ABSTRACT

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Directed By: Ronit Eisenbach, RA
Visiting Associate Professor
School of Architecture, Planning and Preservation

The human experience of sound is an essential element to our understanding of the built environment. However, sound has played a minimal aspect in the construction of meaning in contemporary architecture, and is given little attention in architectural education as a source for design inspiration. This thesis investigates sound as an architectural, cultural and environmental phenomenon through the design of a small listening pavilion.

This thesis has two goals:

1) To provide an exploration into the potentials of sound as a source for design inspiration and architectural meaning.
2) To provide a space that heightens one's awareness of sound, both in the environment, and within the space itself.

SOUND, AWARENESS, AND PLACE:
ARCHITECTURE FROM AN AURAL PERSPECTIVE

By

John W. Bryant

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Advisory Committee:

Visiting Associate Professor Ronit Eisenbach,RA, Chair
Associate Professor Brian Kelly, AIA
Assistant Professor Isaac Williams

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Introduction

The philosophical alienation of the body from the mind has resulted in the absence of embodied experience from almost all contemporary theories of meaning in architecture. The overemphasis on signification and reference in architectural theory has led to a construal of meaning as an entirely conceptual phenomenon… The body, if it figures into architectural theory at all, is often reduced to an aggregate of needs and constraints which are to be accommodated by methods of design grounded in behavioral and ergonomic analysis. Within this framework of thought, the body and its experience do not participate in the constitution and realization of architectural meaning.

Tadao Ando
The Emotionally Made Architectural Spaces of Tadao Ando

This thesis began as a desire to investigate multi-sensory aspects of design. Whereas architectural education and practice are typically dominated by the visual realm, this project seeks an exploration into design that is focused on engaging a more complete sensory experience. Sound offers a rich medium for exploration: it is an essential element of how we understand and relate to space, and its properties and behavior are intimately linked to the physical experience of an environment.

Part 1, *Sound, Architecturally Considered,* provides a background into the historical, physical, technical and perceptual aspects of sound in architecture; it does not attempt to provide an exhaustive study of any particular aspect, but rather to provide an overview of the main issues that will be dealt with in this thesis.

Parts 2 through 4 detail the program, precedents and site of the Listening Box. Lastly, Part 5 illustrates three initial design strategies for the project.

1: Sound, Architecturally Considered

1.1 A Brief History of Sound in Architecture

In oral and pre-literate societies, sound traditionally played a primary role in the generation of architectural spaces. This can be seen in the numerous whispering galleries found in ancient architecture, as well as the “perfect clarity of the Greek amphitheatres where a speaker, standing at a focal point created by the surrounding walls, is heard distinctly by all members of the audience.” (Bill Viola in Sheridan, p.3) In *The Ten Books on Architecture*, Vitruvius devotes as much text to “sound, music and acoustics as he did to site design, materials and color; a level of attention unheard of in current architectural writing.” (Sheridan, p.3)

Vitruvius deals with sound in both “proportional” and “actual” modes. The “proportional” mode “relates the spatio-visual experience of width, height, and depth to the tonal experience of harmonic musical notes,” which provides a “basis for linking the two types of experience and a practical guide for sizing the various parts of building.” (Sheridan, p.3) This concept is arguably the foundation for the concept of architecture as “frozen music.” The “actual” mode of Vitruvian theory “relays specific advice, derived from experience and experimentation, on how sound behaves under certain physical conditions", including the topics of propagation, reflection and sympathetic resonance: a clear forerunner for today's modern acoustic engineering practices. (Sheridan, p.3)

Sheridan and VanLengen illustrate significant differences between the architectural environments of oral and pre-literate societies, and that of literate societies. In oral societies, communication and the transmission of cultural ideas and practices took place "face to face, with the rhythms and melodies of performing bards weaving the extended story lines of epic poems into coherent, communal events for their audiences." (Michael Hobart, in Sheridan, p.3) In societies where this type of communication was the norm:

> Building forms tended to follow dynamic lines of force, rather than the visual/orthogonal lines of organized perspective. Grids and cubic forms did not spontaneously develop in the context, whereas circular, triangular and conical shapes existed in abundance… this pre-literate architecture rarely emerged from its surrounding context, natural or manmade, to stand alone as an independent object 'in space' obeisant to perspectival logic and rationalization. (Sheridan, p. 3)

Sheridan and VanLengen contrast this idea with that of Hellenic architecture, whose development was visually constructed after the invention of the Greek phonetic alphabet. The difference in resulting spaces can be seen in figures 1 and 2. The spatial arrangement of the Citadel at Mycenae is visually disorganized from a modern perspective, but its circular forms and nested spaces are an outgrowth of sacred space in an oral context. The Pisistratid sanctuary at Eleusis (c. 500 BC) on the other hand, demonstrates a more contemporary manifestation of spatial arrangements as a result of sacred space in the context of literacy (Sheridan, p. 4).

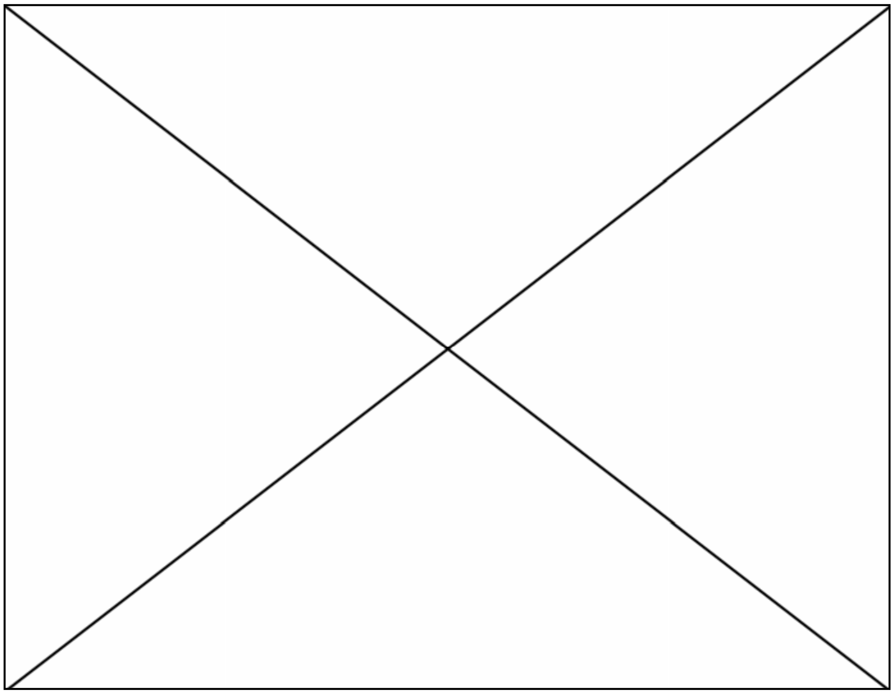


Figure 1: Citadel at Mycenae c. 1250 BC

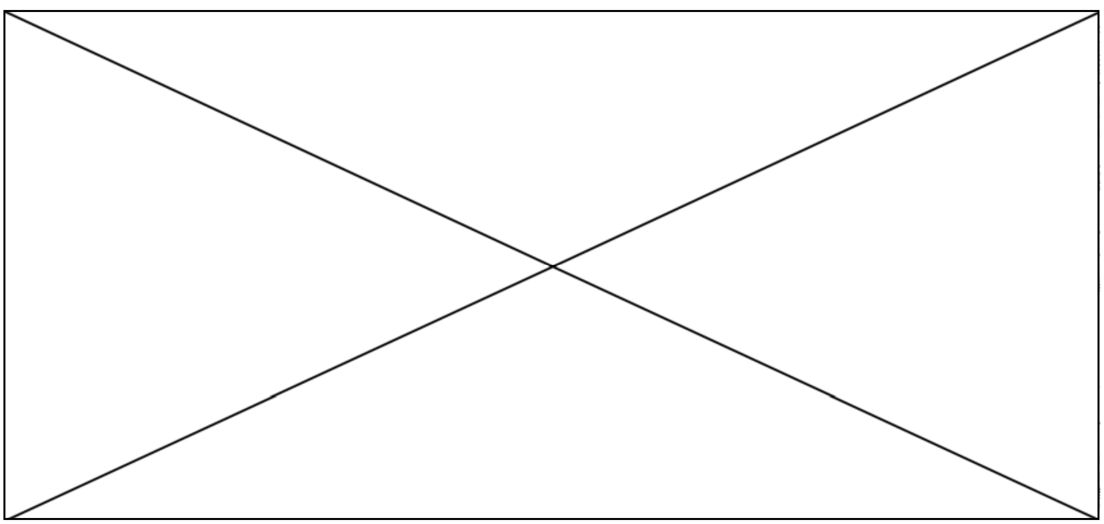


Figure 2: Pisistratid sanctuary at Eleusis c.500 BC

Gothic cathedrals typically come to mind when one thinks of a rich acoustical environment. Sheridan and VanLengen speculate that the richness of the gothic architectural tradition, both acoustically and visually, was a result of the mixing of oral and written traditions. During the rise of Gothic architecture in the 1130's, Northern and Western Europe were comprised of many "insular oral cultures." As these oral cultures were exposed to the literate influences of Latin from the Church, as well written forms of regional dialects:

> The strong aural sensitivity of the previous centuries, similar in ways to that of pre-literate Greece, was carried into the architecture of the church and cathedral even as their 'coherence and inner meaning' relied more and more on the written word. While the acropolis constituted a kind of spatial displacement of the aural/epic past of Greece into visual space, the Abbeys and Cathedrals that ranged across Europe from Le Thoronet in Southern France to Santa Croce in Florence formed an array of sacred resonators for the airing of the Christian word. (Sheridan, p.5)

By the time of the Renaissance, sound in architecture primarily fell within Vitruvian's definition of a "proportional" mode. Leon Battista Alberti saw a fundamental unity between music and geometry. As he stated, "music is geometry fashioned into sound. In music the very same harmonies are audible which inform the geometry of the building." Palladio has provided perhaps the most well-known application of this principle, utilizing "harmonic proportions in plan, section and elevation." (Sheridan, p.6)

This period in history also saw the development of Baroque music in the West, consisting of complex harmonic compositions and diverse ensembles of string, woodwind and percussion instruments. Whereas in the past, the acoustics of architectural spaces worked in tandem with simple musical forms such as Gregorian chant, the development of Baroque music began to put pressure on the acoustic forms of Renaissance churches. As Sheridan and VanLengen note:

> Where Gothic architecture had effected a harmonic rationalization of music, Renaissance music, inversely, initiated a gradual increase in sonic tension between new sounds people were learning to hear, and the architecture of the church. This strain… would eventually lead to a divergence between Classical music and the sacred architecture that so influenced its roots. Music, in effect, outpaced its architectural context and required a new kind of space to be adequately heard. (Sheridan, p. 6)

The result of this move towards complex, orchestral music was the development of the secular concert hall, a "remarkably consistent typology to this day." (Sheridan, p.6) The goals of the concert hall were to "frame and support and unfettered and convincing representation of music." Early concert halls took on simple, rectangular forms, but with time these evolved into fan-shaped halls that allowed the audience to be closer to the musicians. As Sheridan notes, "the history of concert hall design is, in fact, the story of this struggle to create an architecture that has a condensed acoustic envelope within a large, expansive space." (Sheridan, p. 7)

It is generally recognized that many of the great concert halls were designed prior to the advent of acoustics as a science. The development of modern acoustics "grew out of a divergence between aural requirements and a particular building type: this time in the context of American academia." In 1895, Wallace Clement Sabine, an assistant professor in the Harvard Applied Physics Department, researched the problem of a lecture hall that, on paper worked fine, but in practice was an acoustic failure. Through a series of experiments and observations, he "discovered the inverse relationship between the amount of acoustically absorptive material in a space and its reverberation time." (Sheridan p. 7) Sabine went on to develop a more complete theory of architectural acoustics, a principle application of which addressed the problem of reverberation in a room:

> Sound waves took too long to dissipate in the room such that adjacent spoken syllables would overlap and lose definition. Sabine reduced reverberation time by introducing sound absorbing materials, 'acoustical cushions' into the hall. (Sheridan, p.7)

Sabine's developments in acoustical science provide a starting point for a discussion of sound in modern architecture. As exemplified by buildings of the International Style and their progeny, the role of sound within contemporary architecture has typically been addressed in remedial fashion. Glass, concrete and steel surfaces have created environments of "infinitely reflecting internally mirrored spaces." (Sheridan, p. 7) It then becomes the role of the acoustician to attempt to fix the underlying sonic flaws that make these buildings non-function aural environments.

The pursuits of image in architecture, and the hegemony of vision in contemporary society, have trumped any notion of sound as generator of meaningful architectural spaces in contemporary architecture. It is an underlying principle of this thesis that sound can, and should, be an essential artistic and humanistic element within the discourse of contemporary architectural design.

1.2 Fundamentals of Sound

Sound is defined as a pressure wave in an elastic medium. When unrestricted, it spreads from its source outward in all directions, and diminishes in intensity as the square of the distance from the source. It travels at approximately 1130 feet per second in air, and moves faster as the density of the medium increases (for instance, in wood, plaster, concrete and steel). (Burris-Meyer, p7) When a sound wave in the air hits a surface, part of the energy is transmitted, part reflected, and part absorbed in the material. The human perception of sound occurs within the acoustic environment: this consists of the sound source that causes the vibration, the path of transmission through a medium, and the receiver. The quality of sound at the receiver is a function of each of the three parts.

The vibrations from the sound source cause particles in a medium, such as air or concrete, to vibrate about their equilibrium positions within the medium. Adjacent particles, in turn, receive momentum from these collisions, pass it on to other particles, and thus propagate the sound wave. For sound to be transmitted through a medium, it must possess both elasticity and inertia. The particles must be able to move, but also return to their original position after the vibrations have ended. (Grueneisen, p. 45)

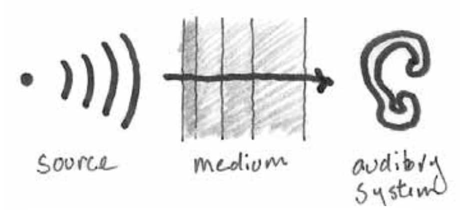


Figure 3: Transmission of sound.

A sound source generally falls into one of two categories: desirable sound (e.g. music, speech, rustling leaves); or undesirable noise (e.g. traffic, machinery). (Grueneisen, p. 45) "Desirable" sound is the result of *periodic* sound waves: regularly repeated patterns of oscillations, the most simple of which is a sine wave representing a pure tone. Periodic waves usually consist of complex combinations of frequencies and pressures over time. Noise is a result of *aperiodic* sound waves. These have no periodic frequency or oscillation. Lastly, *white noise* is a random sound with energy evenly distributed throughout the spectrum. “Tape hiss” is a typical kind of white noise.

1.3 Environmental Acoustics

Environmental acoustics is typically concerned with noise and undesirable sounds, particularly in urban conditions. As population density increases, environmental sound levels also increase as a result of more people, cars and mechanical/electrical equipment. Environmental sounds are generally comprised of natural sounds, man-made noise (such as gatherings of people, music, or cell phone use), vehicular traffic (exhaust and engine noise at lower speeds, tire and wind noise at higher speeds), construction noise, and machinery (industrial machinery and HVAC equipment).

From a design standpoint, environmental acoustics looks at a number of factors to address the sounds in a given landscape. Terrain shapes, such as a hill or earth berm, can be very effective in either blocking or increasing environmental sounds. Similarly, outdoor barriers, such as highway barriers or free-standing buildings, can deflect, absorb or reflect sound, particularly at higher frequencies. Surface

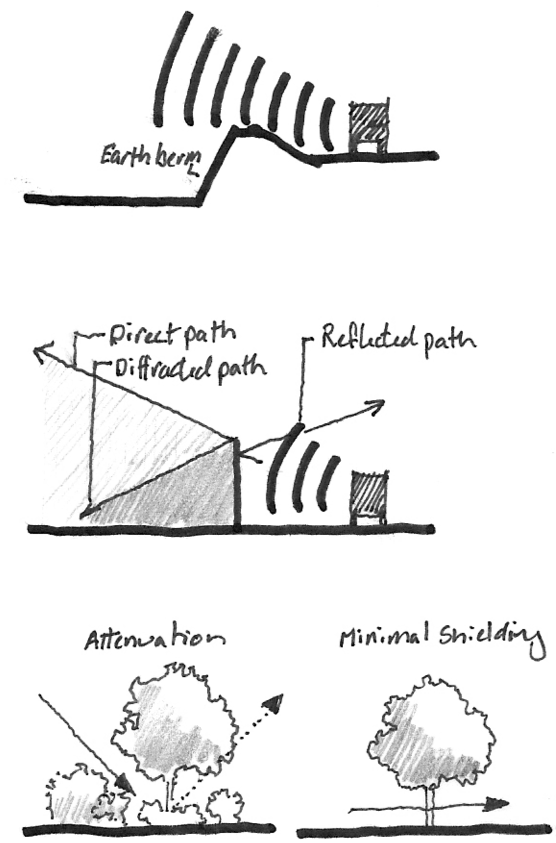


Figure 4: Environmental sound control. Topography (top); solid barrier (middle); vegetation (bottom)

vegetation, including trees and shrubs, can help diminish some environmental noise. Lastly, the placement and orientation of a building can diminish or increase unwanted noise, as well as affecting overall sound levels.

In environmental acoustics the goal is typically to diminish unwanted noise and decrease overall sound levels. An understanding of these techniques, however, can also inform an exploration of different sounds that exist in the environment.

1.4 Architectural Acoustics

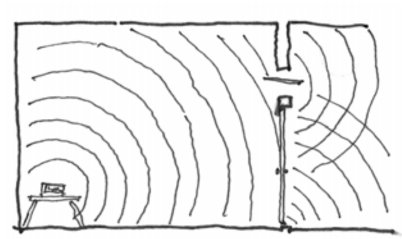


Figure 5: Diffraction in a room.

Within the realm of architectural acoustics, the primary issues of sound behavior are:

- **Transmission**: As the density of a medium increases, sound travels faster.
- **Diffraction**: Sound waves bend around small obstacles, and they spread out beyond small openings.

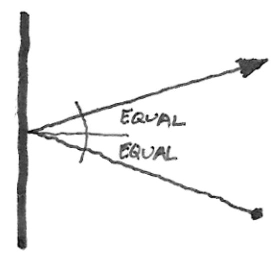


Figure 6: Sound Reflection.

- **Reflection**: As with light, the "angle of incidence equals angle of reflection."
- **Refraction**: A sound wave changes direction as it moves from one medium to another of different density.
- **Absorption**: The transformation of sound energy

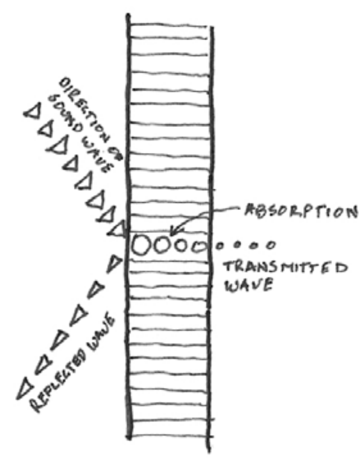


Figure 7: Sound transmission through a solid surface.

into another form of energy (usually heat). Sound absorption in a space can have a dramatic effect on reverberation and loudness.

- **Reverberation**: Sound persists in a closed space by reflection from surface to surface until it has been transmitted to other media (the walls and ceiling), absorbed (carpet and furniture), or has escaped.
- **Resonance**: Vibration occurring at the natural frequency of a system.

Sound can travel directly from source to listener, or it can be "reflected from and modified by many surfaces on the way." (Burris-Meyer, p.55) After it is generated, the movement and quality of sound is determined by the shape, position, surface material, structure, and mass that it encounters. According to Burris-Meyer and Goodfriend (p. 55), three primary goals of room acoustics are that sound travels from a "planned source" to the "listening location":

1) At a satisfactory, near uniform intensity;
2) With direct and reflected sound arriving so close together in time that the definition (percentage articulation in speech) will not be appreciably reduced;
3) With spectrum undistorted through loss (absorption) or over-emphasis (resonance) of certain frequencies.

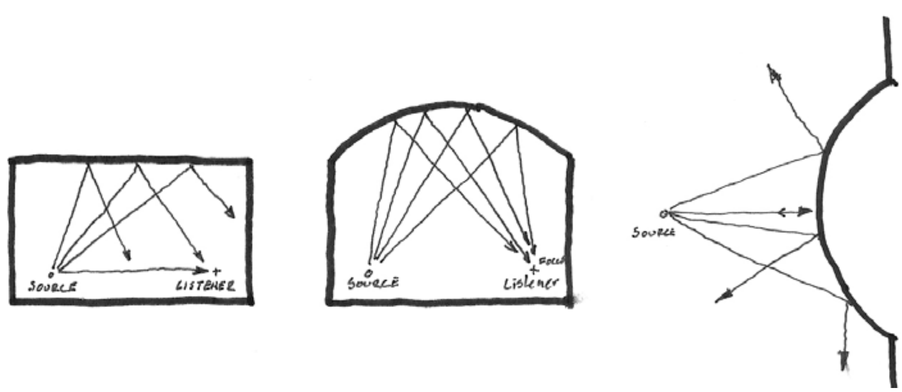


Figure 8: Room shapes and behavior of sound.

The reflection of sound is a function of the shape of the room as well as the type of materials. Figure 8 illustrates three room shapes and the manner in which sound behaves in them. In a room with a flat surface, sound is reflected from the source to the listener. In a room with a concave surface, sound can be focused from the source to the listener. Typical of a whispering chamber, this is not always desirable as it prevents even distribution. Lastly, a convex surface diffuses sound when struck from any angle.

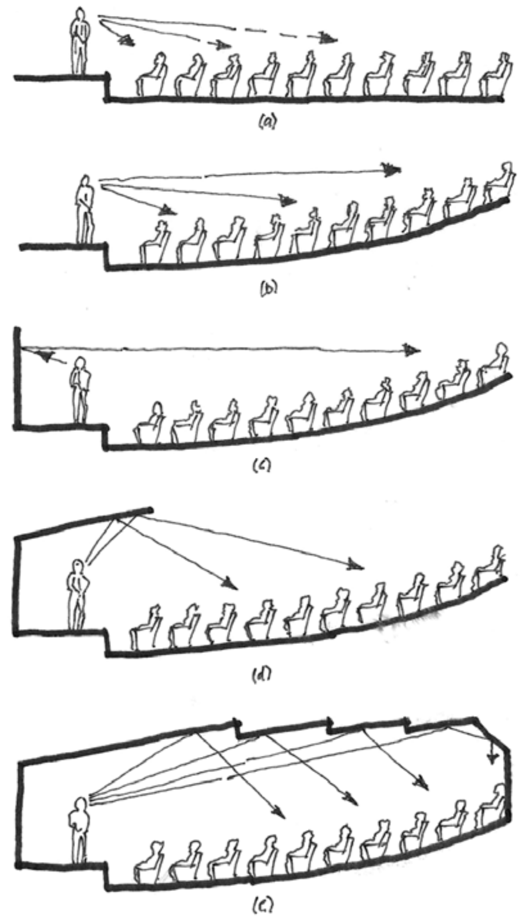


Figure 9: Transition from outdoor to indoor acoustics.

Lastly, figure 9 illustrates the change in the acoustic environment from an outdoor space to a fully enclosed indoor space. In diagrams (a) and (b), the sound source is unaided by any reflective means, and distribution relies solely on the power of the speakers voice. In diagram (c) a solid wall behind the speaker adds a reflective surface, but the reflected sound still travels the same path. The “band-shell” in diagram (d) provides a reflected surface that increases sound levels for listeners farther out. Lastly, room arrangement (e) provides a full ceiling enclosure that enables effective sound reflection for all areas of the auditorium.

1.5 Perception of Sound

The ear is divided into three parts: the outer ear, the middle ear, and the inner ear. Sound is collected by the pinna (the visible part of the ear) and directed through the outer ear canal. The sound makes the eardrum vibrate, which in turn causes a series of three small bones (the hammer, the anvil, and the stirrup) in the middle ear to vibrate. The vibration is transferred to the snail-shaped cochlea in the inner ear; the cochlea is lined with sensitive hairs which trigger the generation of nerve signals that are sent to the brain.

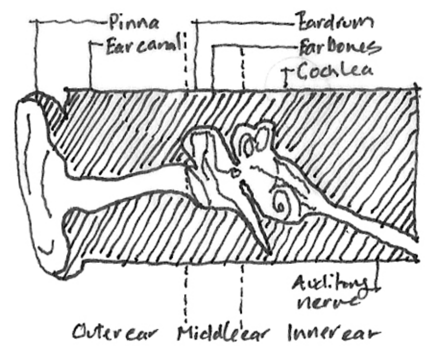


Figure 10: Auditory system.

Human hearing occurs between two threshold curves: the threshold of *hearing* is the limit at which a sound is able to be heard; the threshold of *feeling* occurs as a sound begins to cause pain. (Grueneisen, p. 45) The magnitude of a sound wave at a given time is known as its amplitude, which is specified in terms of pressure. Because the human ear is able to detect a very wide range of amplitudes, a logarithmic decibel (dB) scale is used to measure sound pressure. The minimum sound pressure that the human ear can detect is measured at 0 dB. Calm breathing is measured at approximately 10 db, normal talking falls between 40 to 60 dB, a loud jet from a distance of 100 meters registers at approximately 120 dB, and the threshold of pain occurs at approximately 134 dB.

It should be noted that there is a difference between *sound intensity*, which is measured in decibels, and *loudness*, which is the subjective perception of the sound intensity. A change in sound pressure results in a perceived change in *loudness.* A general rule of thumb is that to cause a sound to be perceived as twice as loud, the sound must be increased in *intensity* by a factor of ten.

1.6 Aural Architecture

In their book *Spaces Speak, Are You Listening?*, Barry Blesser and Linda-Ruth Salter discuss the concept of aural architecture. As opposed to acoustics in architecture, which focuses on the ways that space affects the physical properties of sound waves (spatial acoustics), aural architecture focuses on the way that listeners experience the space (Blesser, p. 5). Blesser and Salter note that while acoustics is a well understood discipline within the field of architecture (generally focused on musical performance or other specialized spaces) the aural qualities of architecture are most often the "incidental consequences of sociocultural forces." (Blesser, p. 5) As a discipline, architects do not address the aural realm of architecture with the same knowledge, understanding or aptitude as they do the visual realm.

The authors present four principal reasons for why this might be so (Blesser, p. 6):

1) Aural experiences are "fleeting", and it is difficult to store their "cultural and intellectual legacy in museums, journal, and archives."

2) The language for describing sound is “weak and inadequate… for both cultural and biological reasons.”

3) Modern culture tends to be oriented towards visual communication, and has “little appreciation for the emotional importance of hearing.”

4) Issues of aural architecture tend to be dismissed as not “legitimate domain for intellectual inquiry.”

This thesis is based on the idea that, despite its current subjugated role within the realm of architectural considerations, sound remains a rich and essential source of meaning in architecture.

The process of being aware of sound progresses through a series of stages: “transforming physical sound waves to neural signals, detecting the sensations they produce, perceiving the sound sources and acoustic environment, and finally, influencing a listener’s affect, emotion, or mood.” (Blesser, p.12)

Blesser and Salter have defined the concept of *auditory spatial awareness* within this framework. Auditory spatial awareness includes both the ability to detect that “space has changed sounds”, as well as the “emotional and behavioral experience of space.” (Blesser, p.11) As stated by the authors:

> Listeners react both to sound sources and to spatial acoustics because each is an aural stimulus with social, cultural, and personal meaning… depending on the physical design and the cultural context, aural architecture can stimulate anxiety, tranquility, socialization, isolation, frustration, fear, boredom, aesthetic please, and so on. (Blesser, p. 11)

Ultimately, the authors suggest, much knowledge exists about physically measuring acoustics and sensory detection, but significantly less into the "phenomenology of aural space."

Lastly, Blesser and Salter define the four components of aural architecture that correspond to auditory spatial awareness:

1) **Social**: the aural qualities of a space that can "emphasize aural privacy… aggravate loneliness" or "reinforce social cohesion." (Blesser, p. 11)
2) **Navigational:** the aural qualities of a space that allow one to orient and move through space.
3) **Aesthetic:** "just as visual embellishments can make a space aesthetically pleasing to the eye, so aural embellishments can do so for the ear, by adding aural richness to the space." (Blesser, p. 11)
4) **Musical Spatiality:** the aural qualities of a space that enhance our experience of music and voice.

The concepts of aural architecture and auditory spatial awareness have been introduced as conceptual frameworks that allow for a discussion of sound in architecture that goes beyond mere acoustics to issues of personal and cultural meaning.

2. Sound, Awareness and Place: Program

2.1 Design Goals

This project proposes a small pavilion on the north side of the architecture school at the University of Maryland, College Park, that provides a contemplative space for listening. It suggests a simple building to accommodate this program: a sheltered enclosure with a place to sit, for a maximum of four people. The structure should function to heighten one's awareness of sound within the structure itself, as well as of the sounds occurring in the surrounding environment.

This project has two primary goals. First, by providing a space that encourages people to focus on the aural environment, it seeks to raise awareness and appreciation of sound as an essential element of artistic and cultural consideration in architecture (and in particular for design students at the architecture school). Second, I have structured this project to allow for a focused exploration into the issues of sound in architecture, from both an acoustical standpoint, as well as from the standpoint of architectural meaning. Therefore, this thesis is about both the process (design exploration) and the project (the pavilion itself).

This project will be built. As such, the design process will be intimately wedded to the project's physical realization. This will inform the process in terms of time, resource and labor constraints. However, a goal of the project is to use these constraints to architectural advantage. In other words, how can a lack of resources initiate a novel use of materials? How can my own limitations as a craftsman force a design solution that is elegant in its simplicity?

2.2 Program Elements and Considerations

The actual size of the sound box will be determined during the design phase, but it will be limited to a maximum dimension of 10' x 10' x 10'. While 100 square feet in plan forces a simple program, the architectural considerations (especially because the project will be built) are as potentially rich and diverse as any other project. Moreover, an essential aspect of this project is that it seeks to keep the programmatic scope narrow, so that the attention paid to each element can be high.

The preliminary design issues are listed below. These issues are intended to frame both the program, but also the direction that the design process will take. A successful project will include a deliberate and thoughtful response to each of these issues, as well as issues that come up during the design process.

- **Roof:** what function can the roof play in this program? In what ways can it capture sound, create sound, and reverberate sound? Can the roof be manipulated to change the varying intensities of environmental sound?
- **Wall:** what is the role of the wall in this program? Here, wall must function in at least two ways: as a resonating body, but also as a determinate of opacity. How much visual connection should there be between the inside and the outside? Does the structure lose significant resonant qualities when there are openings to the outside? Is this something that can be manipulated – opened,

closed, or slid? Can the wall be both surface and structure? Is it self-supporting?

- **Floor:** what are the functional requirements of the floor? How can the floor heighten the auditory environment? How can the sound of a footfall be intensified?
- **Foundation:** Is this shelter fixed in place, or can it be moved? If it's fixed, how is the foundation engaging the ground? How can this add functionality, or beauty, to the program (for instance, can it add to the acoustic environment in any way?). If it can be moved, how is this accomplished? How many people would be required to move it? How could the structure be mobile while still accounting for the steep terrain of the site?
- **Inhabitation:** how do people gather in this pavilion? Are there chairs or benches? Are they built-in or free standing? Do people stand? How much space is devoted to circulation and how much to sitting? Is there a central gathering point? A hearth? Do they face each other, encouraging conversation, or do they sit back to back, encouraging silence, or conversation without visual cues (think about staring up at the stars, lying next to someone)? How does the nature of an aural space affect interactions? Can the gathering arrangements be manipulated?
- **Entry:** how can the entry to this pavilion serve as a threshold signaling a move into a predominantly aural environment? How can a ritual be attached to entry to accomplish this? To what extent is the ritual aural (for instance, opening or closing creates a distinctive sound) or kinesthetic (for instance, it

involves a physical act of sliding, lifting, moving, lowering, etc), or tactile (rough/smooth, cold/warm). Is the door always open, or can it be closed once inside?

- **Site:** As discussed in more detail in part 5, what are the potential siting options? What are the logistics of installing this pavilion on university property: legal, technical, safety, etc?
- **Approach:** similar to entry, how can the approach bring one's awareness to sound? A path of gravel? An approach along reverberative wooden planks? How can this structure be ADA accessible? How can this be accomplished within the site?
- **Image:** What does this structure look like? Does its form attempt to express something about its function? Is the form allowed to be the "pure" outgrowth of sonic function? Can it fall within an existing formal typology?
- **Material:** Are there material considerations beyond functional ("functional" here referring to a material's acoustic qualities)? How do my own technical abilities limit the choice of materials (for instance, can I use steel if I can't weld)? Is there a way to use recycled materials?
- **Natural Elements:** Primitive HVAC? How do wind, rain, and sun interact with the pavilion? Can they be used to enhance the program? Can the pavilion create sound by harnessing them? Can the sound of rain, howl of wind, and expansion from the sun's heat be used to sonic advantage? How much interaction do the inhabitants have with the natural elements? Is there an attempt to keep people warm in the winter, cool in the summer?

- **Seasons:** how does this pavilion address the four seasons? Does it passively watch as the seasons change, or can the structure itself change with the seasons?
- **Construction:** what are the time, resource and labor constraints on the project? How can these be used to creative, aesthetic and functional advantage?
- **Manipulability:** is the experience about just sitting and listening, or is it about affecting sonic change within the pavilion? What aspects of the program can be manipulated: sound, site, visual opacity/transparency? Can there be unified attitude about manipulability that extends to all of these issues?
- **Lifespan:** How long is this pavilion intended to exist? Is its demise planned, or does it stay on site indefinitely? How does the lifespan of the shelter affect its design?

3: Precedents

Precedents for this project include formal precedents, which are described within the framework of the "primitive hut", as well as programmatic precedents, which deal specifically with issues of sound in architecture.

3.1 Formal Precedents: "primitive hut reconsidered"

The following projects address the idea of the primitive hut through the lens of a specific activity, site or ritual. By limiting the material essentials of architecture – roof, wall, floor and "hearth" – and allowing the investigation to both rigorously and playfully infuse the material elements with poetic intention, these projects offer insight into the substance of architecture. The primitive hut becomes a didactic tool; a diagram that provides an elemental material definition of architecture. The program – be it a ritual, ceremony or activity – is then allowed to transform these elements to fit the specific programmatic and poetic requirements. Because of the simplicity and elemental nature of the projects, one can easily trace the development from basic element to the material realization of poetic intention. What does a wall mean in relation to the ceremony of drinking tea? How can a roof define "beach"? How is the hearth manifest in the act of crossing a stream? How is the concept of "floor" addressed in an aqueous setting?

Certain priorities begin to emerge when one looks at these projects as a whole:

- Heightened sense of entry, often associated with physical exertion such as opening a heavy door, climbing stairs, and in one example, swimming underwater to re-surface within the shelter.
- Views out to the landscape: there is generally a very deliberate decision about where views are directed.
- Devices for gathering: perhaps related to the notion of the hearth, these can include seating, a table or a physical element that invites use.
- A defined sense of orientation: this can be up/down or front/back, or a combination of these.

A final, essential aspect of these projects is that the designer is intimately involved in the making of the project. Each project works within the constraints of the technical capabilities of an individual or small group, to realize its completion. Ultimately, in each example the technical limitations of construction become a defining poetic dimension of the work.

3.1.1 Pastoral Quartet, Mike Cadwell

The architect Mike Cadwell completed a series of four small buildings around the literary theme of "Pastoral." Perhaps best exemplified by Thoreau's retreat to Walden Pond, a pastoral work "envisions a withdrawal from ordinary life to a place apart, close to the elemental rhythms of nature, where a man achieves a new perspective on life in the real and complex world." Cadwell reminds us, however, that one's "meditation in seclusion" is ultimately a public gesture: "While there is a retreat, there is also a return." (Cadwell, p. 6)

Collectively, the projects are unified by their derivations from American building archetypes, wood construction, clear tectonics, simple programs, and basic site relationships. Individually, each project addresses "a specific pair of forms, a specific pair of activities, and a specific relationship to the earth." (Cadwell, p. 7) Lastly, the projects are organized around a general seasonal theme:

spring	*Bridge-Box*	*walk-sit*	*over water*
summer	*Drum-Barge*	*swim-stand*	*in water*
autumn	*Ark-Tower*	*climb-sit*	*over ground*
winter	*House-Tunnel*	*descend-lie*	*in ground*

Table 1: Pastoral Quartet outline (Cadwell, p. 7)

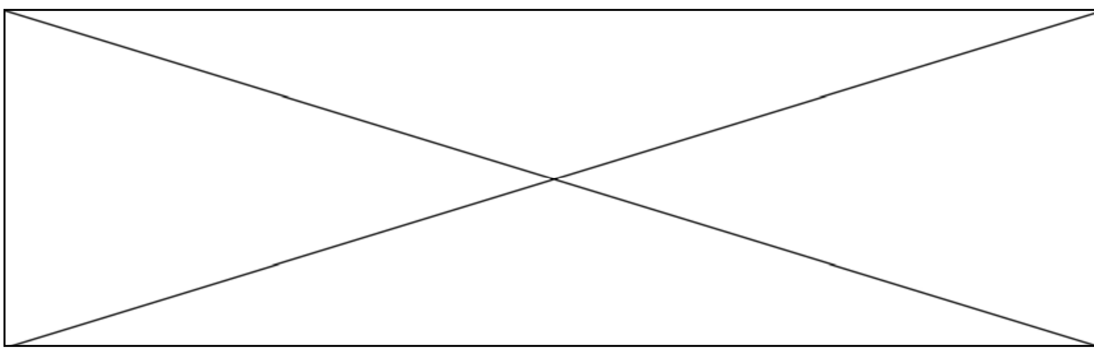


Figure 11: Bridge-Box. Exterior (left); interior (center); section (right)

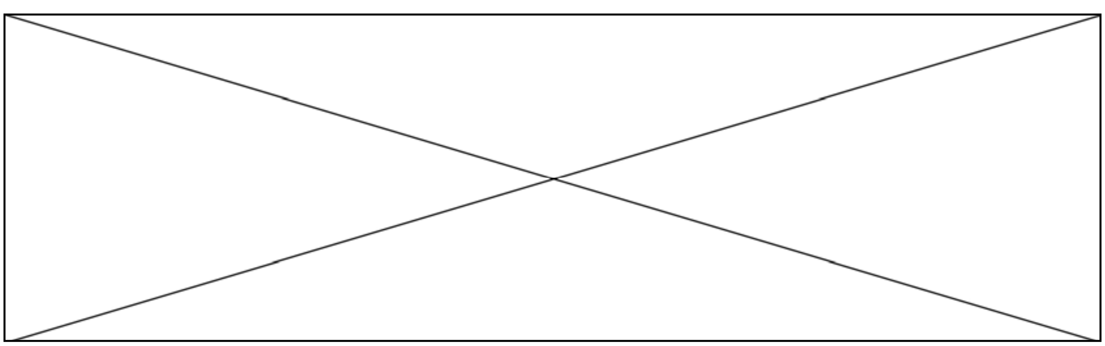


Figure 12: Drum-Barge. Exterior (left); interior (center); section (right)

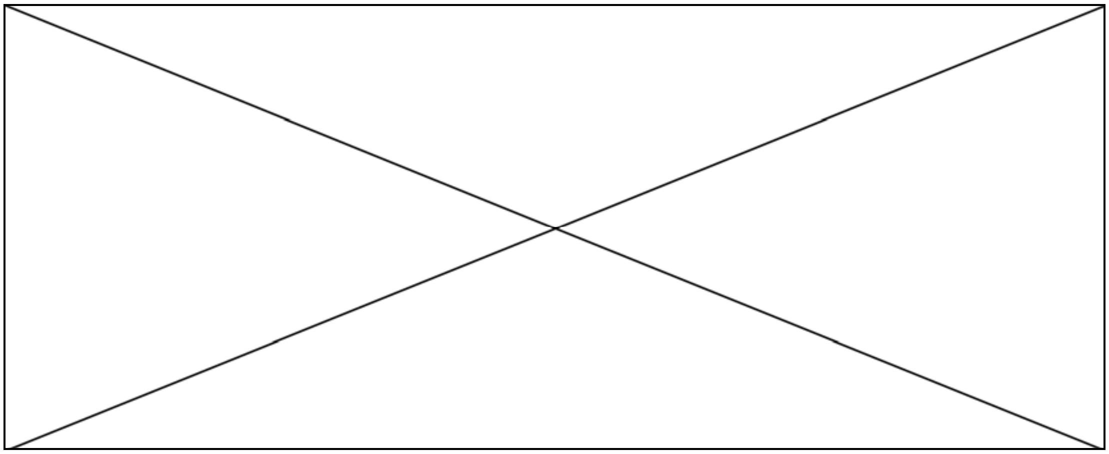


Figure 13: Ark-Tower. Exterior (left); interior (center); section (right)

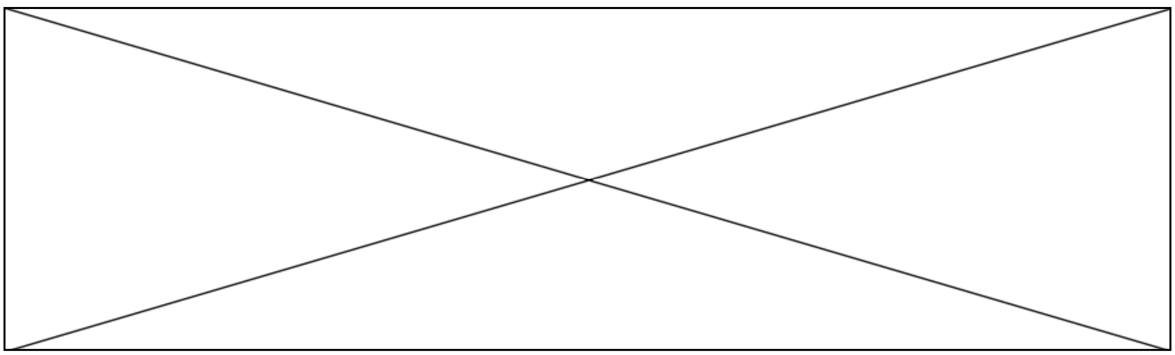


Figure 14: House-Tunnel. Exterior (left); interior (center); section (right)

3.1.2 Dunescape, SHoP Architects

In this project, SHoP Architects submitted a proposal to the PS1 design museum competition that sought entries under the program of an urban beach. SHoP approached the problem by envisioning an urban beach without sand. They diagrammed five of the elements deemed as essential to the idea of “beach.” These included: umbrella, cabana, beach-chair, boogie-board, and surf. A simple “use” diagram was made for each element. Using parametric modeling software and digital fabrication, the form of the "Dunescape" project arose from a conglomeration of the diagrammatic shapes into one structure.

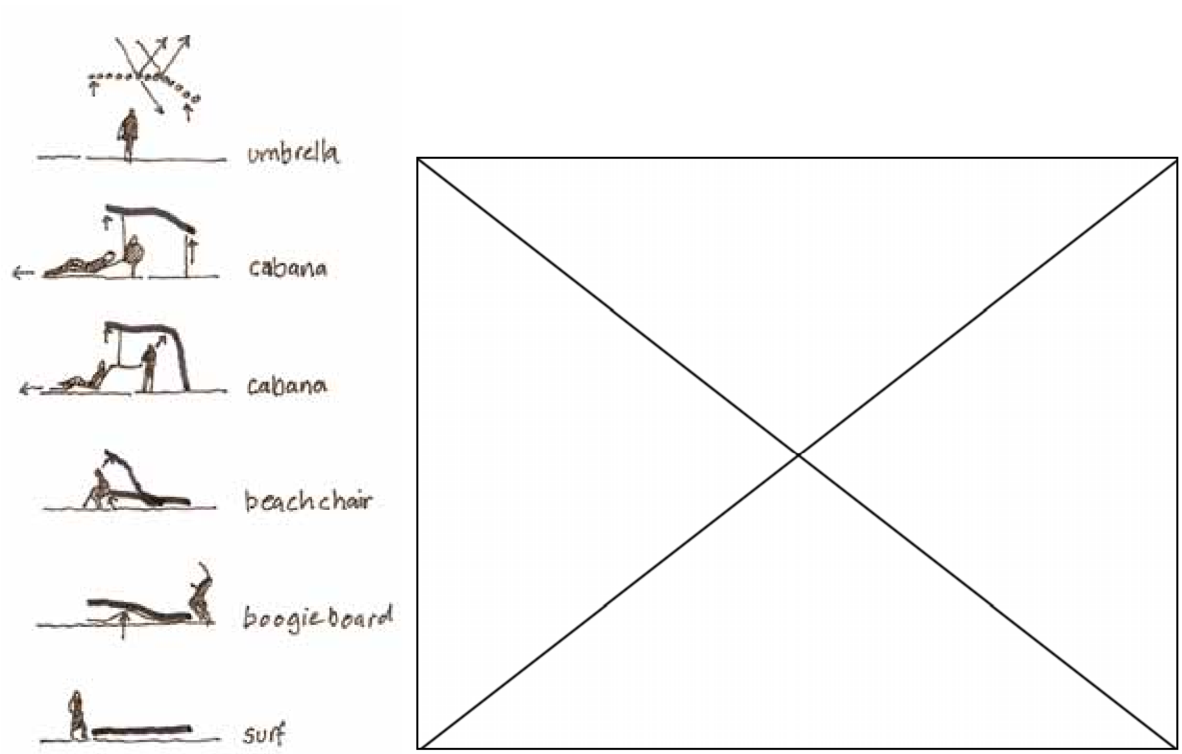


Figure 15: Dunescape. Use diagrams (left); as built (right)

<u>*3.2 Sound Precedents*</u>

3.2.1 Swiss Sound Box

This project by Peter Zumthor was Switzerland's entry for Expo 2000. Deriving its tectonic form from the way that luthier's stack wood, this project became a "sonic pavilion" where musicians were playing throughout the space, and visitors could walk through and experience the changing sonic environment.

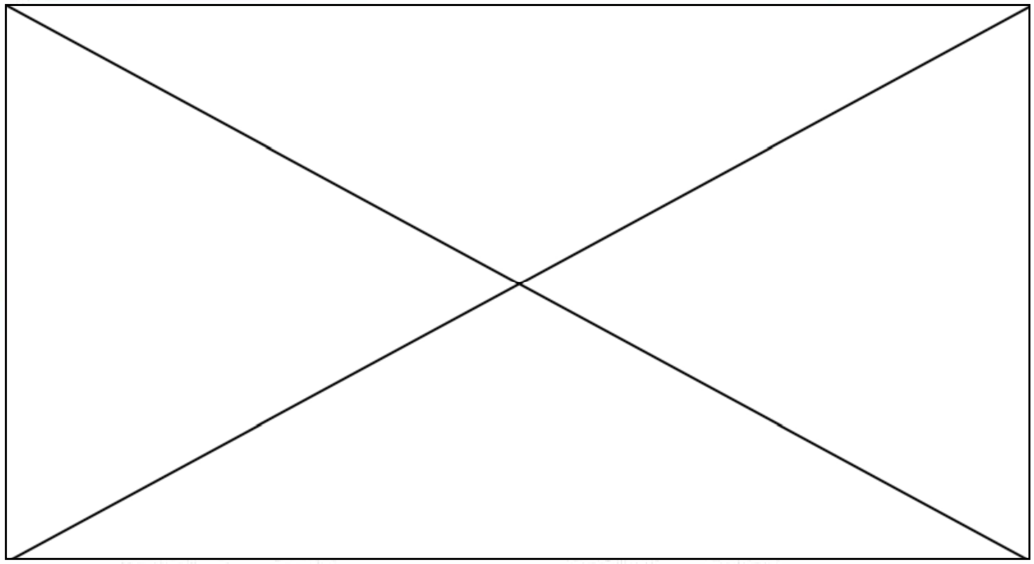


Figure 16: Swiss Sound Box

3.2.2 Mix House

This project looks at the idea of aural transparency. The house is designed with two large sound-receiving volumes. The idea is to capture and intensify sounds from the environment and bring them into the house as a kind of environmental sound mix.

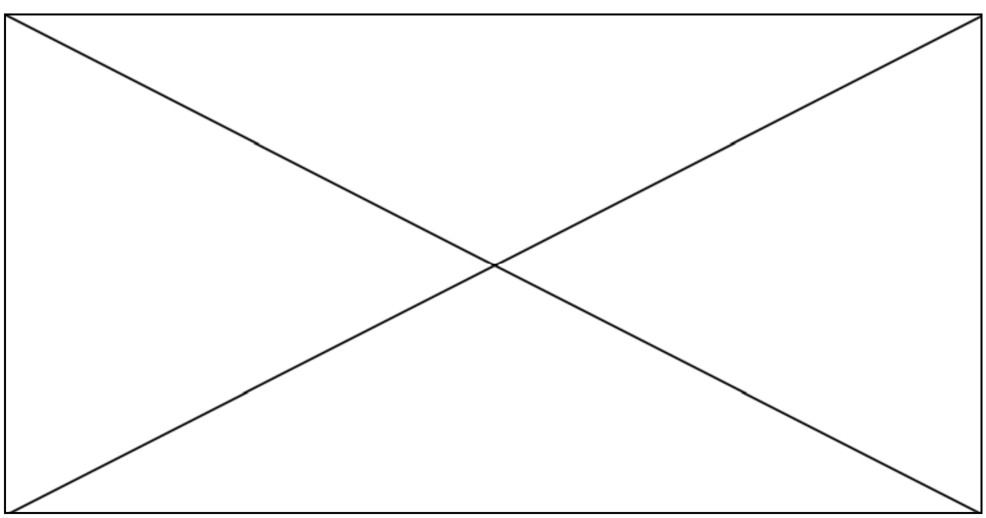


Figure 17: Mix House

4: Site

4.1 Site Selection

It was established early-on in this thesis that the project site would be on the grounds of the University of Maryland School of Architecture, Planning, and Preservation. This was partly a result of the logistics involved in the construction of the project, but more significantly, it was driven by a desire to explore a project that could be specifically relevant to the life of the architecture school, and also engage the greater campus community. Three primary factors revealed themselves as relevant to this decision: circulation, proximity and "sonic interest". Pedestrians moving along the pathways of the architecture school are either coming to/leaving from the architecture school, or, they are passing by the architecture school on the way to another part of campus. Potential sites needed to engage both movement systems. Second, proximity was understood as both a visual and physical relationship to the architecture building. The closer the site was to the Architecture building, the stronger the potential relationship it offered to the school. However, this advantage was offset if the proximity to the school decreased the visibility of the site from other parts of campus, and to people who were not specifically related to the architecture school. Lastly, the "sonic interest" of the site was a measure of the presence of multiple auditory phenomena, including vehicular sounds, pedestrian sounds, and nature sounds (rustling leaves, chirping birds, etc.). "Sonic interest" also considered the environmental acoustics within the vicinity of site: primarily, a variety of buildings and terrain that would offer a distinct and dynamic environmental soundscape.

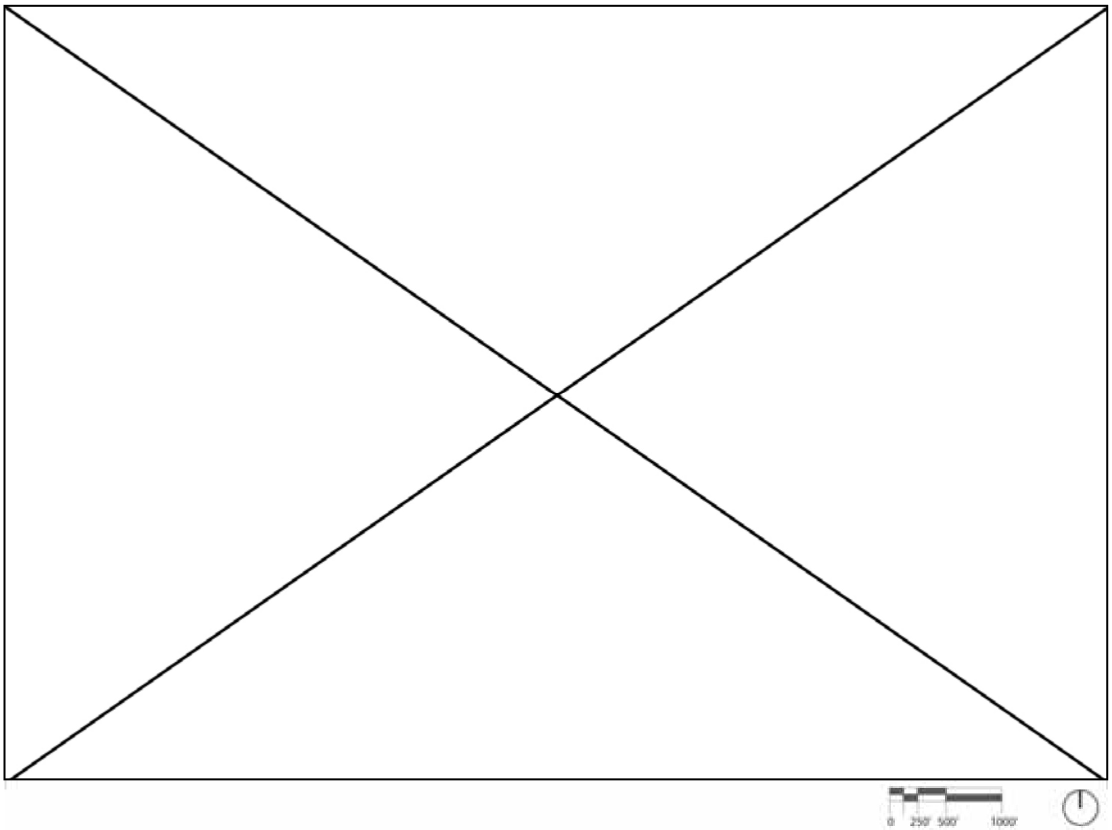


Figure 18: Site Context – UMCP Campus

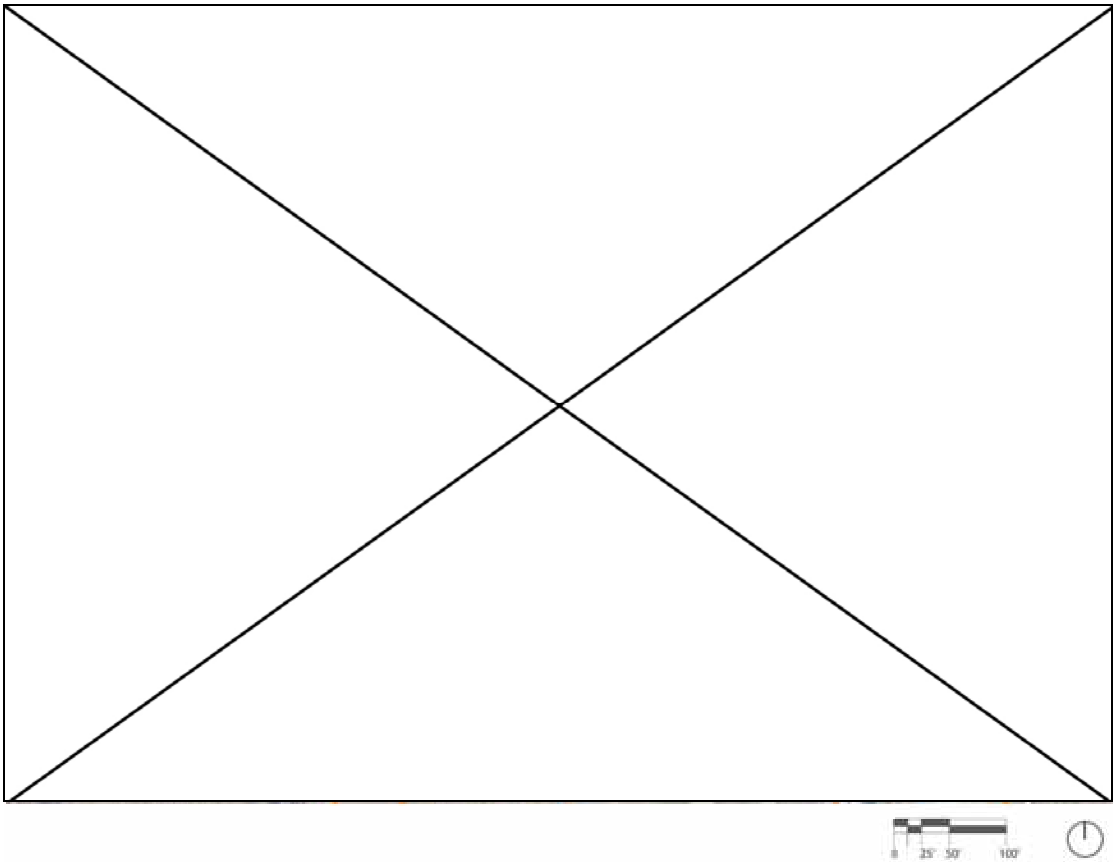


Figure 19: Pedestrian Circulation

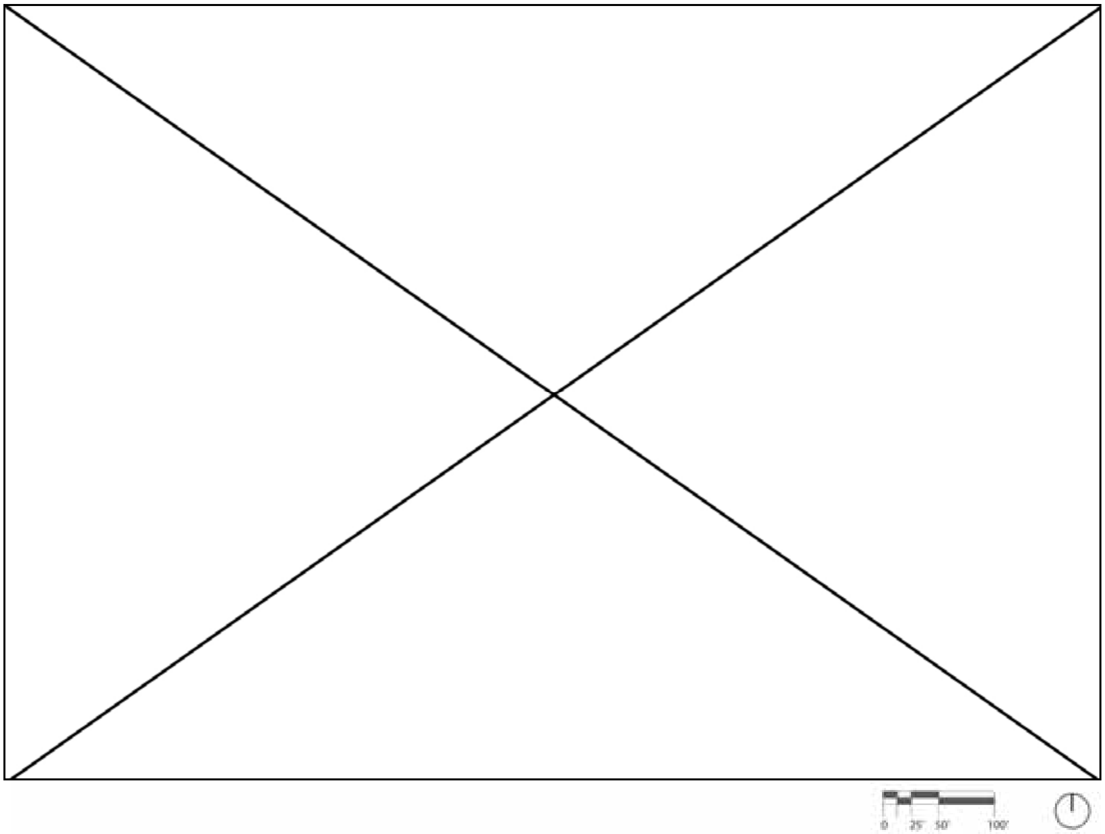


Figure 20: Vehicular Circulation

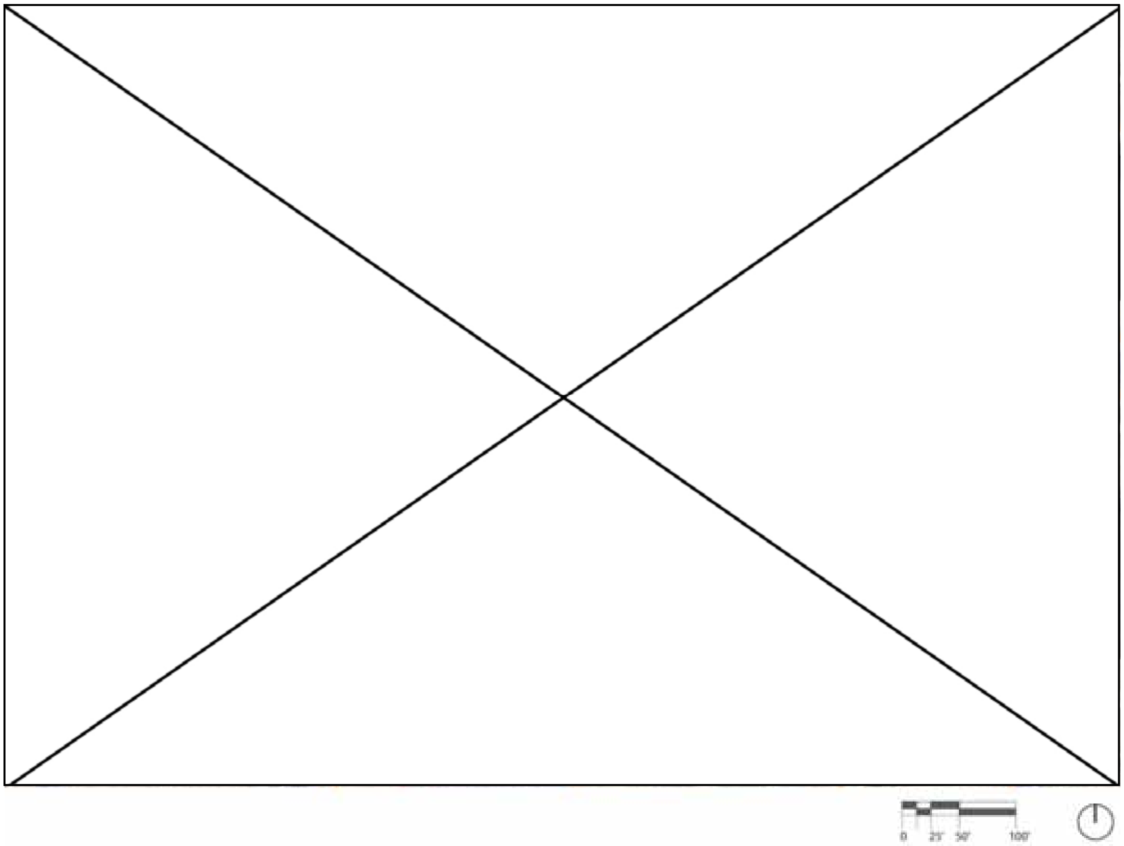


Figure 21: Potential Sites

4.2 Selection Process

An inventory of twelve potential sites around the architecture building was compiled (attached as appendix A). Sites on the south side of the building offered good proximity in relation to the architecture school, but they offered little visual or pedestrian access for non-architecture students. They also ranked low in terms of "sonic interest". Sites on the east side of the building ranked high in terms of proximity to the architecture school and both visual and pedestrian access for non-architecture pedestrians. However, they ranked lower for their "sonic interest". Sites on the west side of the building ranked low for their proximity and connection to the architecture school, but slightly higher in terms of visual and pedestrian connection for non-architecture students. Ultimately, it was determined that the sites along the north side of the building offered the best combination of factors. The sites have good proximity to the architecture school, but they also sit along paths that are well traveled by non-architecture pedestrians. The sites also offer a potentially high degree of visibility to vehicular traffic coming into or out of the campus. Perhaps most importantly, the north side of the building offers the most varied and diverse soundscape. Vehicles passing along Campus Drive create a very distinct crescendo and Doppler Effect. The grove of trees on the western half of the site provides many natural sounds (rustling leaves, chirping birds, etc.). Furthermore, the many paths that run through or cross this site offer a great variety of pedestrian sounds. Lastly, as demonstrated in the sections, the site has an intriguing "canyon" created by the Art and Architecture buildings, as well as the steep drop in terrain from Campus Drive down to the Architecture building.

4.3 Sonic Environment: Art/Architecture Corridor

For purposes of this thesis, the Art and Architecture corridor ("the corridor") is defined as the space bordered by the Art building to the north, the Architecture building to the south. The space between the two buildings is a significant movement corridor for vehicular and pedestrian traffic. It also serves as a primary point-of-entry/exit for the campus. Campus Drive, the primary east/west road through campus, runs between the two buildings. Lot 1, a massive surface parking lot on the east edge of campus, is a primary source of vehicular pedestrian traffic moving through the corridor. In addition to the primary east/west vehicular circulation, there are multiple pedestrian pathways that lead people through the corridor into or out of campus, but also, within the corridor. Whereas the primary pedestrian circulation occurs in the east west direction, there are also three significant north/south pathways that cross, or run adjacent to the east-west corridor.

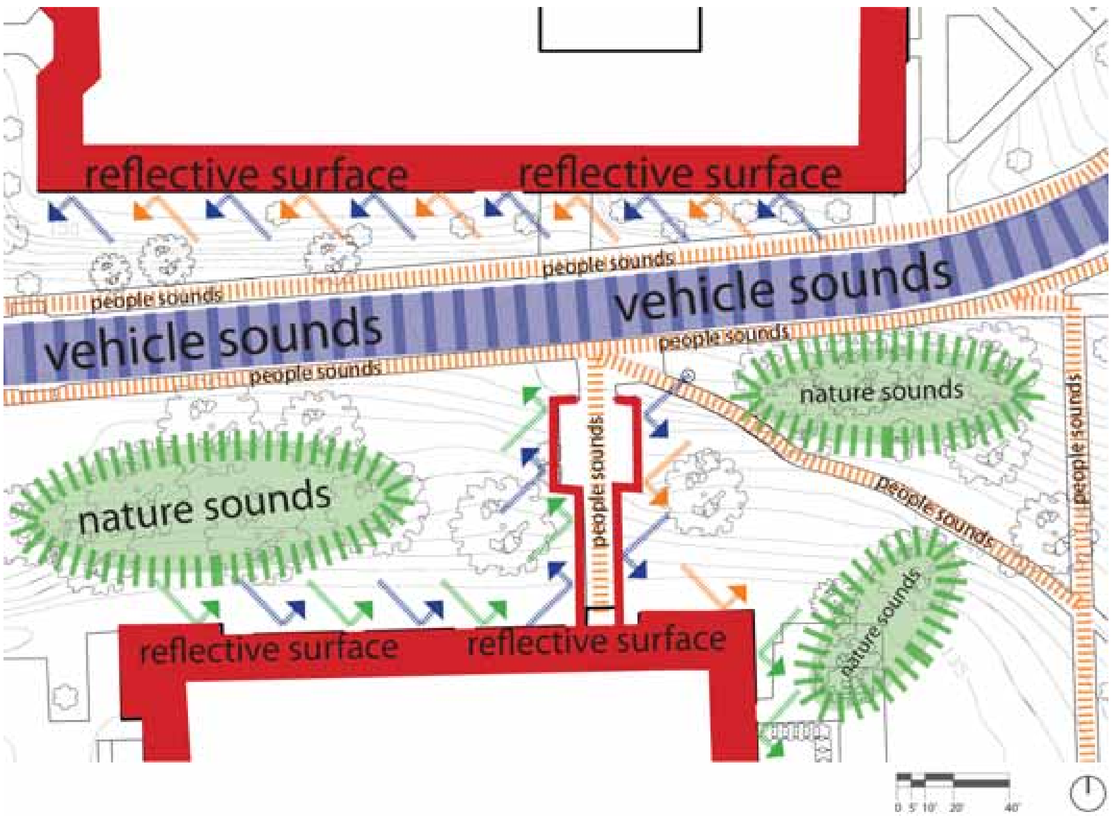


Figure 22: Sonic environment - elements

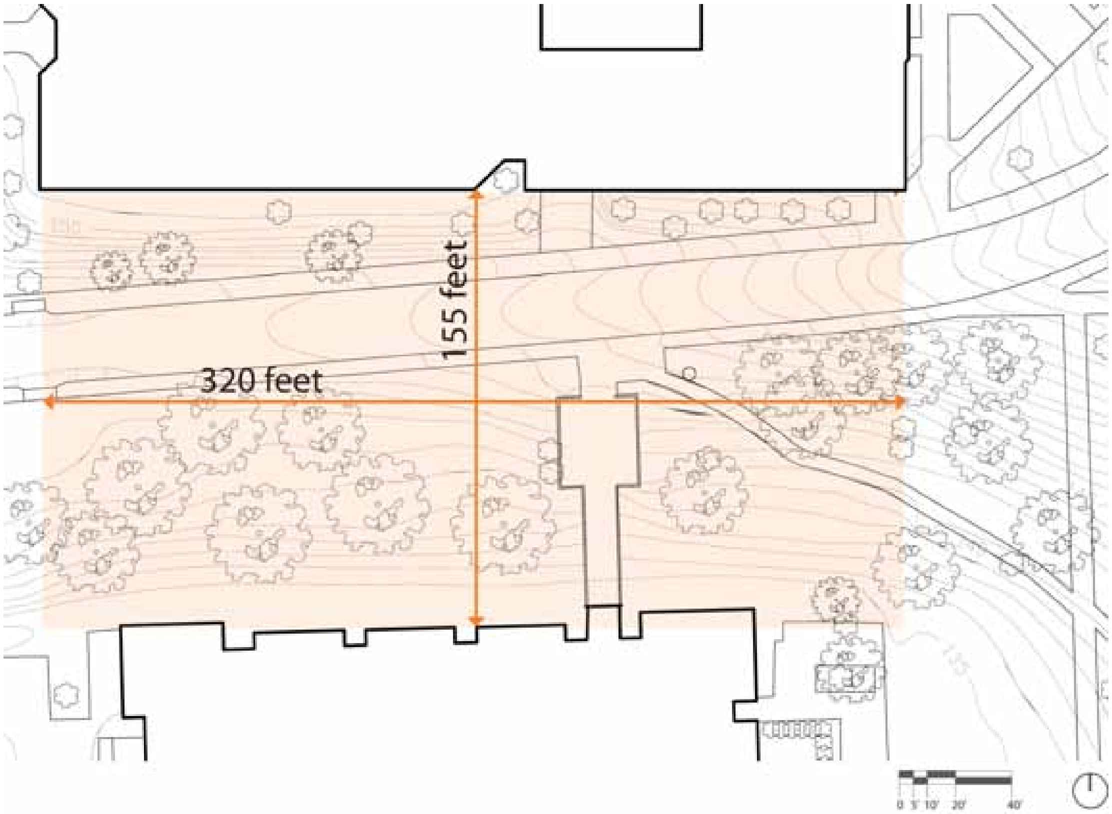


Figure 23: Sonic Environment – site dimensions

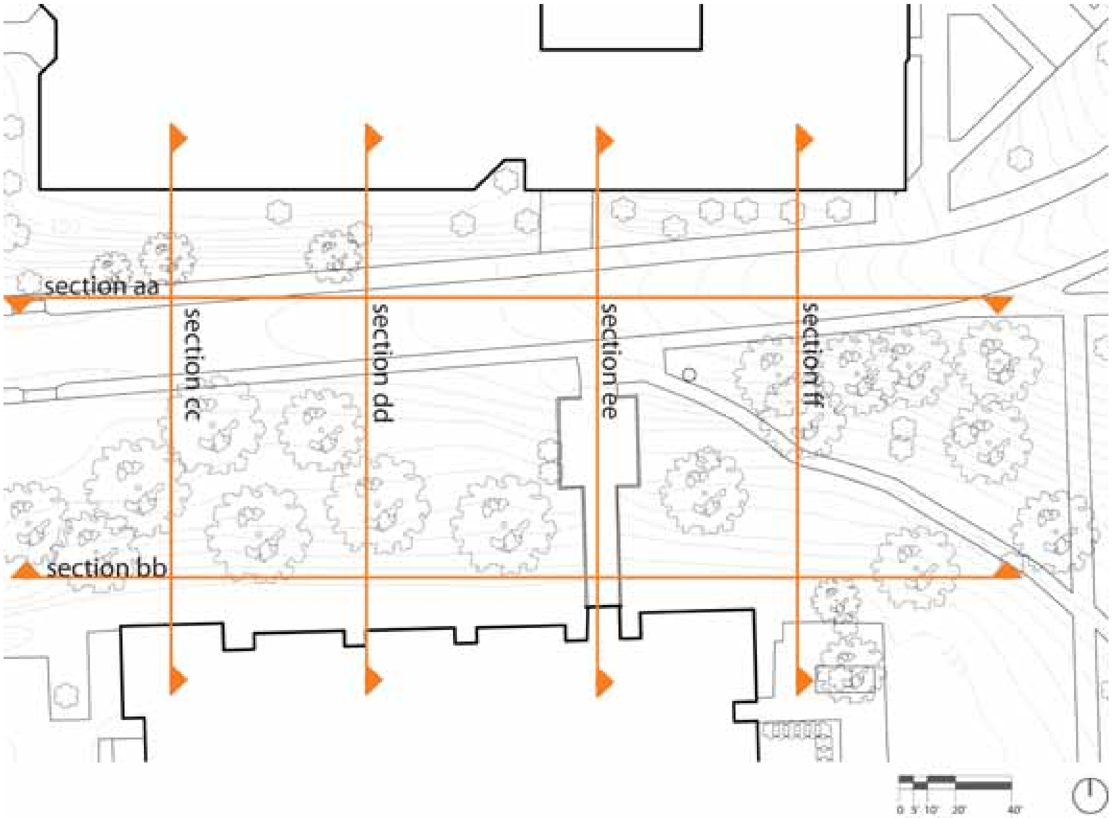


Figure 24: Section Key

Figure 25: East/West Sections - section aa (top); section bb (bottom)

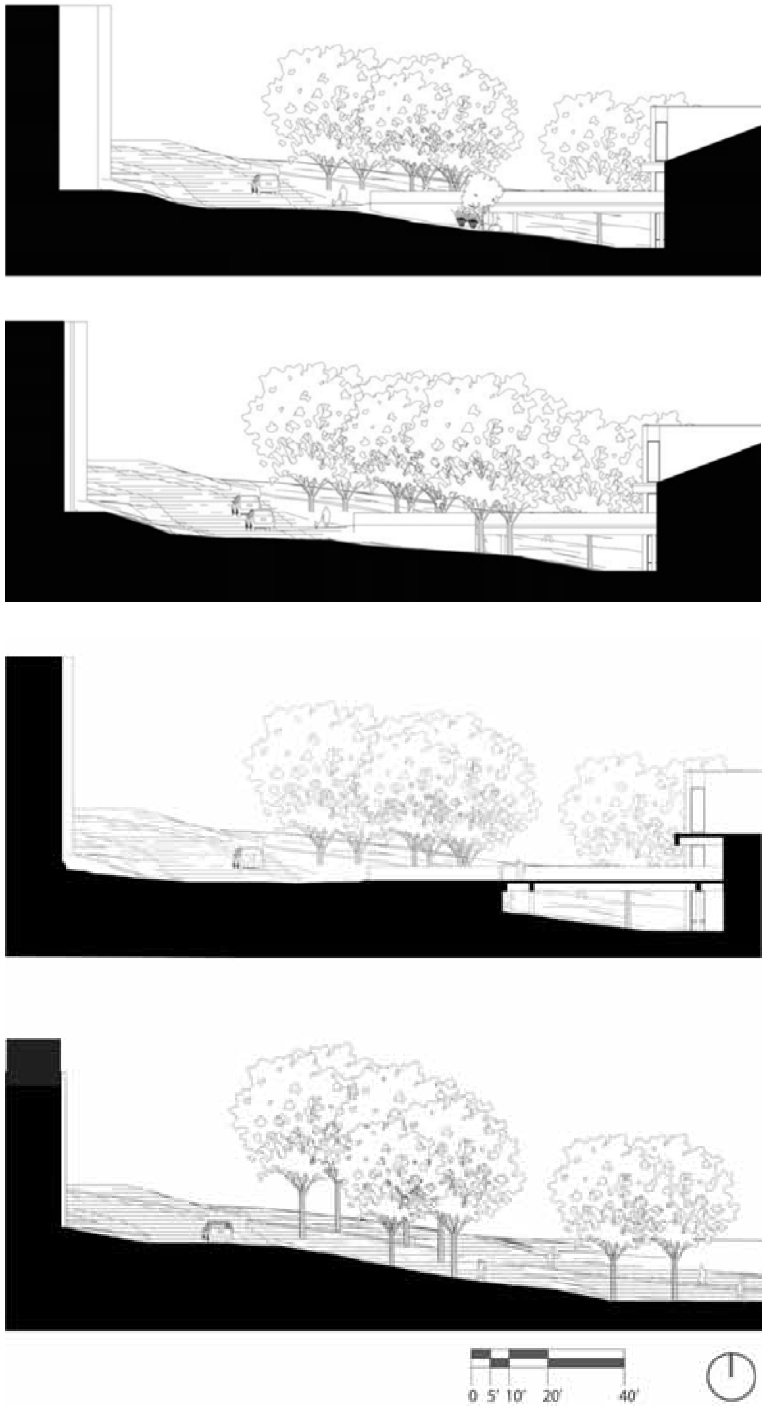


Figure 26: North/South Sections (in descending order from top, section cc, section dd, section ee, section ff.

4.4 Project Sites

This thesis distinguishes between the "sonic site" which is understood as the entirety of the art/architecture corridor as a sonic environment, and the "project site" which is defined as the specific footprint of the building. The alternative parti analysis in Part 5 will look at three potential "project site" strategies. Each project site is different in terms of its practical considerations, but unified by program and by relation to the sonic environment of the corridor. As this corridor can be understood as a whole, a prime consideration will be a specific site that can engage the corridor as a whole. A potential strategy will also be that the built project is moveable, thus allowing for flexibility within the corridor.

5: Design Approach

5.1 Conceptual Design Strategies

As stated before, this project has two primary goals: 1) offer a design exploration into the aesthetic, technical, cultural and pragmatic issues of sound in architecture, of which an essential part is the act of building the project, and 2) provide a listening pavilion that serves to heighten the participant's awareness of sound, both inside the pavilion and in the surrounding outdoor environment.

The design issues detailed in Part 3 suggest the potential richness of the project, despite its small size. Within the program description, there are three preliminary strategies that begin to emerge. As detailed in the section on site, this project has approached the issue of site as two distinct entitities: one being the larger, "sonic environment", and the other being the building footprint, the "specific site." While all three preliminary strategies are sited within the sonic environment of the art/architecture corridor, their design strategies are a result of the specific site. In each case, the specific site determines the manner in which the project physically manifests itself, as well as the approach it takes to engaging the sonic environment. The three strategies are: 1) Free-standing Pavilion, 2) Architecture Bridge, and 3) Mobile Pavilion. In each case, the specific site is different, but the design issues detailed in part 3 will be essentially the same.

5.2 Free-standing Pavilion

The site for the free-standing pavilion can be seen in figure 27. The significant issues related to this approach are: how does the pavilion sit on the site? How is it anchored to the ground? Figure 28 shows an early, full-scale massing model that was used to test out the size of a 10’x10’x10’ pavilion on this site.

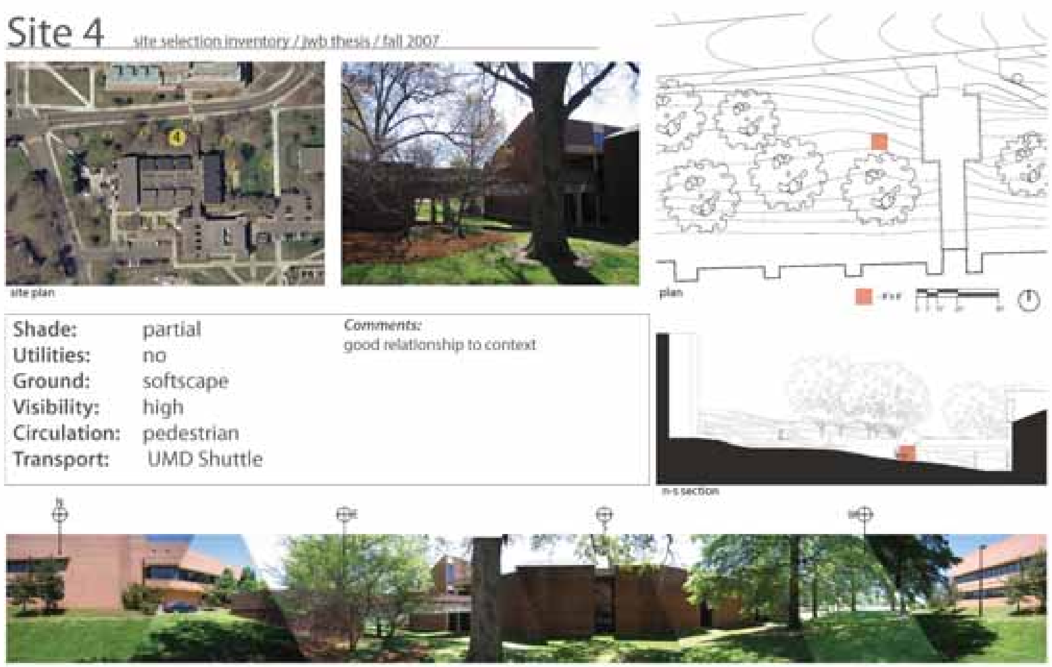


Figure 27: Site Information

Figure 28: Massing model images

5.3 Architecture Bridge

The architecture school bridge is one of the primary points of entry to the Architecture School. The space below the bridge, as shown in figures 29 and 30, is the primary area of interest for this design strategy. In this case, the Listening Box would relate in section to the lower part of the bridge. In the transverse direction, the bridge is approximately 13’ wide, with 11’ of headroom. There is significant programmatic potential to pick up sounds from both the east and west sides of the site. Additionally, the lower part of the bridge offers a very interesting connection to the troll studio within the architecture school, as seen in figure 30.

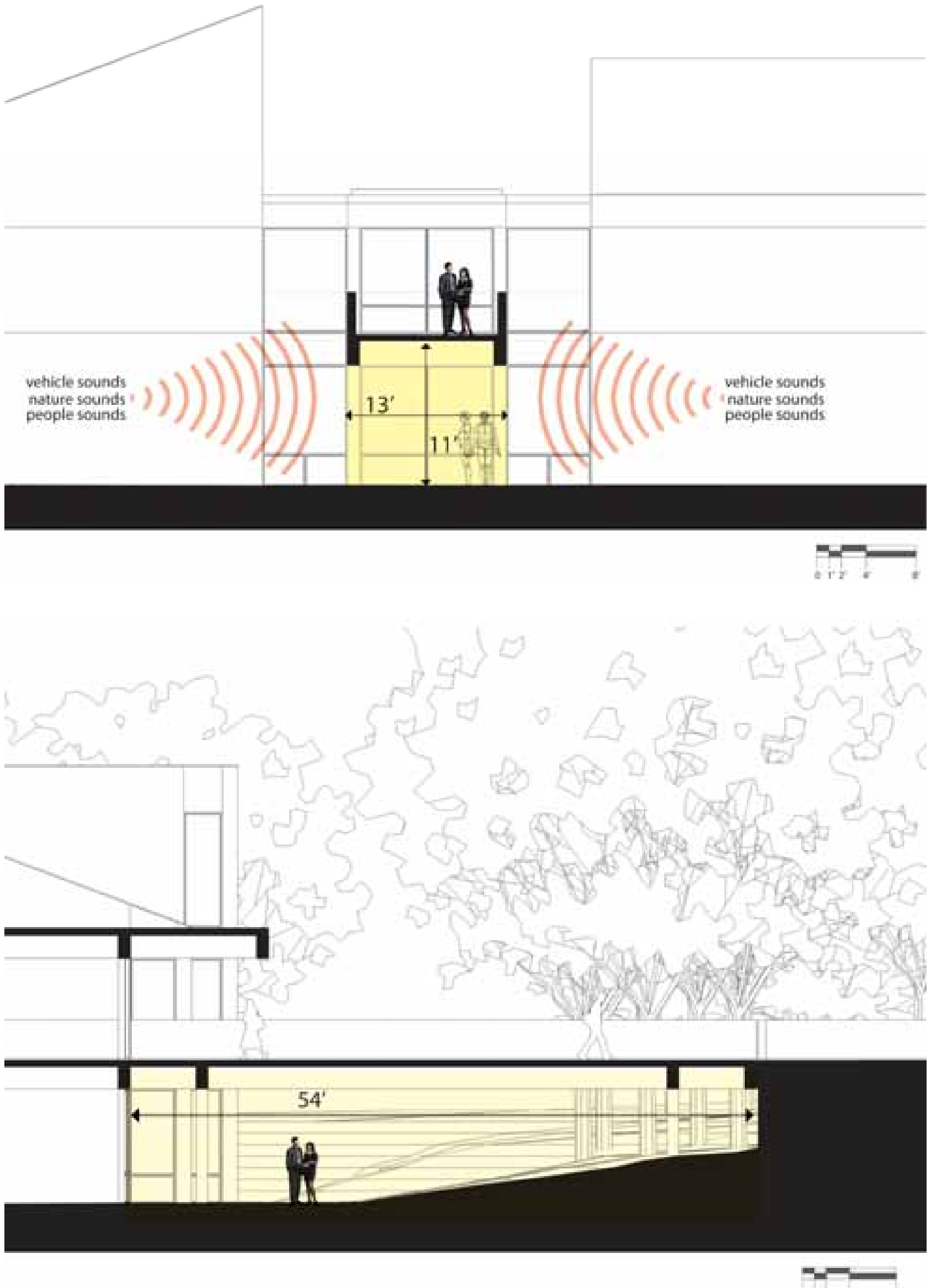


Figure 29: Architecture Bridge; transverse section (top), longitudinal section (bottom)

Figure 30: Architecture Bridge; from troll studio looking out (top); from underneath bridge (middle); exterior elevations (bottom).

5.4 Mobile Pavilion

The final design strategy proposes the idea of making the listening box mobile. This might take a number of manifestations. There are two primary approaches for mobility: 1) it could have wheels and a handle like a wheelbarrow, and be able to be pushed around the site by one or a few people; or 2) it could deconstruct and then be reassembled: perhaps in a simple manner such as folding table, or in a more complex way as in a backpacking tent.

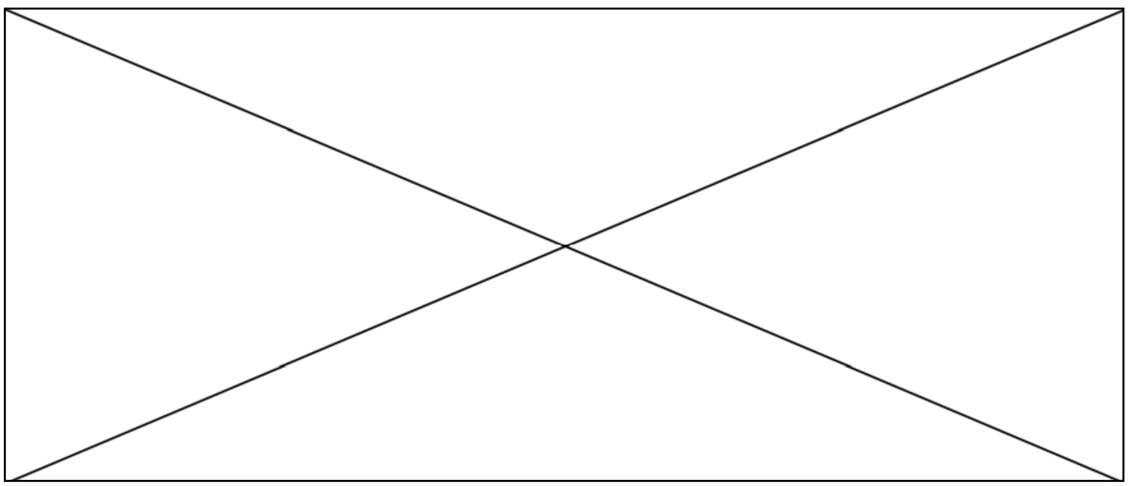


Figure 31: Mobility Precedents. *Garden Sukkah,* Allan Wexler (left); folding table (right)

5.5 Conclusion

As an initial observation, each of these approaches has at least one distinct advantage. The free-standing pavilion potentially offers the richest development of the project as "work of architecture". It can be understood in the round, and offer a clear relationship to its site. The Architecture Bridge seems to offer the most interesting site, with a myriad of potential solutions to the problem within the existing structure of the bridge. The Mobile Pavilion potentially offers the best solution to the program "a place to listen." Because it can be moved, it allows for the aural observation of the art/architecture corridor from a variety of listening points.

6: Design Conclusions

This thesis took a number of divergent turns during the exploration. The design process began by studying the physical properties of sound and material through the construction of a series of small instruments. From there, it transitioned into a range of installation strategies along the length of the bridge (figure 32). The idea of *threshold* emerged during this phase as a key conceptual and programmatic element of the project. The installation studies also revealed the potential of threshold to be understood as a sequence of transitional experiences, not just one experience (see figure 35).

The exploration phase of this project continued to study the idea of architecture as an instrument, and how the sound produced could be a meaningful part of the threshold into the architecture school (figure 34). A number of media were employed during the exploration, including physical and digital models, time-lapse video, sound recording and process sketches. This allowed for a variety of process studies, and a broad range of representational techniques.

The project culminated as architectural instruments that employed sound to alter, intensify, reveal, or defamiliarize place and ritual, providing a didactic experiential threshold to the University of Maryland School of Architecture, Planning, and Preservation. Three final elements were designed, including a *solar booth* (figures 36 and 39), a *wind harp* (figures 36 and 40), and a *crit hearth* (figures

36 and 41). Each element functioned individually to “alter, intensify, reveal or defamiliarize” aspect of place and ritual of the architecture school and the University of Maryland campus. As a set, they created an experiential entry to the architecture school that introduced important aspects of the study of architecture to the broader campus community.

The idea that the project would be built was a key component of the initial concept for this project. As the design process progressed, however, it was clear that the exploration of concepts and strategies required considerable investigation through means other than building at full scale. The final presentation included a series of movies and multi-media clips that allowed the audience to get a virtual experience of the project, and seemed to be highly successful as a way of presenting the experience.

As a project, the exploration of the concepts of sound, place and threshold were extremely valuable and rewarding. The process was very instructive, and the addition of the multi-media component of the presentation proved to be highly effective as a means of conveying the experience; as importantly, it proved to be a rich area for design exploration.

Were the project to be extended another semester, it would be an incredibly rewarding and instructive experience to actually build these three installations. For now, however, the ideas will remain active in my mind, and will surely find their way into built projects in the future.

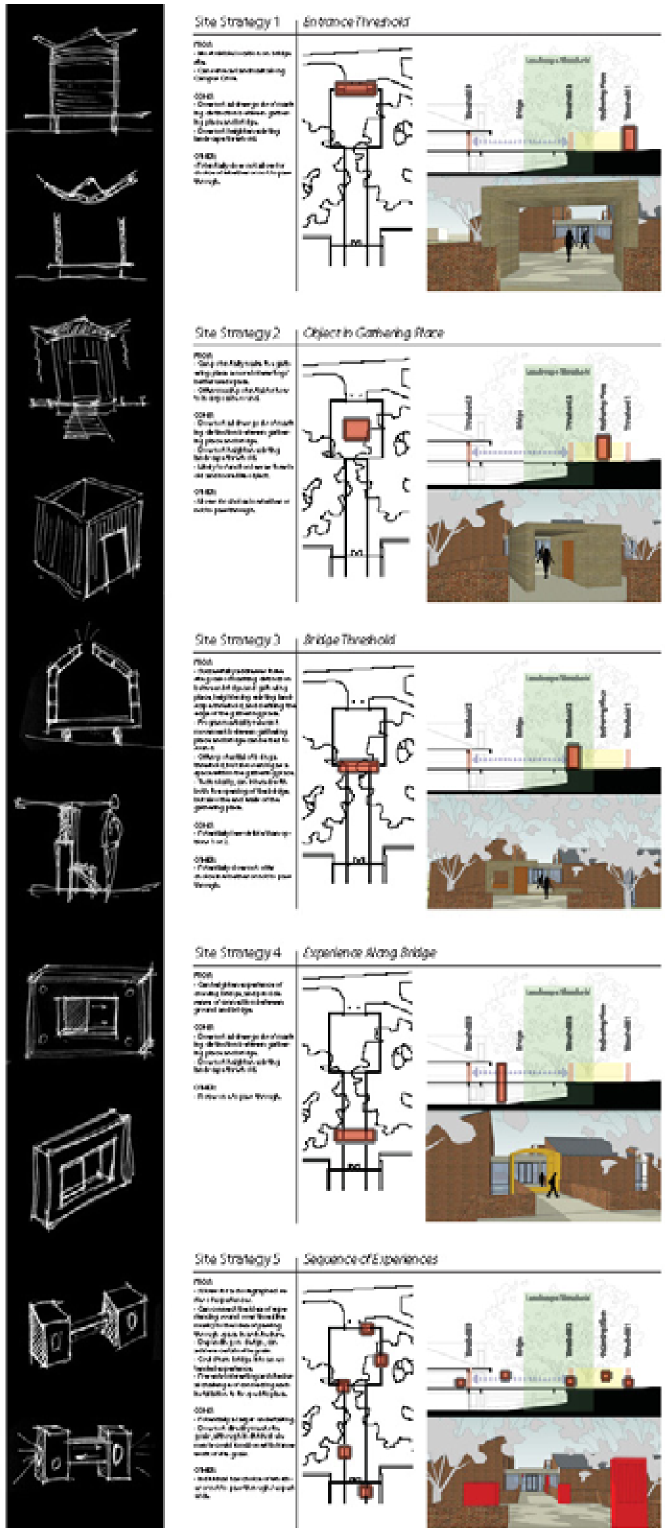


Figure 32: Process exploration – instrument studies and early installation studies.

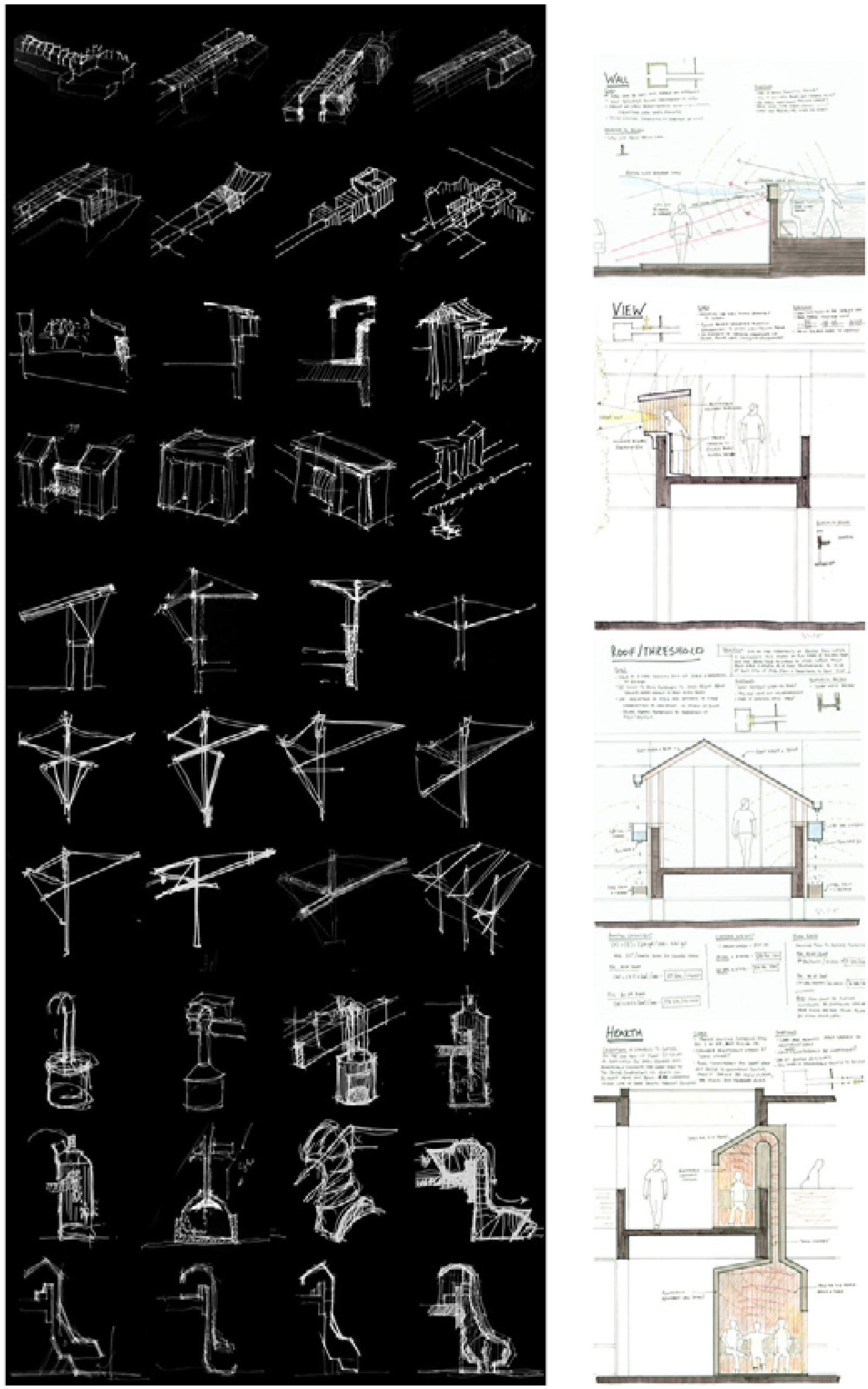


Figure 33: Process exploration – detail development and "architecture as instrument."

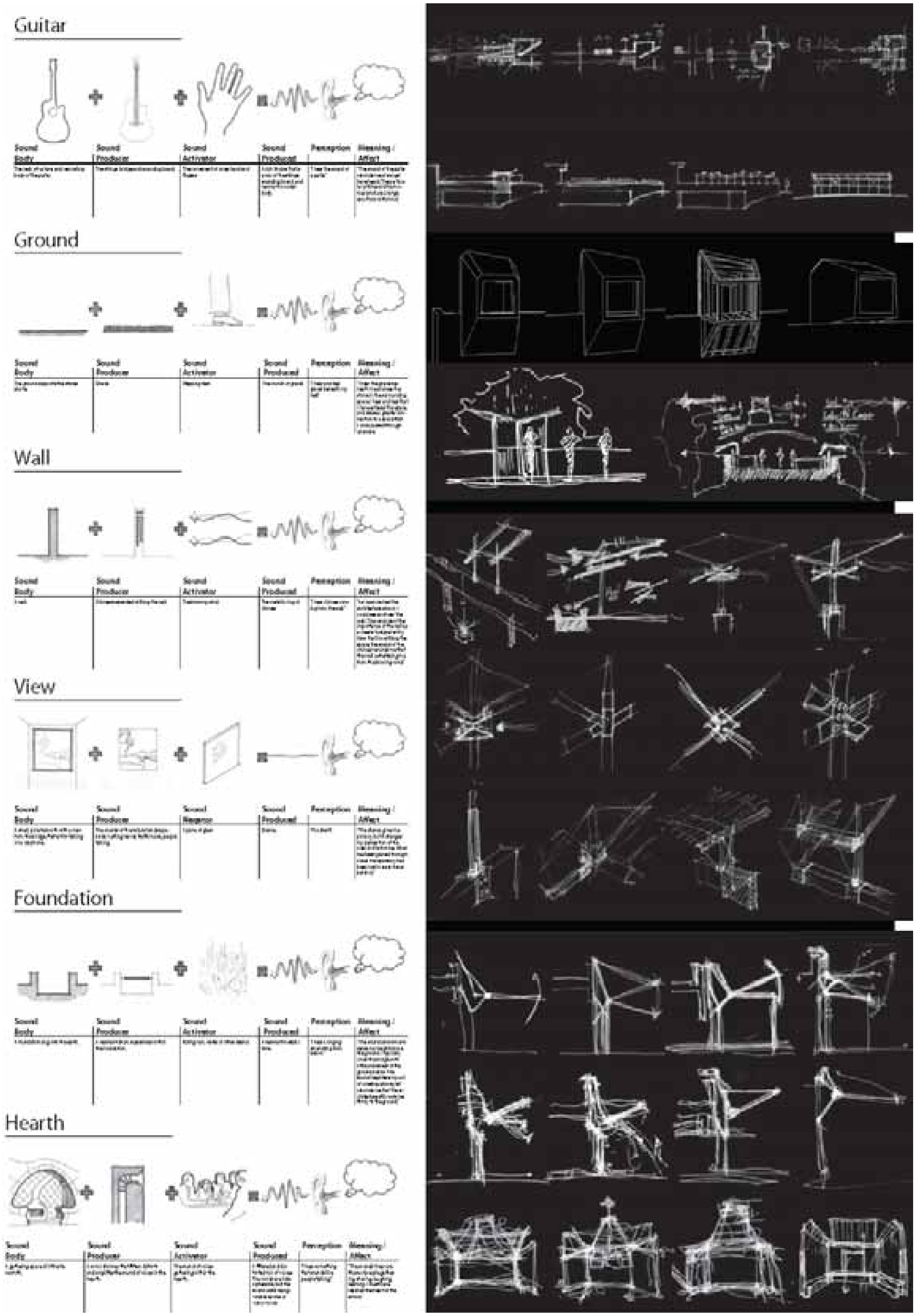
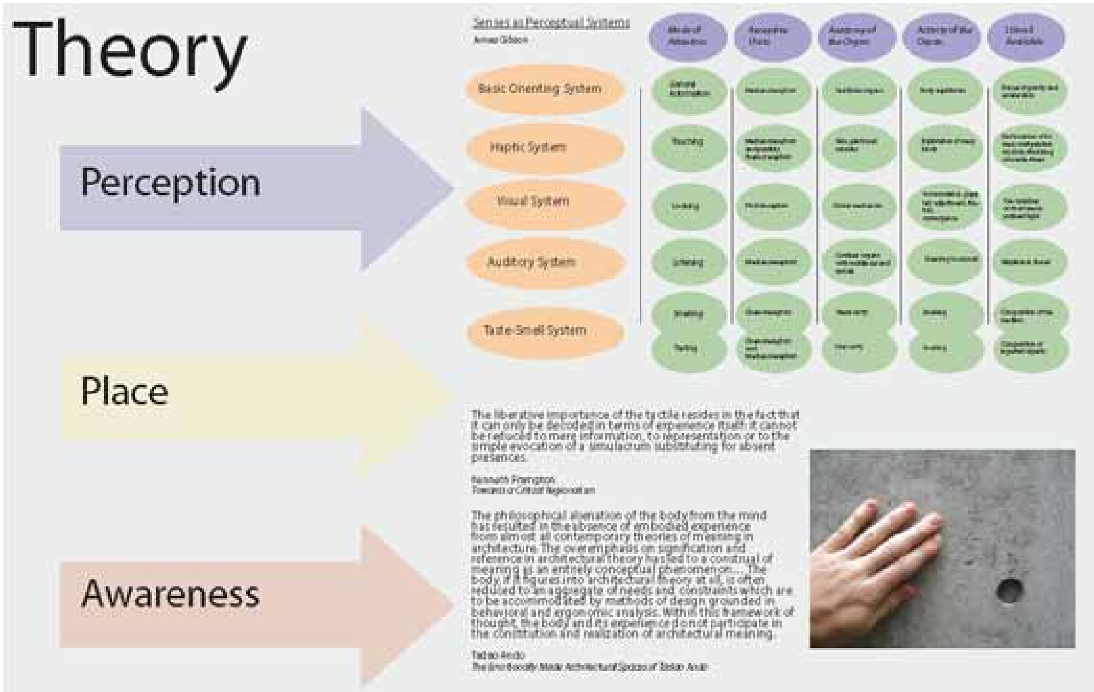


Figure 34: Process exploration – "sound and meaning" and detail development.



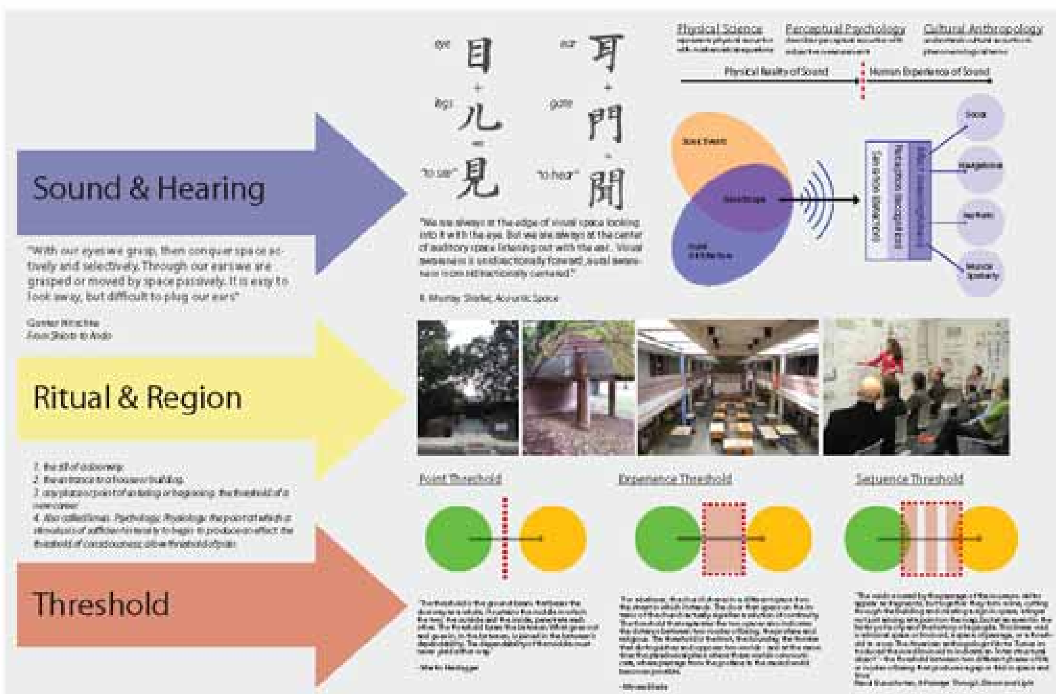


Figure 35: Theory diagrams – evolution of project concepts.

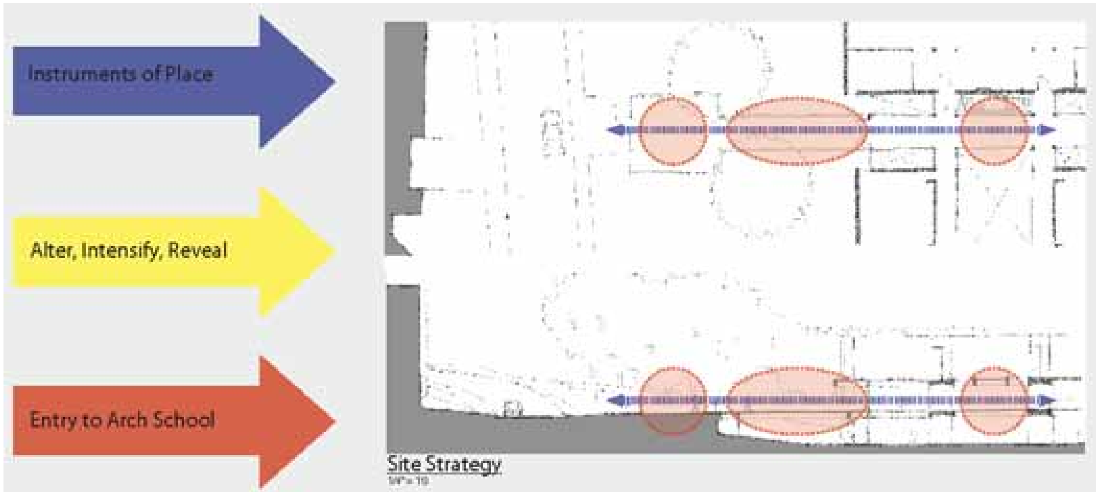


Figure 36: Top – site strategy. Bottom – element sections and details.

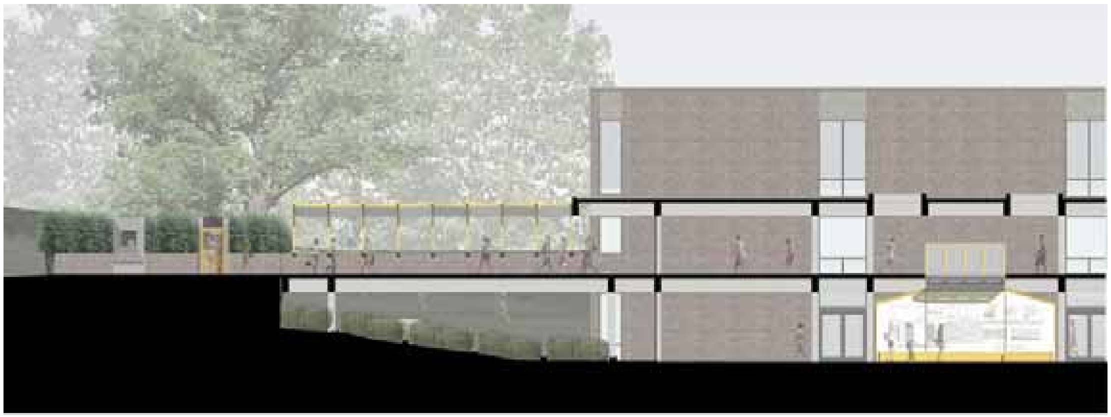


Figure 37: Top – site section looking east. Bottom – site axonometric.

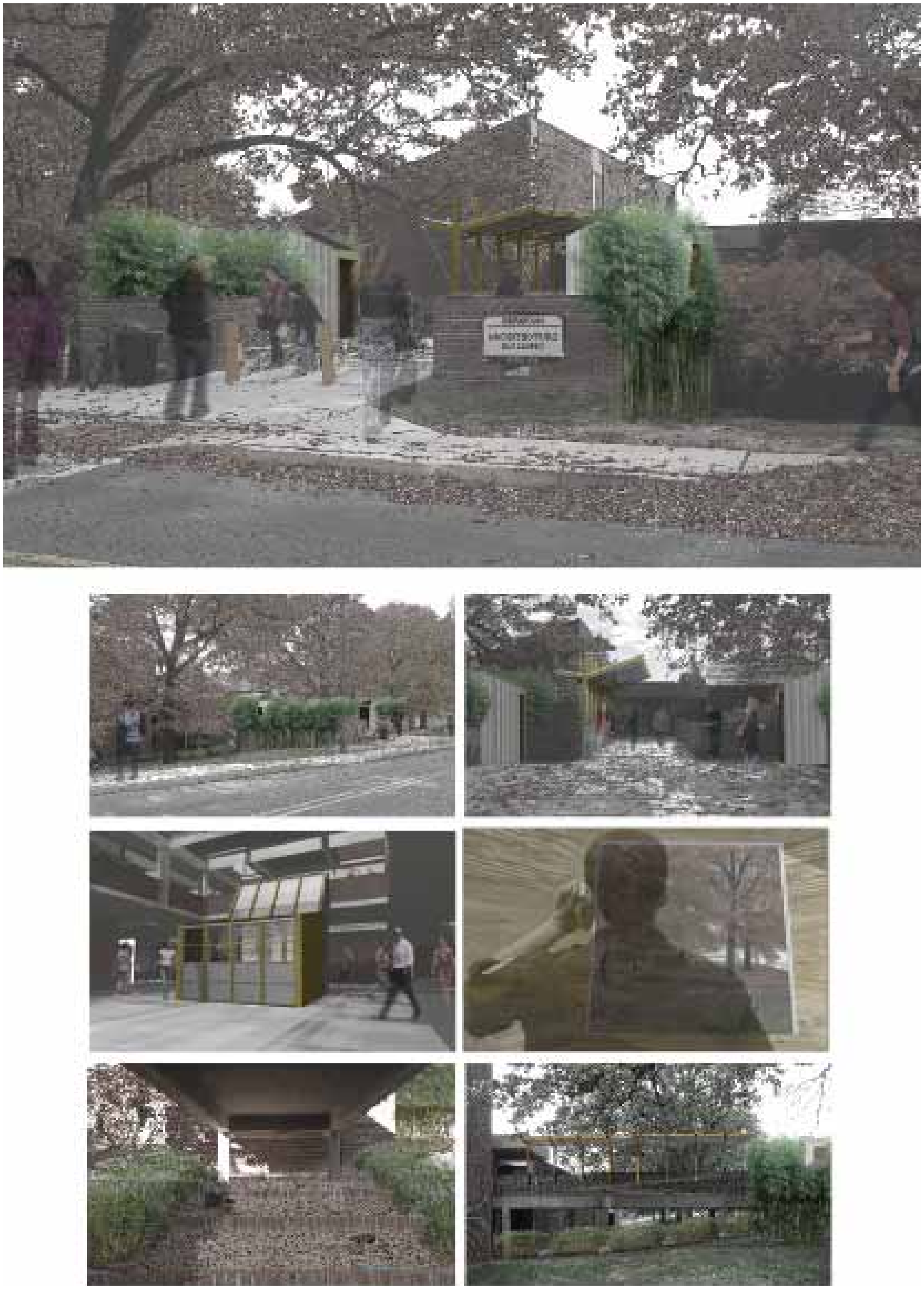
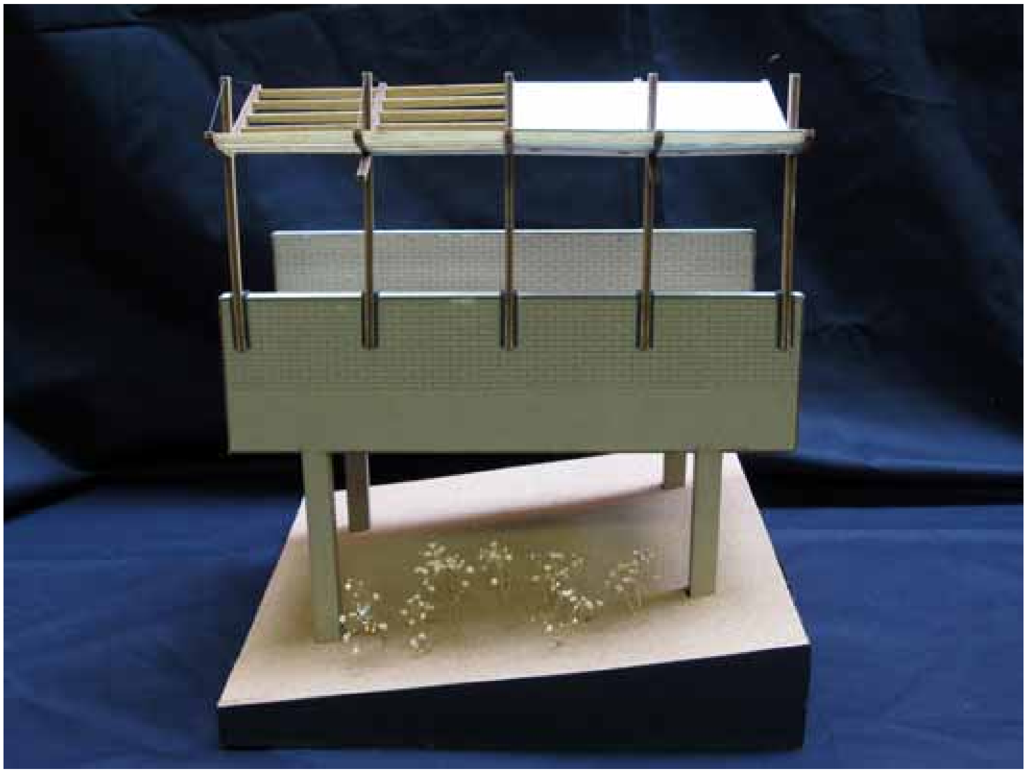


Figure 38: Perspectives. Top – main approach. Bottom – sequence through project.

Figure 39: Physical model – *Solar Booth*



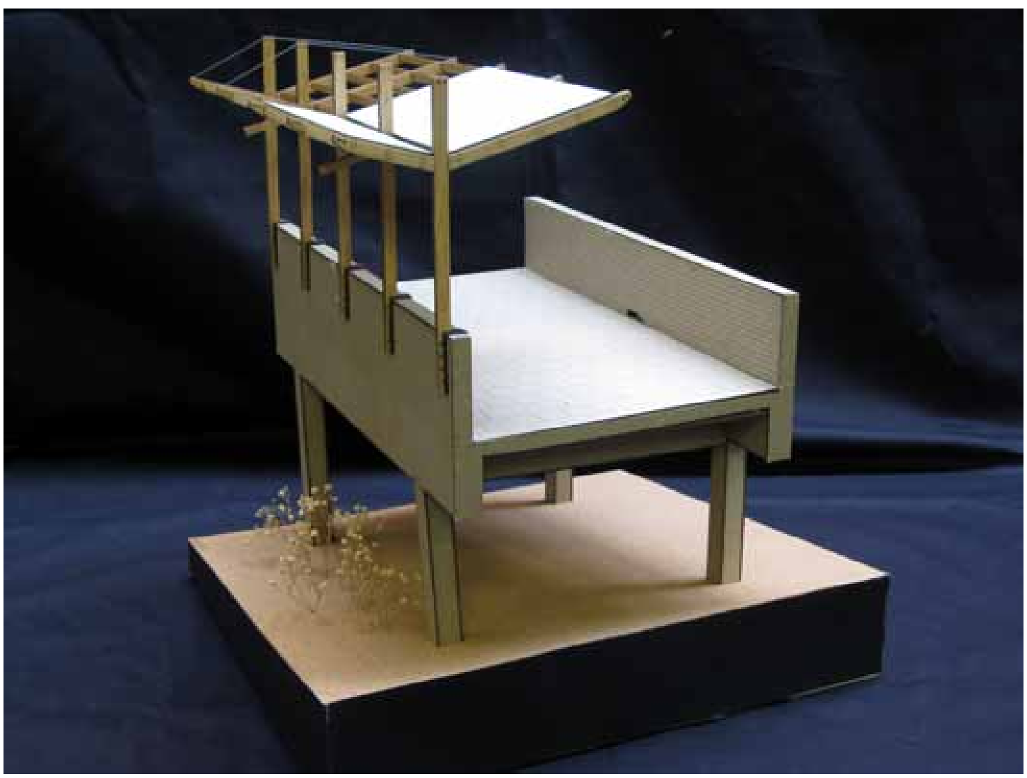


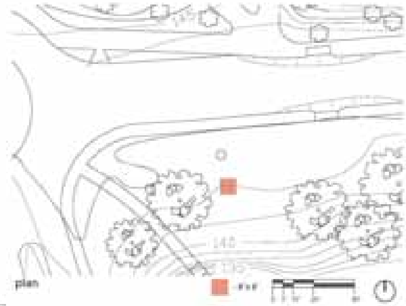
Figure 40: Physical model – *Wind Harp*

Figure 41: Physical Model – *Crit Hearth*

Appendix A

Site 1
site selection inventory / jwb thesis / fall 2007

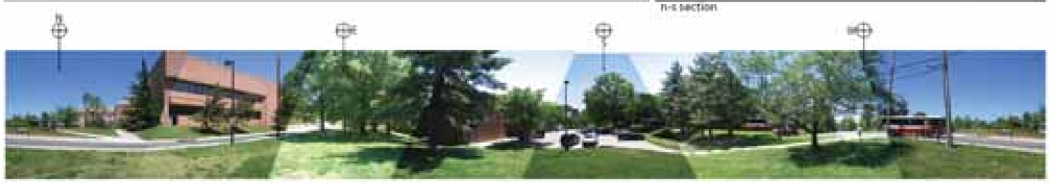

site plan


plan

Shade:	full sun
Utilities:	yes
Ground:	softscape
Visibility:	high
Circulation:	ped and auto
Transport:	UMD Shuttle

Comments:
comments about the specifics of this site


n-s section



Site 2
site selection inventory / jwb thesis / fall 2007

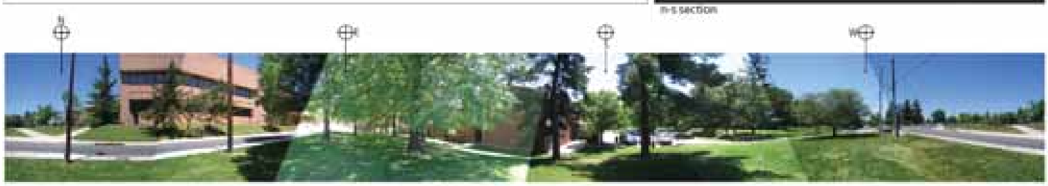

site plan


plan

Shade:	full sun
Utilities:	yes
Ground:	softscape
Visibility:	high
Circulation:	ped and auto
Transport:	UMD Shuttle

Comments:
comments about the specifics of this site


n-s section



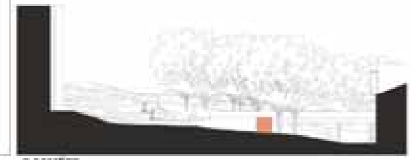
Site 3 site selection inventory / jwb thesis / fall 2007

site plan

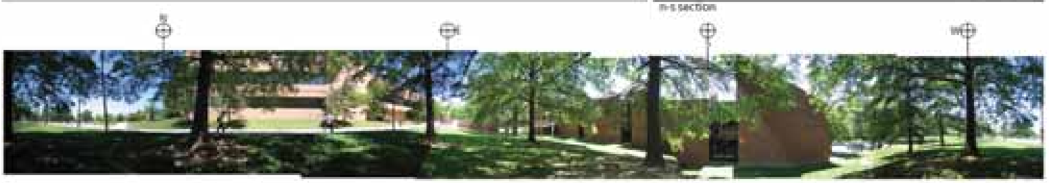
plan

Shade:	full sun
Utilities:	yes
Ground:	softscape
Visibility:	high
Circulation:	ped and auto
Transport:	UMD Shuttle

Comments:
comments about the specifics of this site

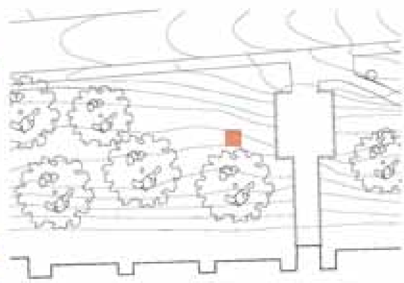


n-s section



Site 4 site selection inventory / jwb thesis / fall 2007

site plan



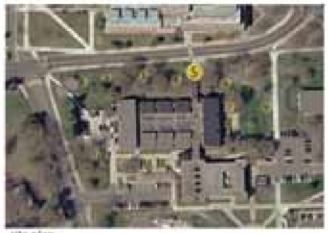
plan

Shade:	partial
Utilities:	no
Ground:	softscape
Visibility:	high
Circulation:	pedestrian
Transport:	UMD Shuttle

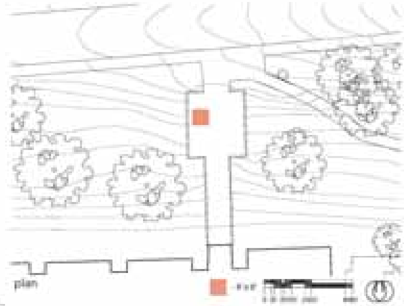
Comments:
good relationship to context

n-s section

Site 5 site selection inventory / jwb thesis / fall 2007



site plan



plan

Shade:	full sun	*Comments:* on the bridge
Utilities:	no	
Ground:	hard scape	
Visibility:	high	
Circulation:	ped and auto	
Transport:	none	

n-s section

Site 6 site selection inventory / jwb thesis / fall 2007

site plan

plan

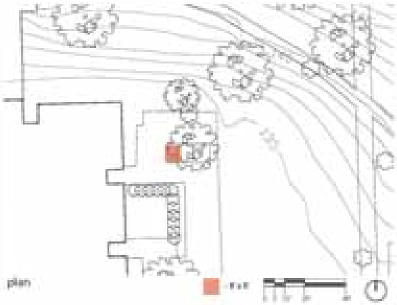
Shade:	partial	*Comments:* front door / back door
Utilities:	no	
Ground:	softscape, uneven	
Visibility:	medium	
Circulation:	ped	
Transport:	none	

n-s section

Site 7

site selection inventory / jwb thesis / fall 2007

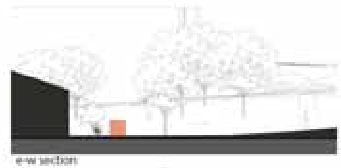
site plan



plan

Shade:	full sun
Utilities:	yes
Ground:	softscape
Visibility:	high
Circulation:	ped and auto
Transport:	UMD Shuttle

Comments:
comments about the specifics of this site

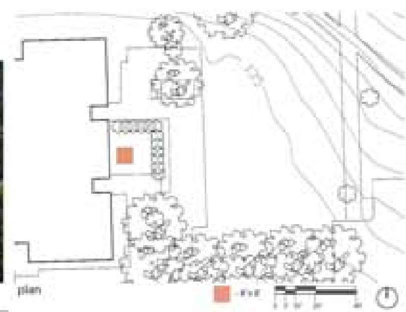


e-w section

Site 8

site selection inventory / jwb thesis / fall 2007

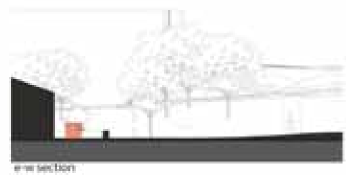
site plan



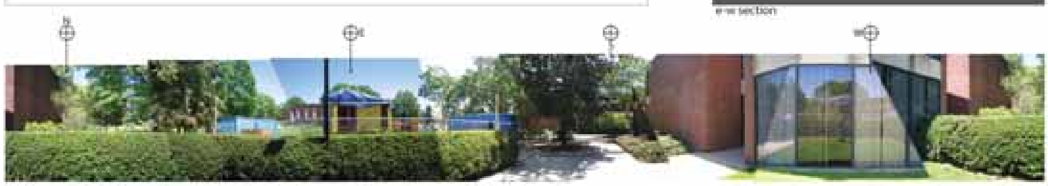
plan

Shade:	full sun
Utilities:	yes
Ground:	softscape
Visibility:	high
Circulation:	ped and auto
Transport:	UMD Shuttle

Comments:
comments about the specifics of this site

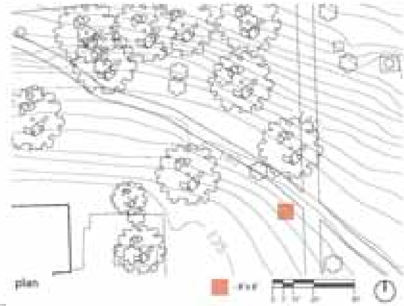


e-w section



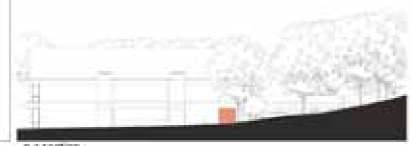
Site 9 site selection inventory / jwb thesis / fall 2007

site plan

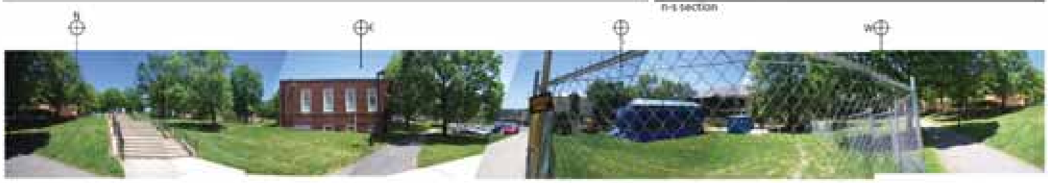


plan

Shade:	full sun	*Comments:* comments about the specifics of this site
Utilities:	yes	
Ground:	softscape	
Visibility:	high	
Circulation:	ped and auto	
Transport:	UMD Shuttle	

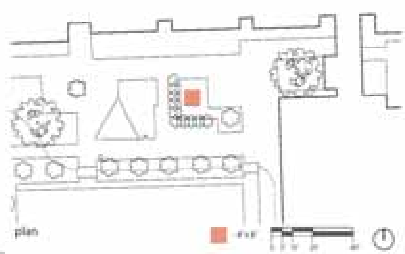


n-s section



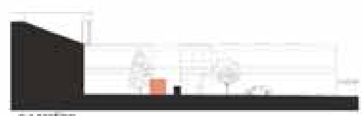
Site 10 site selection inventory / jwb thesis / fall 2007

site plan



plan

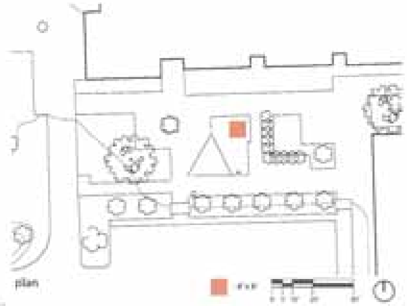
Shade:	full sun	*Comments:* comments about the specifics of this site
Utilities:	yes	
Ground:	softscape	
Visibility:	high	
Circulation:	ped and auto	
Transport:	UMD Shuttle	



n-s section

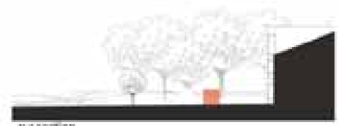
Site 11 site selection inventory / jwb thesis / fall 2007

site plan

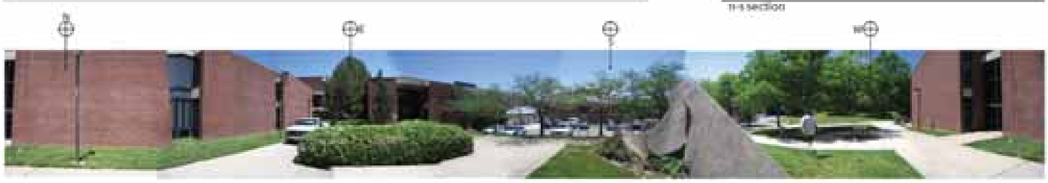


plan

Shade:	full sun	*Comments:* comments about the specifics of this site
Utilities:	yes	
Ground:	softscape	
Visibility:	high	
Circulation:	ped and auto	
Transport:	UMD Shuttle	

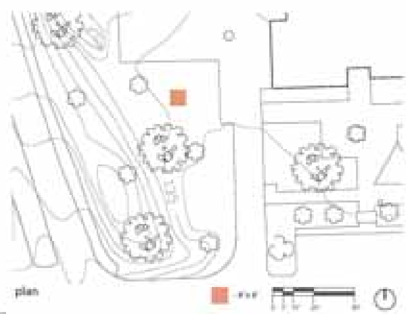


n-s section



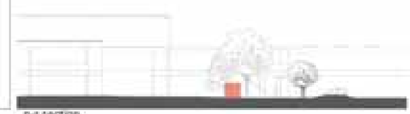
Site 12 site selection inventory / jwb thesis / fall 2007

site plan



plan

Shade:	full sun	*Comments:* comments about the specifics of this site
Utilities:	yes	
Ground:	softscape	
Visibility:	high	
Circulation:	ped and auto	
Transport:	UMD Shuttle	



n-s section

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