musicians, or the air to constantly be in motion. The only option was to increase the volume of certain parts of the orchestra through an architectural intervention.



Initial sketch used to rule out ideas like the doppler effect due to the inherent inability to move the audience or performers easily during a performance



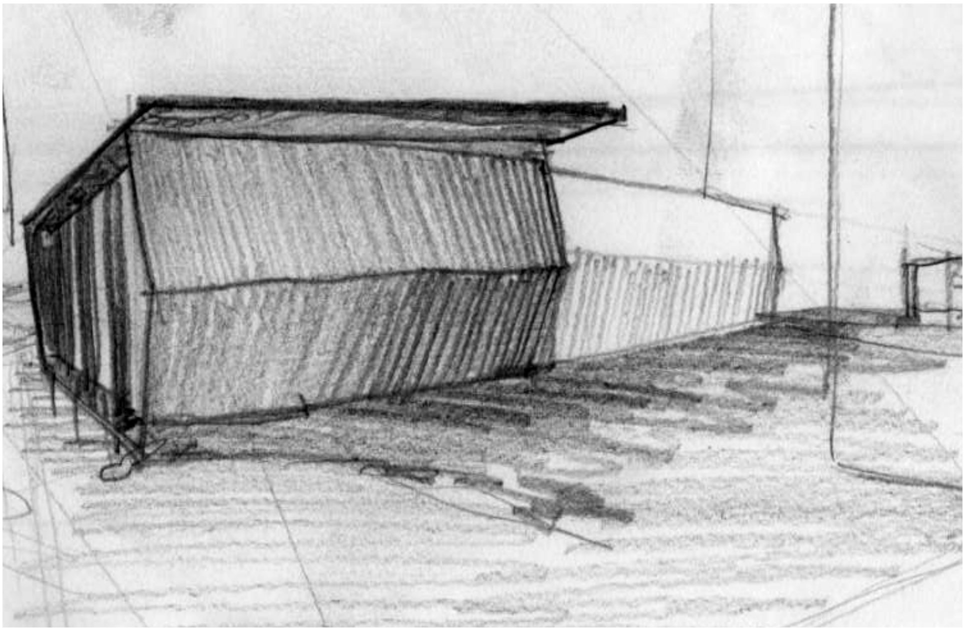
Section drawing showing the construction of a proposed speaker box. Dense hardwoods make up the majority of box construction due to their ability to reflect sound well. An extruded aluminum speaker cone is shown suspended by a rubber gasket that accomodates excursion and incursion. The entire box is then set in an insulated concrete platform to prevent rattling due to mechanical resonance.

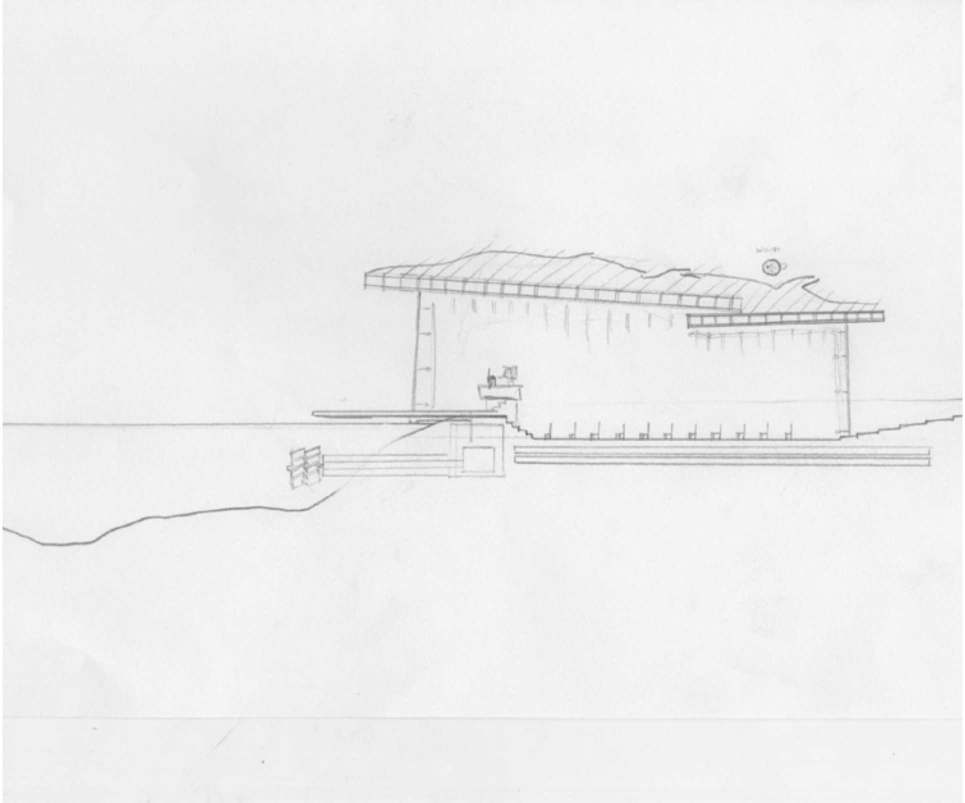
The design of this performance venue calls for a series of large-scale "speakerboxes" to be placed on stage. These boxes are directly responsible for the amplification of certain parts of the performing group and in turn responsible for the pulsation heard by the audience members. Speaker boxes are used to project and amplify the sound created by an instrument (the speaker cone). My design increases the scale of a speaker box to the point where a small number of musicians can be placed inside and act as the driving force for the speaker cone. To further the amplification abilities of a speakerbox a folded, ported, speaker box can be used. Musicians inside the box play music and generate a pressure wave (sound), this pressure wave pushes the speaker cone forward toward the audience at a specific frequency depending on the note/notes being played. The outward movement of the speaker cone is called excursion and the following inward movement, incursion. By properly sizing the speaker box, one can align the pressure wave caused by the excursion of the cone with the pressure wave that travels out of the port due to incursion. This alignment effectively doubles the power of the pressure wave and increases the volume.

# Final Design

## Organ Performance

The organ performance building sits directly on the Clinton River on the axis created by the main building and the residence. It has a small footprint, and can accomodate aproximately 100 audience members. The pew style seating can be raised and lowered from the floor to allow traditional seated performances, or to provide a dance hall like atmosphere. This building attempts to blur the line between structure and musician. This is accomplished through the buildings design. It includes two different types of organs that are sounded by the environment around the building. The first of these is a set of water-powered organ pipes that are placed directly beneath the performance stage. Water from the clinton river is diverted under the building via a man-made channel. This water forces air trapped below the building through a series of pipes similar to those found in the Sea Organ in Croatia. The second environmentally powered instrument is a rank of pipes placed on the roof of the building. These pipes are sounded when wind blows across the openings. Wind speeds of 8 m.p.h. are commonplace thanks to the positioning of the building near the river, and the pipes have been sized so that they can all be operated at this wind speed. Their pan-pipe like design also allows all of these pipes to be overblown with increasing wind speeds. This means that as the wind blows harder, the pipes sound at progressively higher pitches. Together these two nature-powered organs aurally activate both the organ building and the entirety of the site throughout the day. The two organs also dictate what key the music played inside must be in, in order for the music not to be dissonant.



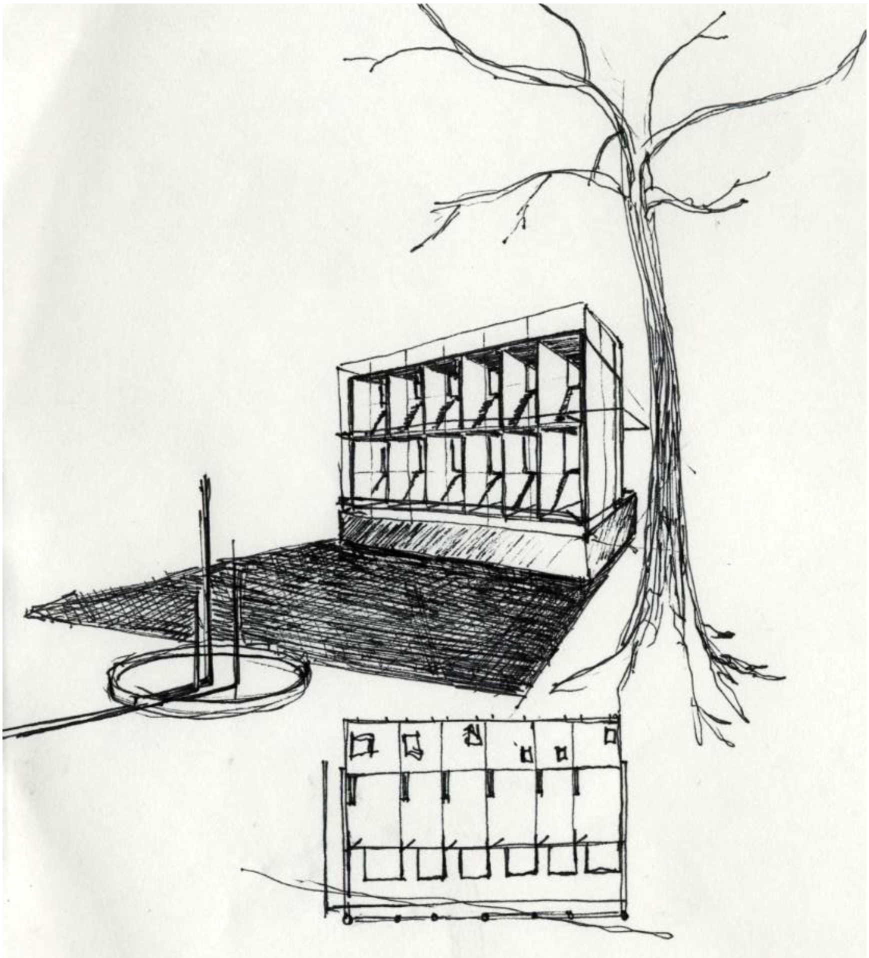


Top: exterior sketch of the facade condition of the organ performance building
Above: section drawing showing the interworkings of the organ system

# Final Design

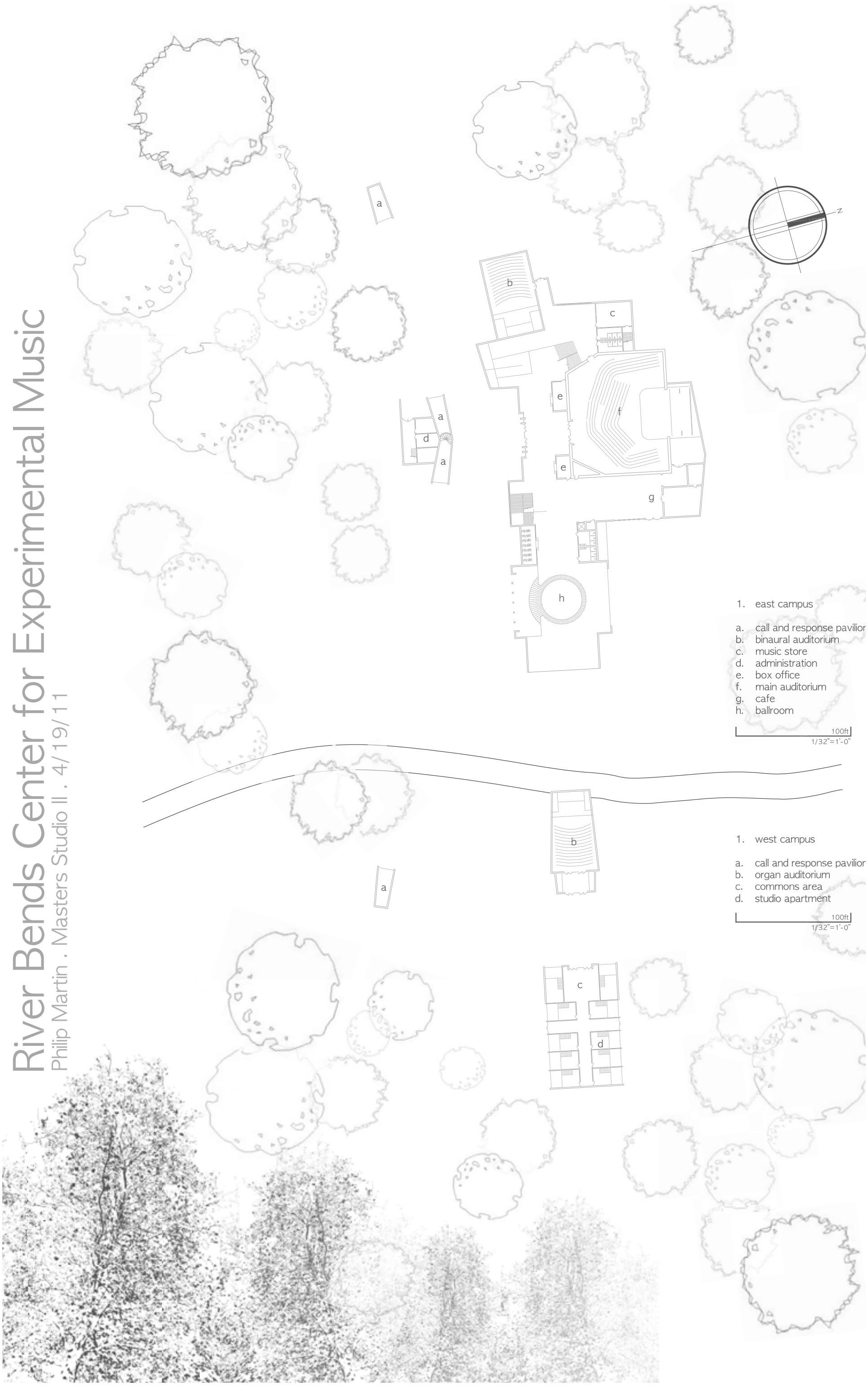
## Residence

This building is where composers and musicians in residence will live during their stay at the center. This building is located furthest from the entrance to the center so that a certain level of privacy can be achieved. The residential component to the RBP Center for Experimental Music consists of a basic building with eight loft apartments and a communal space. Each apartment is two stories tall. The lower story has a small kitchenette and living space, while the upstairs is a dedicated sleeping quarters with access to a communal roof garden. Despite the fact that this is not a performance venue, it is still an integral component to the center. It provides the residents with a comfortable place to collaborate and practice without the pressure of being on stage with an audience.



Exterior sketch of the residential component showing the two story facade and shading solutions.

# Final Design
Campus


River Bends Center for Experimental Music
Philip Martin . Masters Studio II . 4/19/11
1. east campus
a. call and response pavilior
b. binaural auditorium
c. music store
d. administration
e. box office
f. main auditorium
g. cafe
h. ballroom
100ft
1/32"=1'-0"
1. west campus
a. call and response pavilior
b. organ auditorium
c. commons area
d. studio apartment
100ft
1/32"=1'-0"
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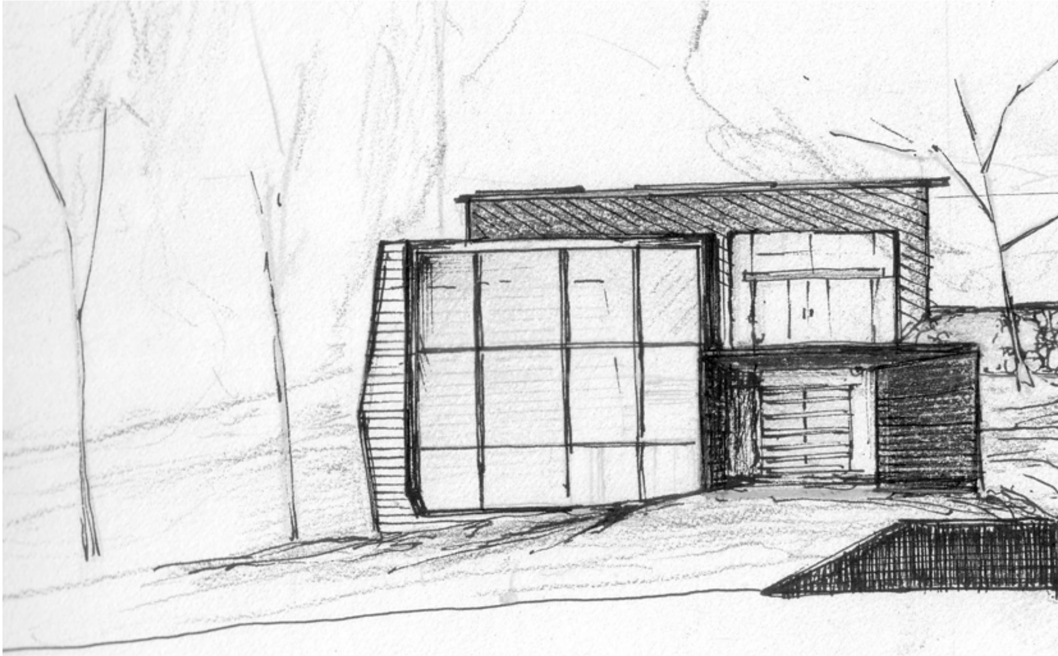
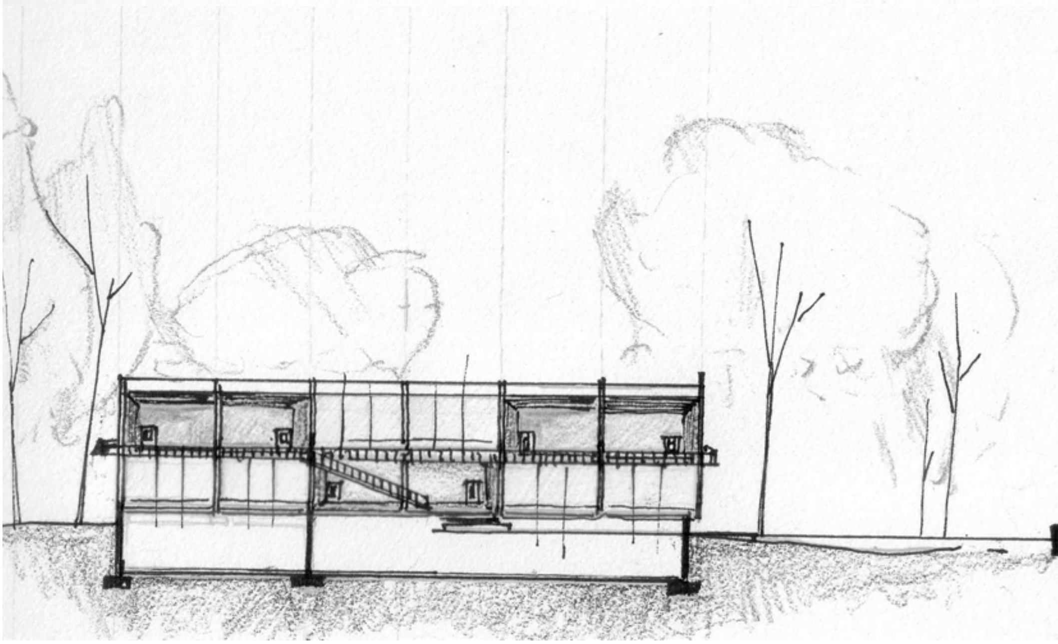
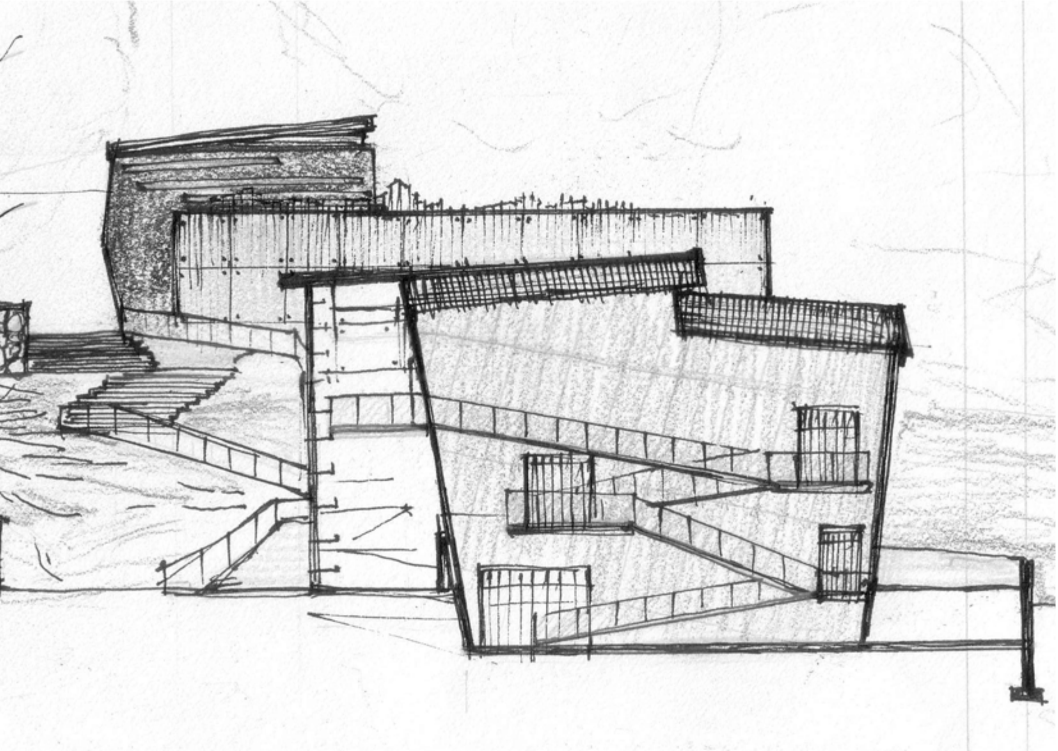
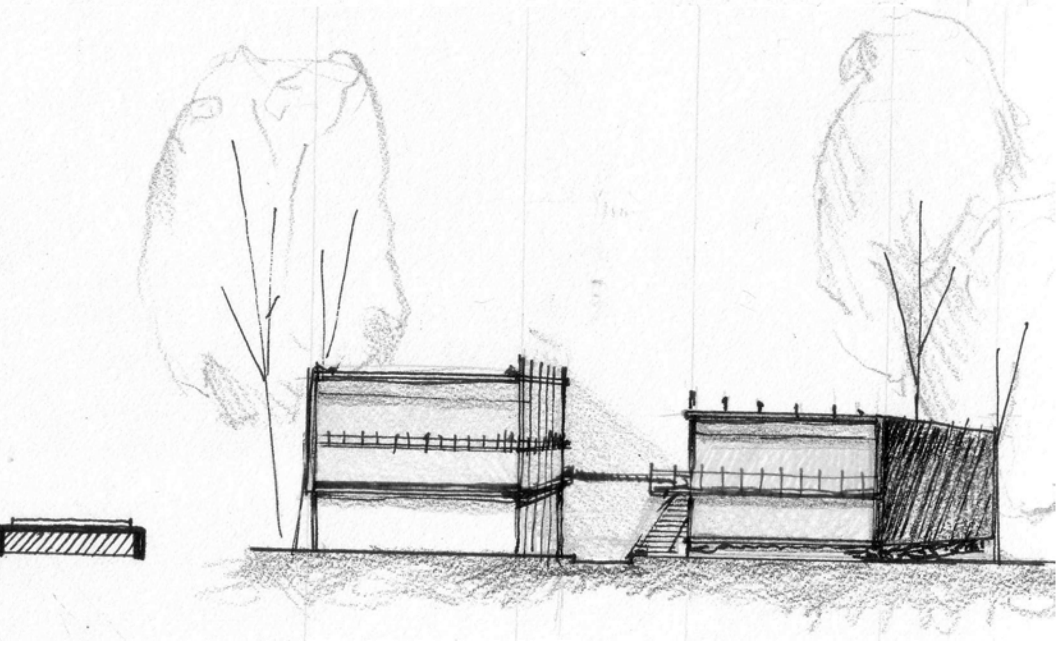
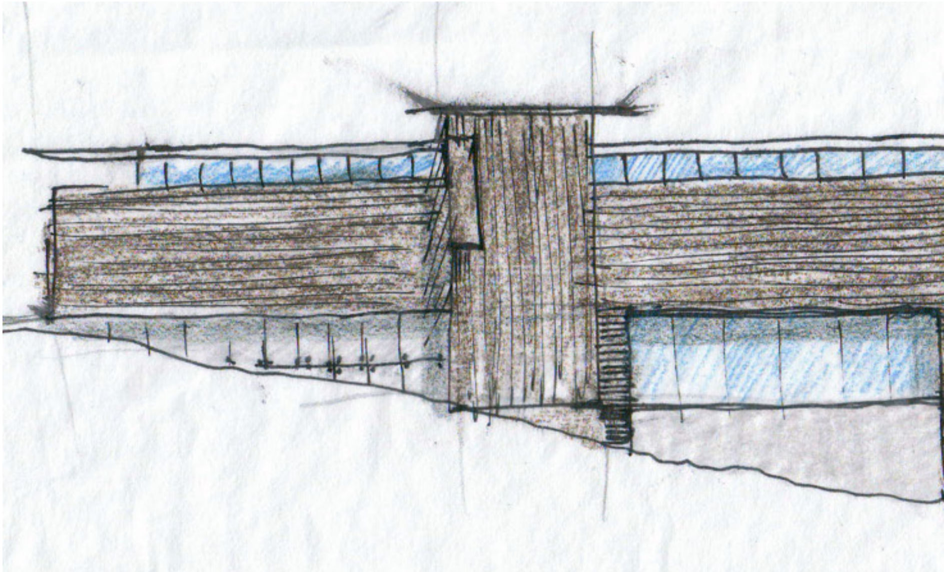


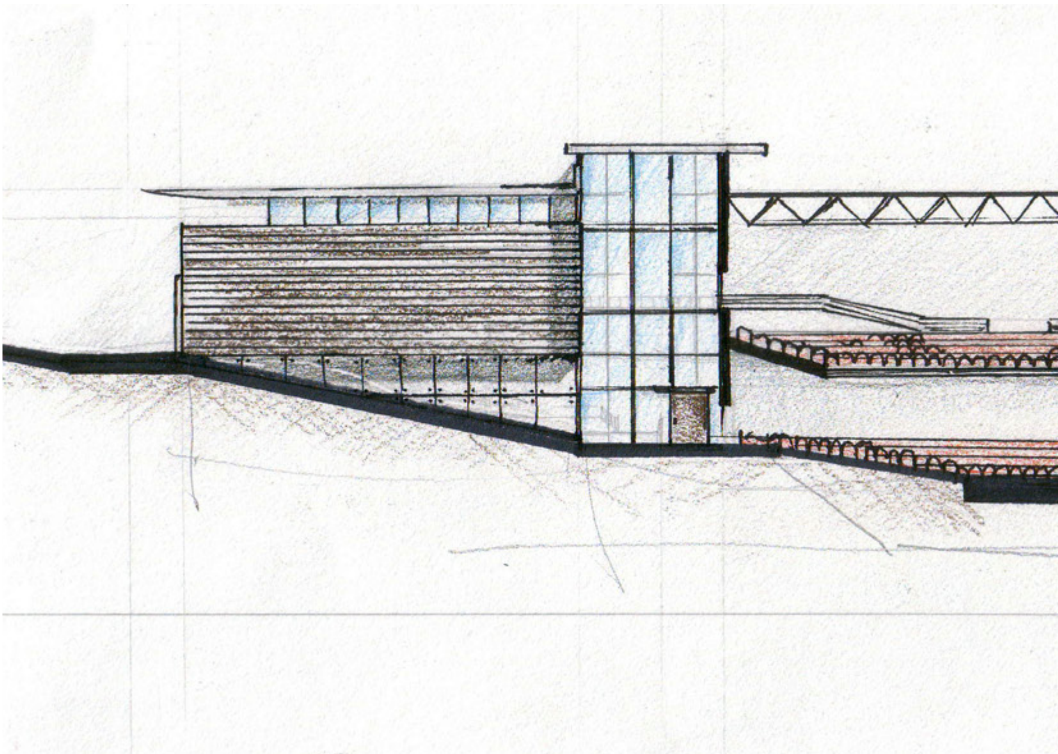


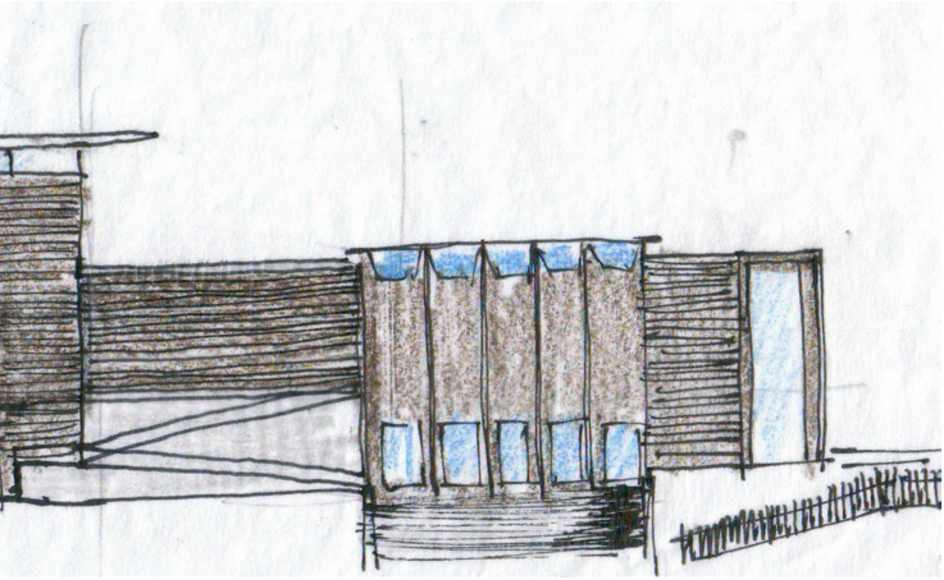


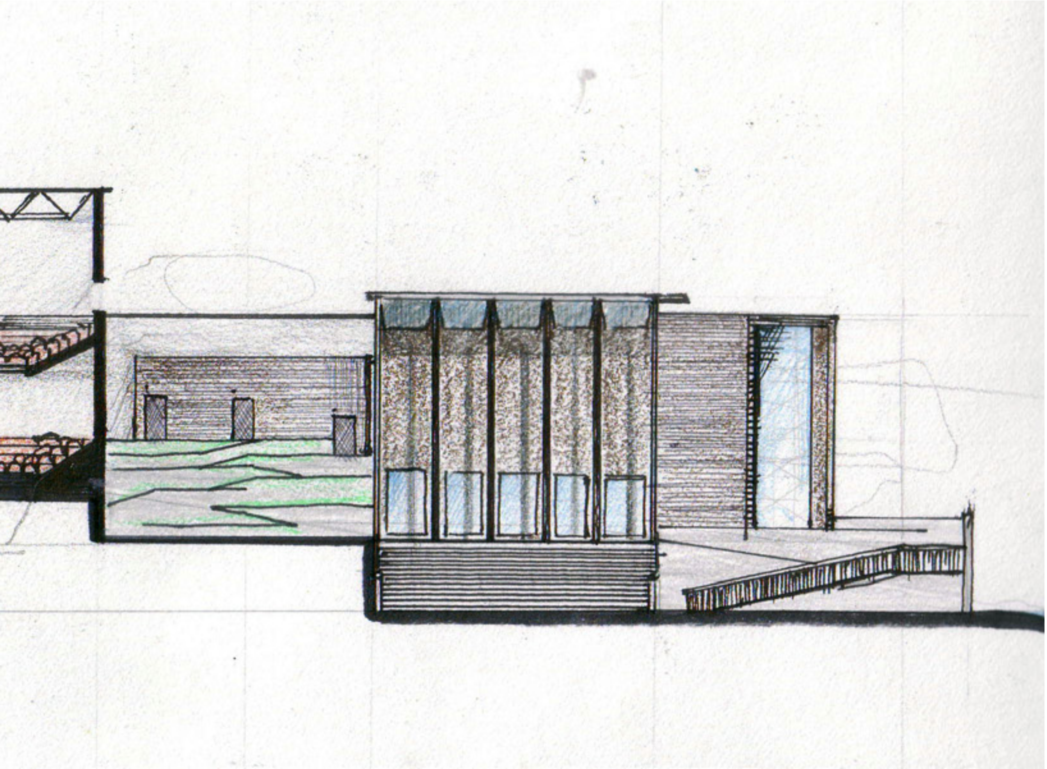


Top: Section/elevation showing a view of the campus looking westward, up the slope
Above: Section sketch showing the residential component of the center









Southern sections/elevations of the main building showing the facade conditions and materiality. Also shown is the relationship between the split level design

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