

Sound Skin Space: An Intervention to Stimulate Acoustic Interaction
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What would it mean to make space inspired by the sounds of a particular place. The sounds are natural and man-made heard on the site; the place is Virginia Polytechnic Institute and State University's campus. I designed a series of outdoor spaces that reflect sound, and provide a structure where people can add to the sounds of campus.

This project creates space that facilitates acoustic activities of a university. The walls reflect and focus sound due to their material and geometry. Sound is treated as a building material; used to help form the spaces that are visibly bounded by concrete and plywood. Concrete walls and plywood floor will alter the acoustic activity on the site; the acoustic fabric will be constantly changing, providing unique moments for people to discover as they pass through the site.

Sound: a vibration in an elastic medium, such as air, or water!

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"...the actions that produce sound appear scattered in space and time, tied to events that merely take place within a larger state of being."²

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iii Pure

tone:

a

vibration

produced

at

a

single

frequency. iv

soundskinspace

"You can't make sound become hard and solid; but you can make it seem to stand still, as if hovering in place, so that you can walk around inside its acoustic structures."³



Frequency: the rate of repetition of a periodic event.



Pitch:

the

subjective

response

of

human

hearing

to

frequency.



Wavelength: the distance a sound wave travels during one cycle of vibration.



Structure-borne

sound:

sound

energy

that

can

travel

through

building

materials.



Free field: when sound waves are free from the influence of reflective surfaces.



sound skin space

an intervention to stimulate acoustic interaction

Brooke Karius
Virginia Polytechnic Institute and State University

Reflection: the return of a sound wave from a surface.

acoustic life



urban connections: flow, porous, boundary

The site is at the northeast end of the drillfield on Virginia Tech's campus in Blacksburg, Virginia. At the intersections of the road circumscribing the drill field and the straight road running tangent to it are two triangular shaped green-spaces. They sit between the town and campus from east to west, as a permeable boundary between academic and social life. People rarely spend more time here than the minute it takes to walk across the site. This area of campus is highly populated in the morning as students and professors are going to classes, and at the end of the day, but most of all in the afternoon as people head to town for lunch. At other times the noise of the bus waiting at the stop overpowers all other acoustic activity present on the site. Once the busses part, the site is rather quiet, I always felt as if it was holding its breath until the next throng of passengers. The acoustic life of the site goes through this cycle, experiencing similar sounds at the same time each day.

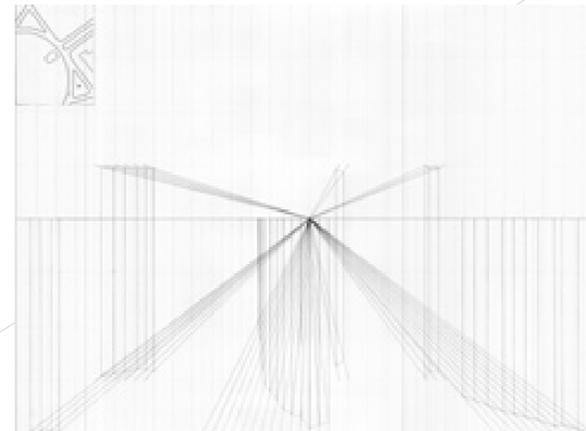
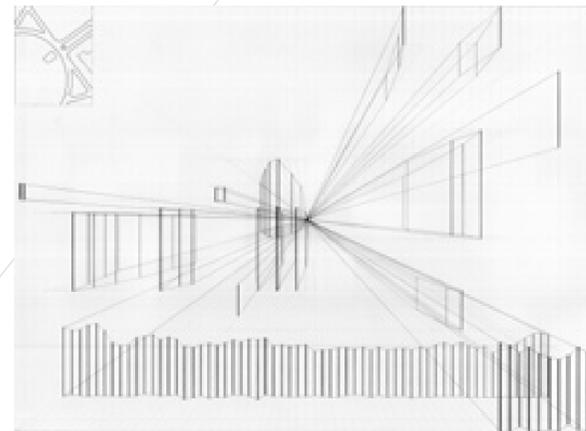
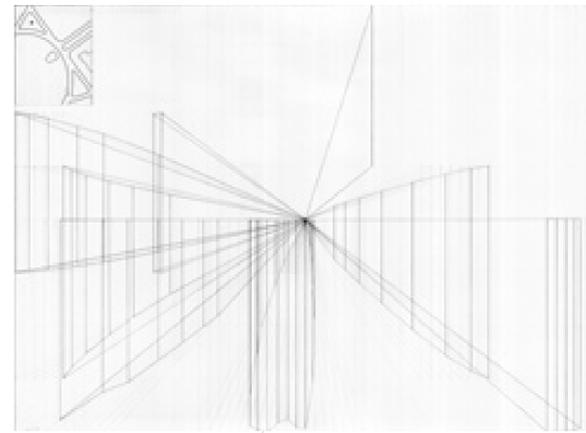


hierarchy

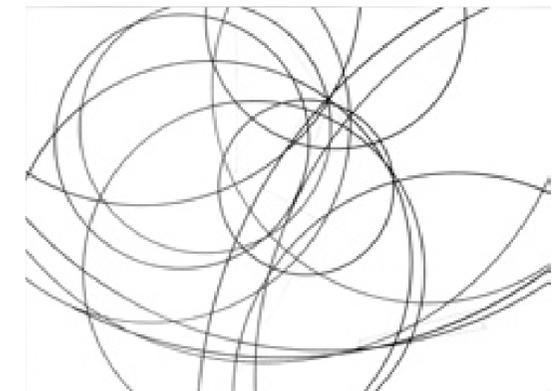
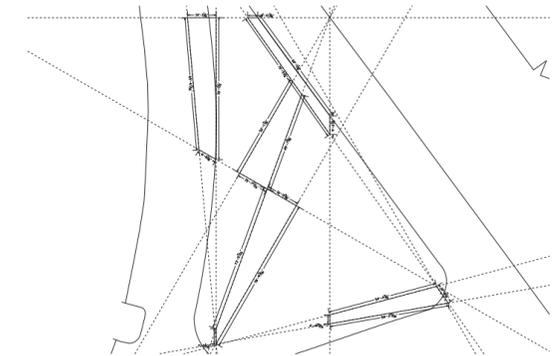
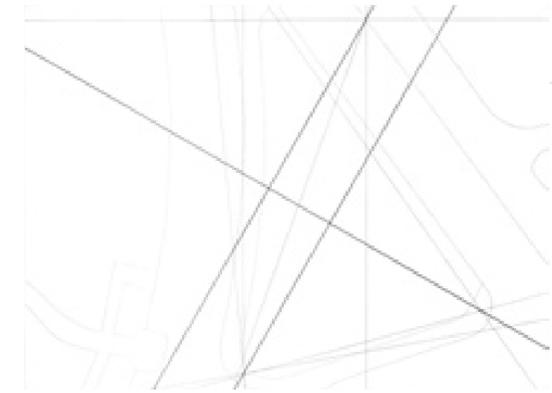
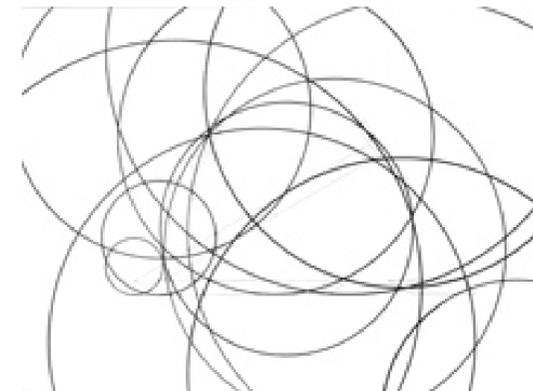
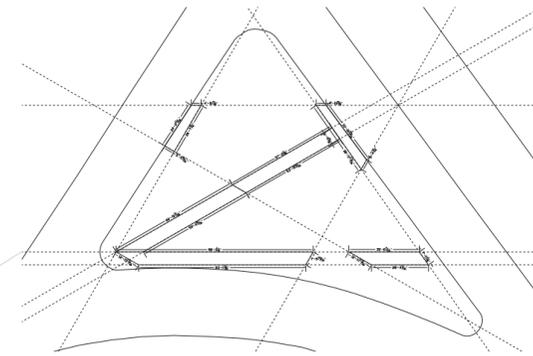
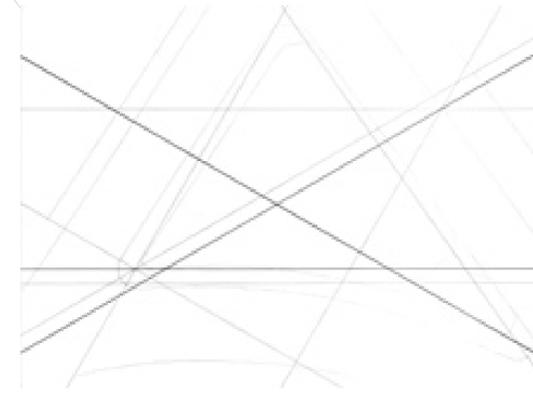
"A line is an infinite series of points. Space can be defined by lines."⁴ I propose that the series of points is created with sound. Points of sound will be focused by reflecting natural sounds from the site, off of concave and convex concrete walls to a series of focal points. Thereby defining and emphasizing space with lines of sound. The design development led to a set of drawings showing the dimension of circles that create the desired focal points. Segments of circles are realized in the form of walls. The walls are oriented in a way to acoustically connect with the surrounding area, the bell tower, the drillfield, the bus stops, and the plaza in front of the library.

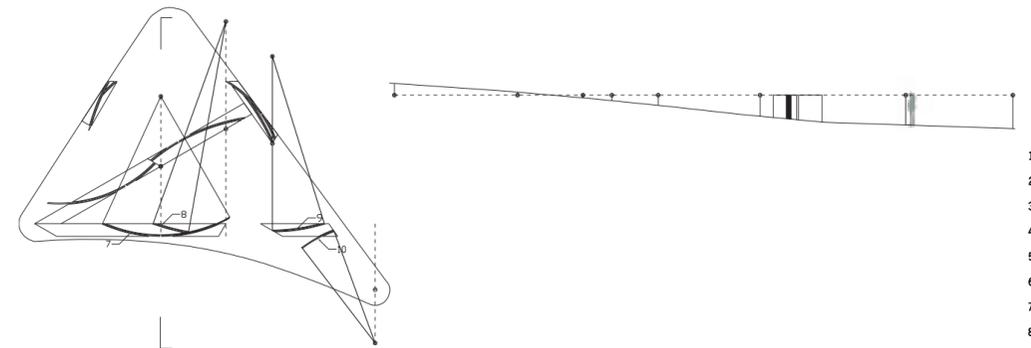
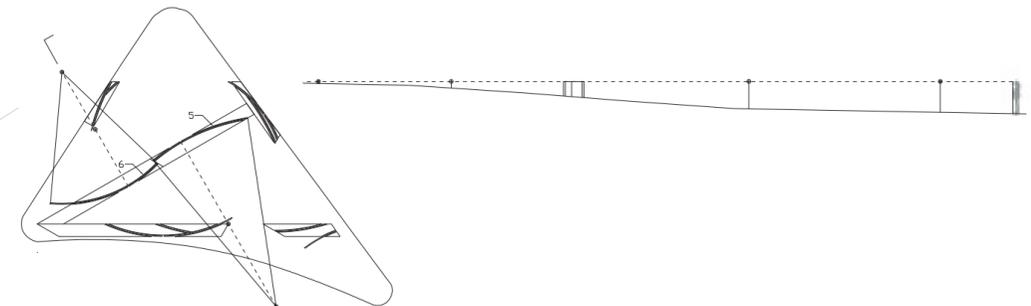
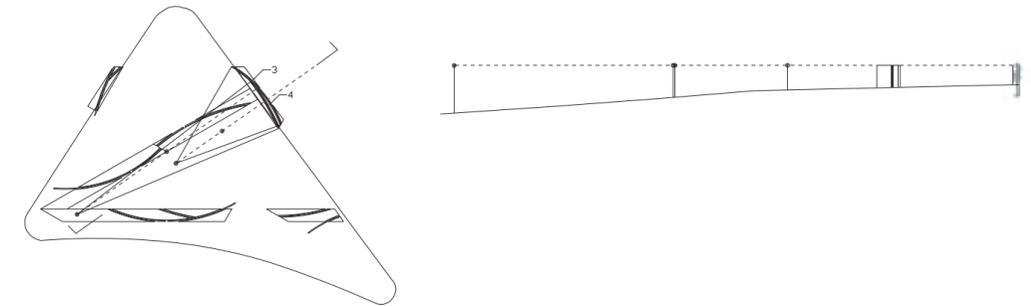
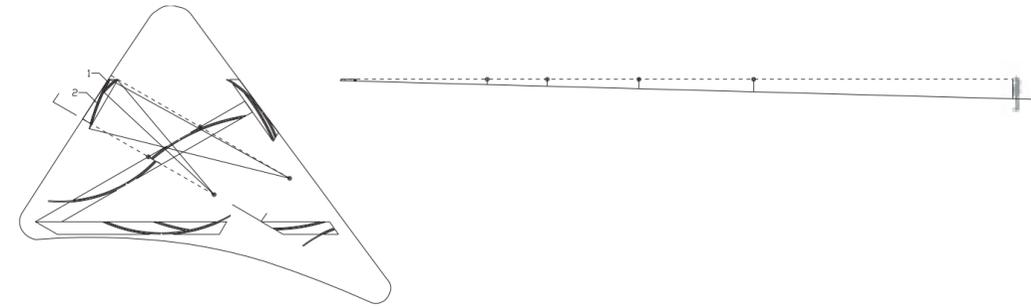
A change in the material of the ground signals pedestrians that they have entered the acoustically dense spaces. All of these elements acting simultaneously cause an acoustically active environment; constantly changing the nature of this place.

Sound has the ability to make us more aware of our surroundings. A solitary person may feel less alone in an acoustically active environment, than an acoustically dead environment. In this I found potential to use sound as an architectural material to heighten the intention of the space.



narrative





1. R77°-10"
arc 9'-6"
2. R105°-10"
arc 27'-8"
3. R57°-9"
arc 40'-4"
4. R112°-10"
arc 27'-7"
5. R98°-1°
arc 54'-9"
6. R68°-1°
arc 60'-7"
7. R72°-0°
arc 66'-7"
8. R110°-8°
arc 17'-5"
9. R90°-0°
arc 25'-2"
10. R61°-11°
arc 18'-5"

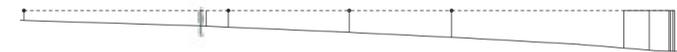
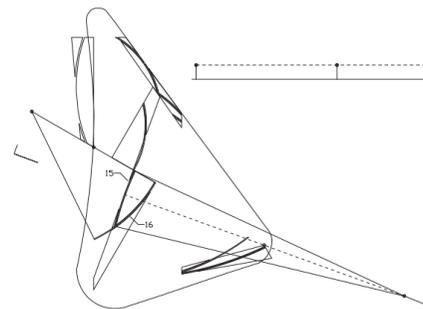
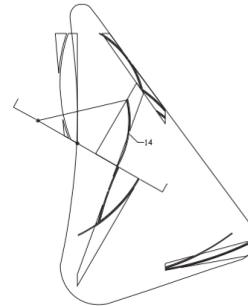
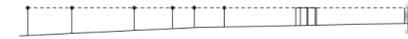
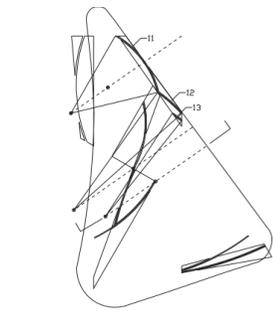


plans 1/16" = 1'-0"

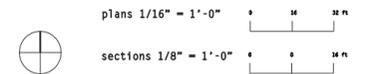


sections 1/8" = 1'-0"



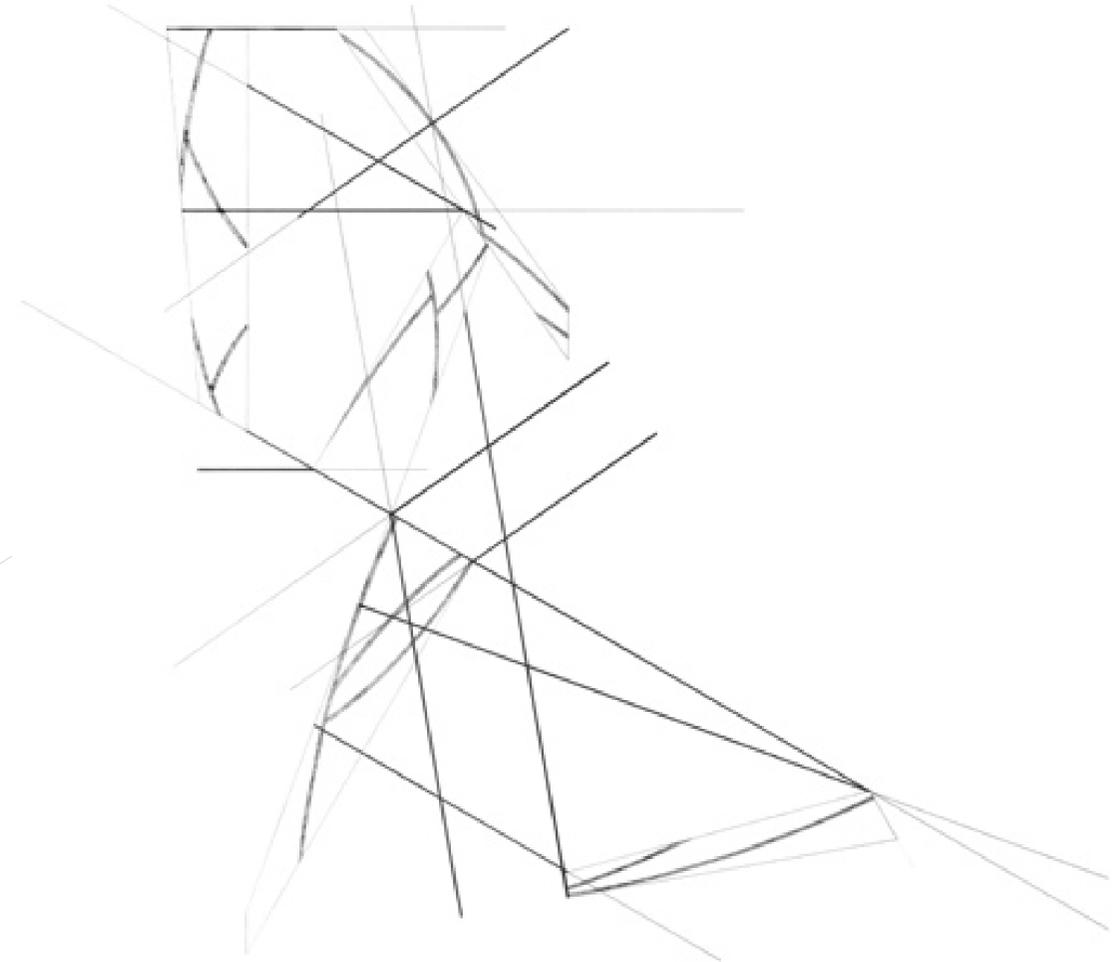
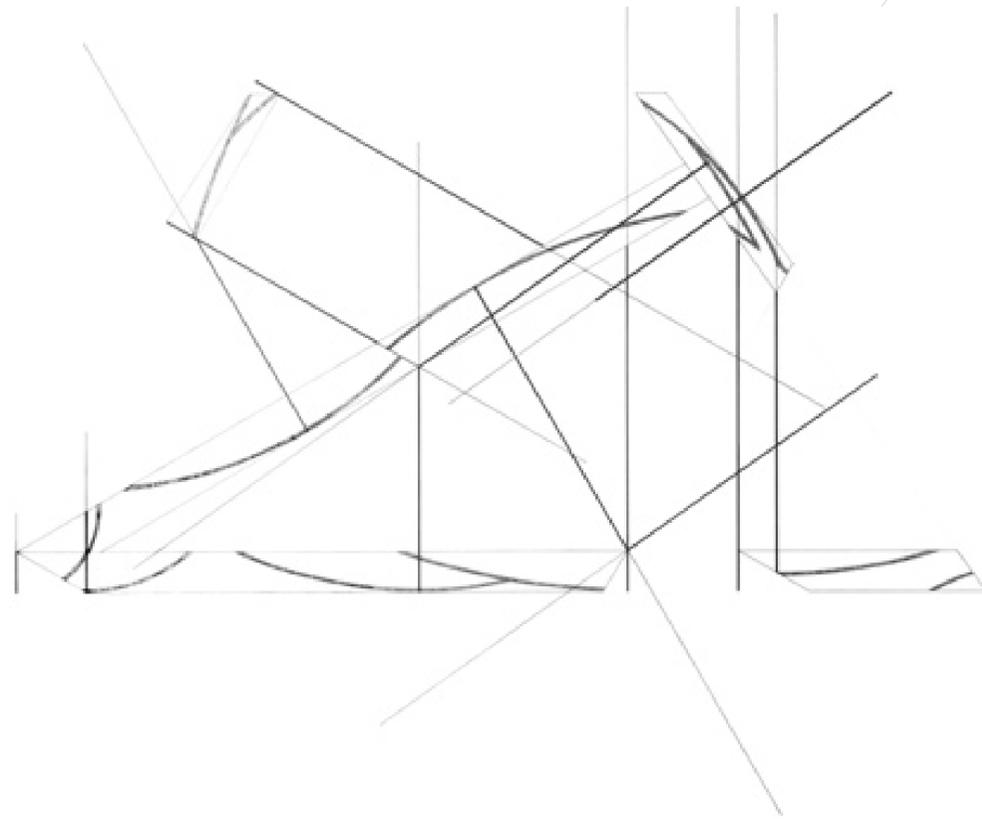


- 11. R57'-3"
arc 46'-11"
- 12. R92'-7"
arc 21'-0"
- 13. R78'-6"
arc 6'-10"
- 14. R58'-6"
arc 44'-11"
- 15. R189'-6"
arc 36'-5"
- 16. R91'-0"
arc 54'-0"
- 17. R141'-10"
arc 49'-6"
- 18. R206'-10"
arc 57'-9"



remnant of circular arc

bending of material

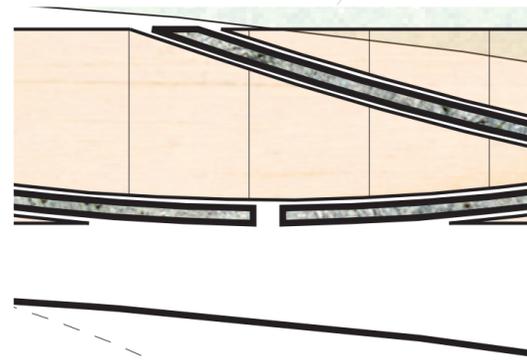
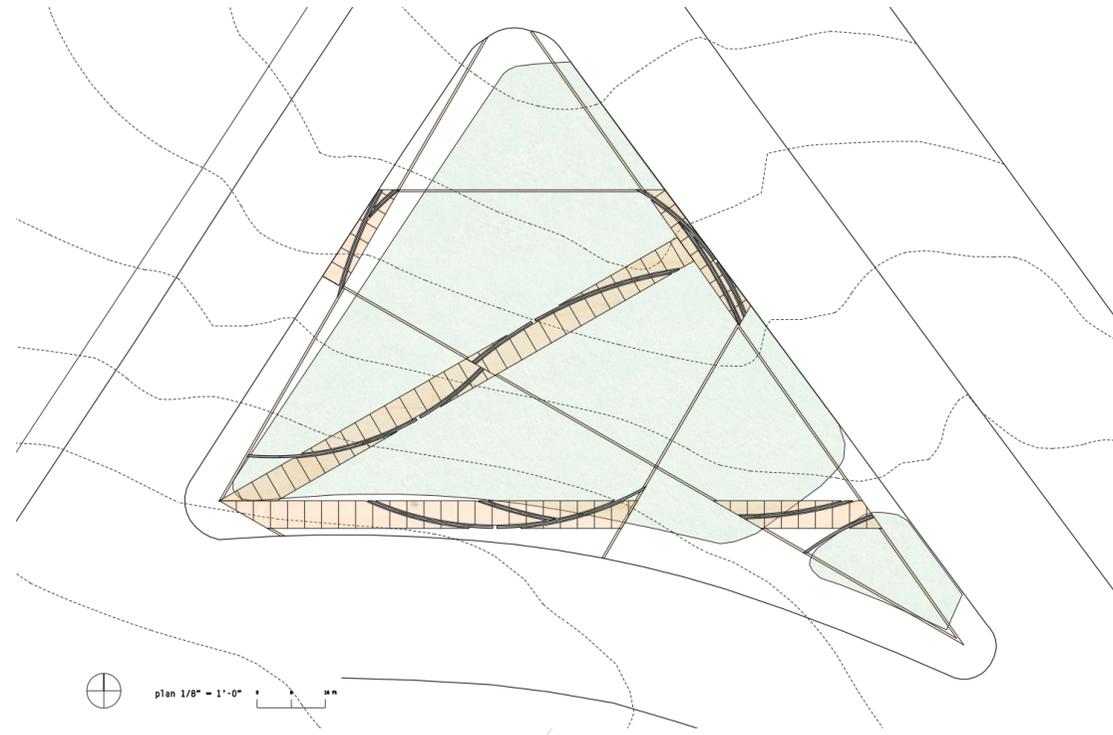


acoustic qualities of the ground plane

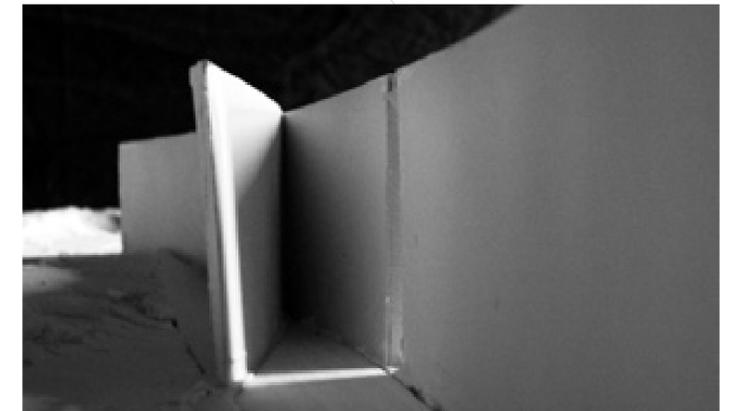


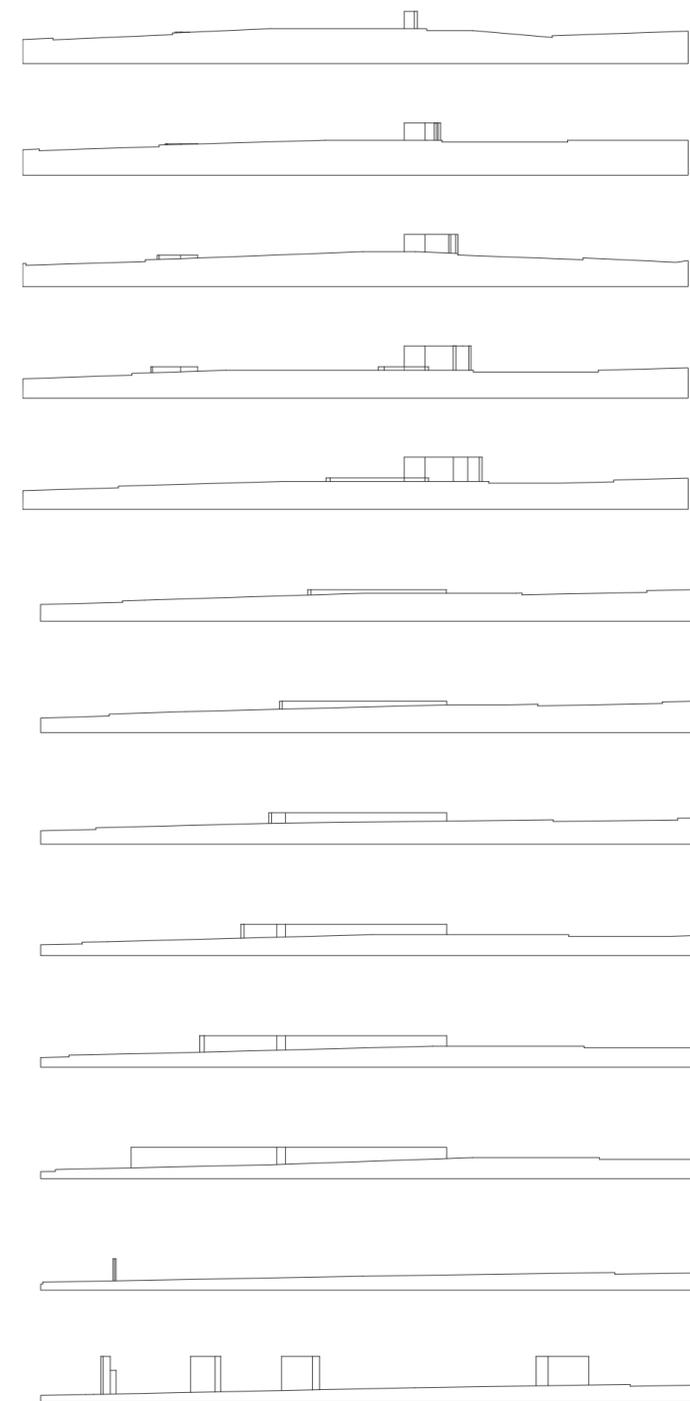
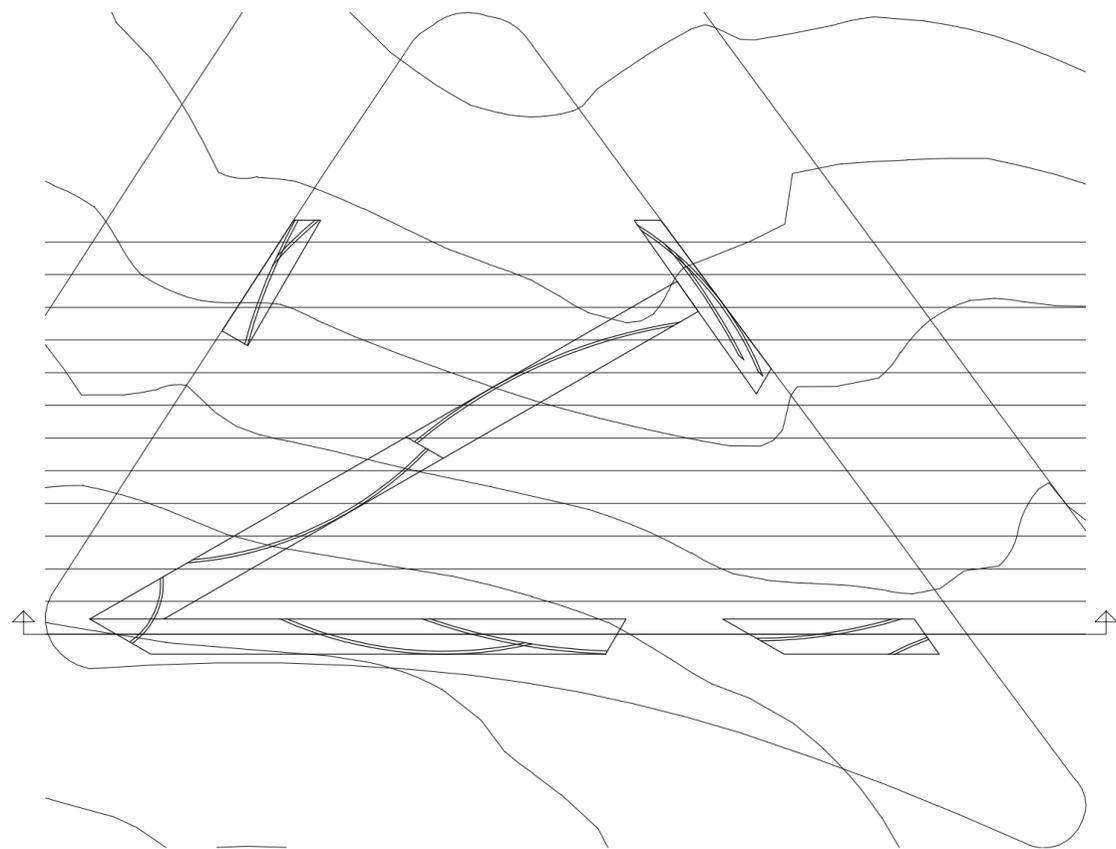
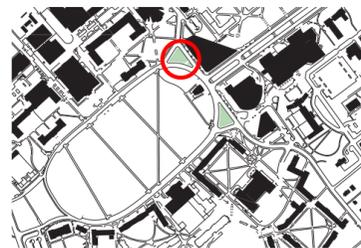
24 Echo: the distinct repetition of the original sound and is sufficiently loud to be clearly heard above background noise. 25

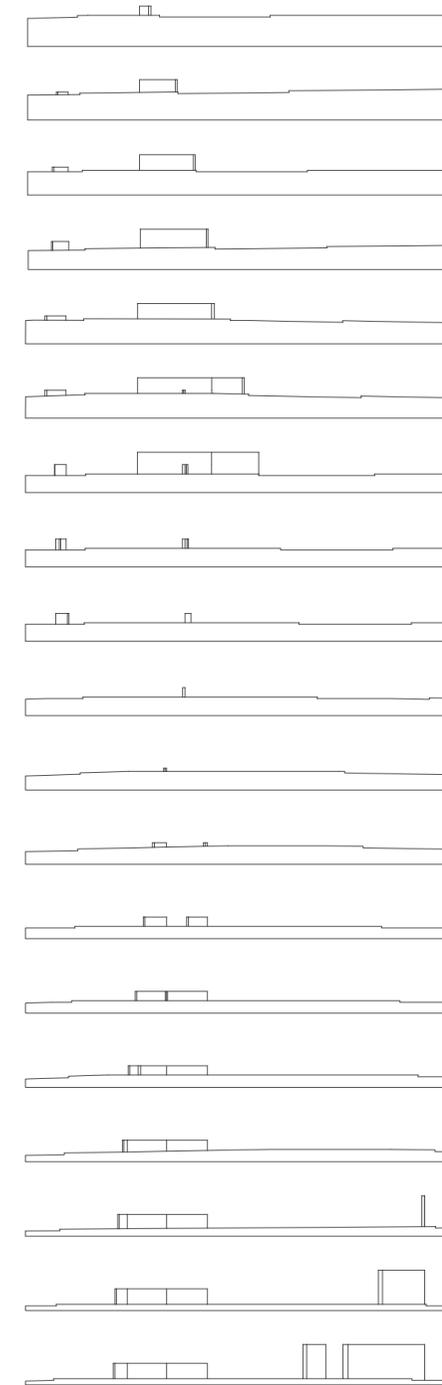
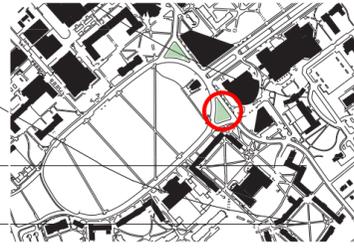
temporary transformation of place



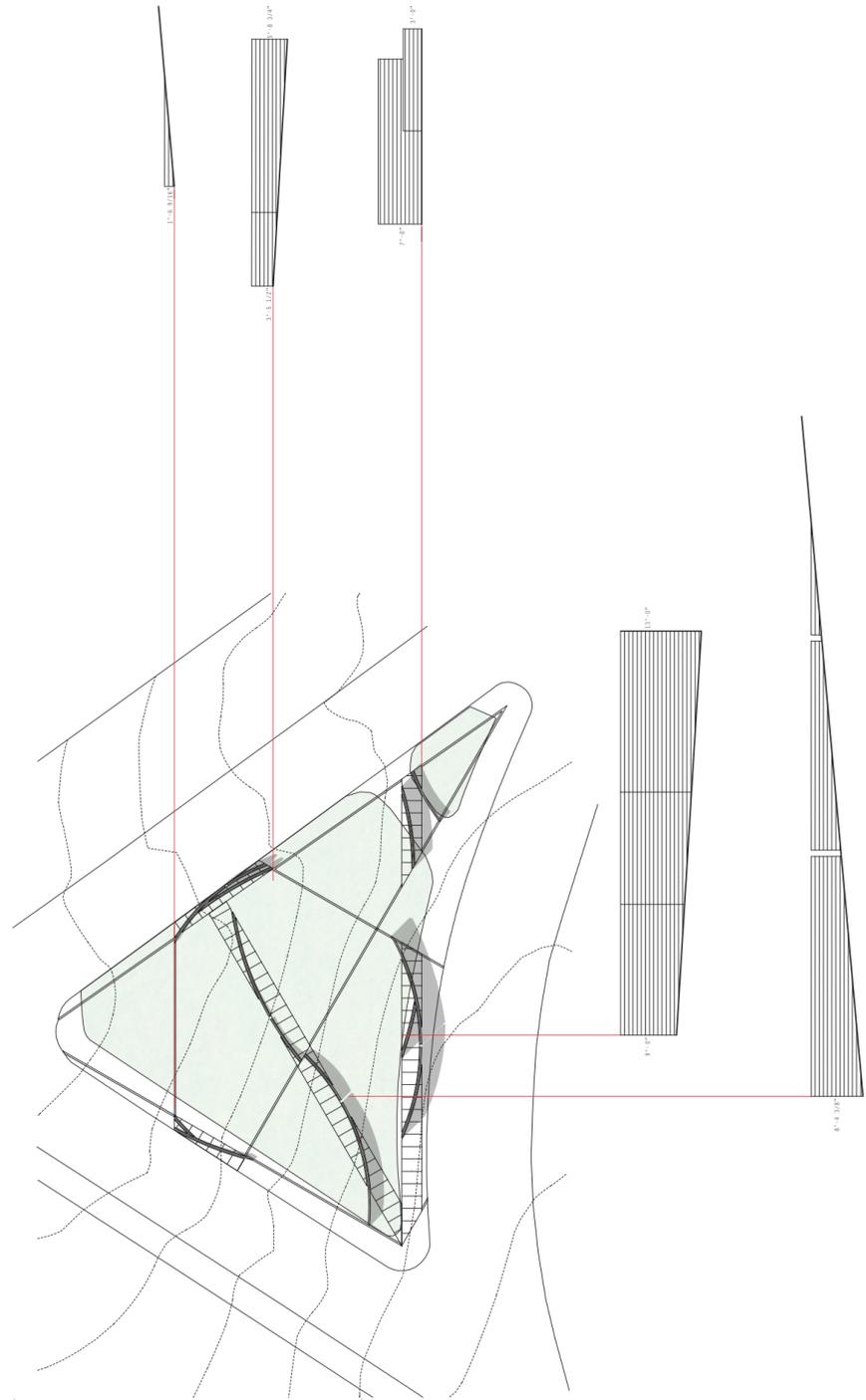
"A curve acquires its meaning through its contrast with straightness."⁵ The ground is composed of straight lines, the walls of circular arcs. Where the straight line meets the arc is a tangent point. In the point on the wall where the tangent is, I cut an 8" slit the height of the wall. The band of light passing through the wall makes the tangent point more evident than it would have been and adds a dramatic lighting effect to the acoustic activity.







30 Transmission loss: a measure of how much sound energy is reduced in transmission through materials. 31



plan 1/16" = 1'-0"

elevations 1/8" = 1'-0"

sound

energy

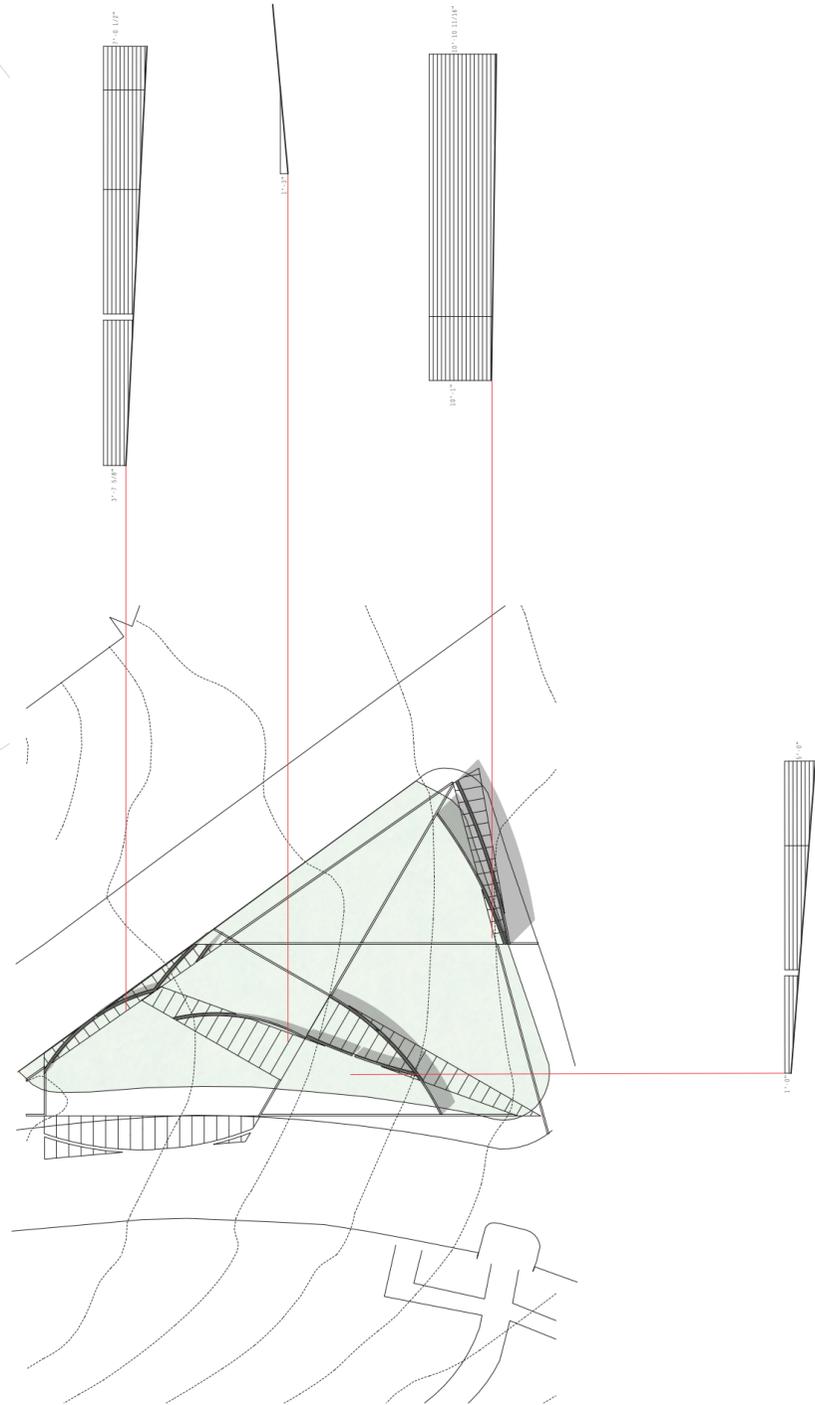
can

bypass

constructions

through

indirect



plan 1/16" = 1'-0"

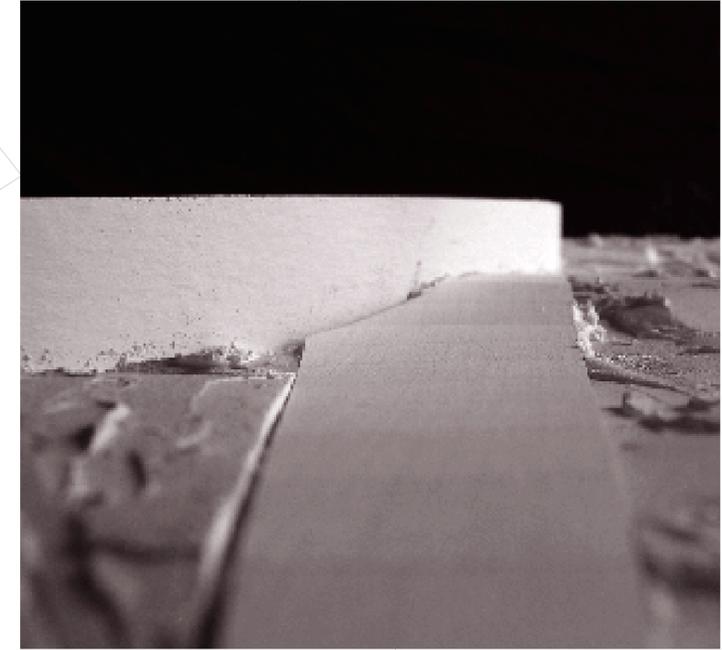
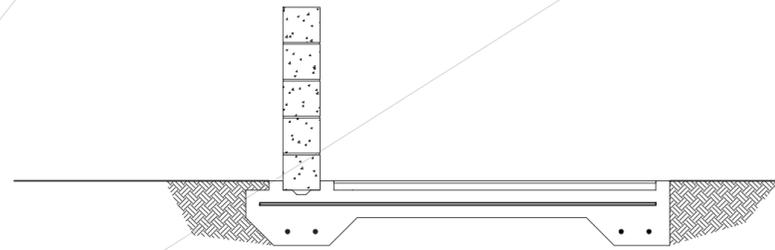
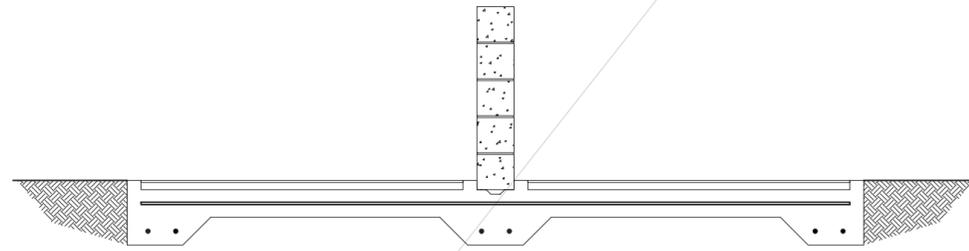
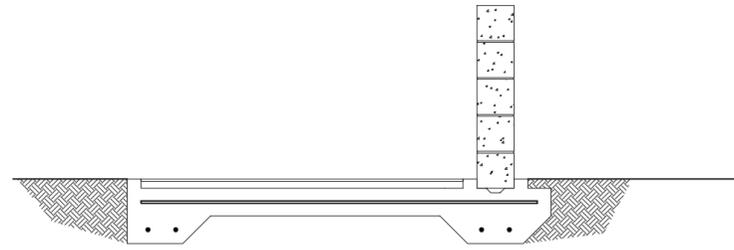
elevations 1/8" = 1'-0"

start with the object

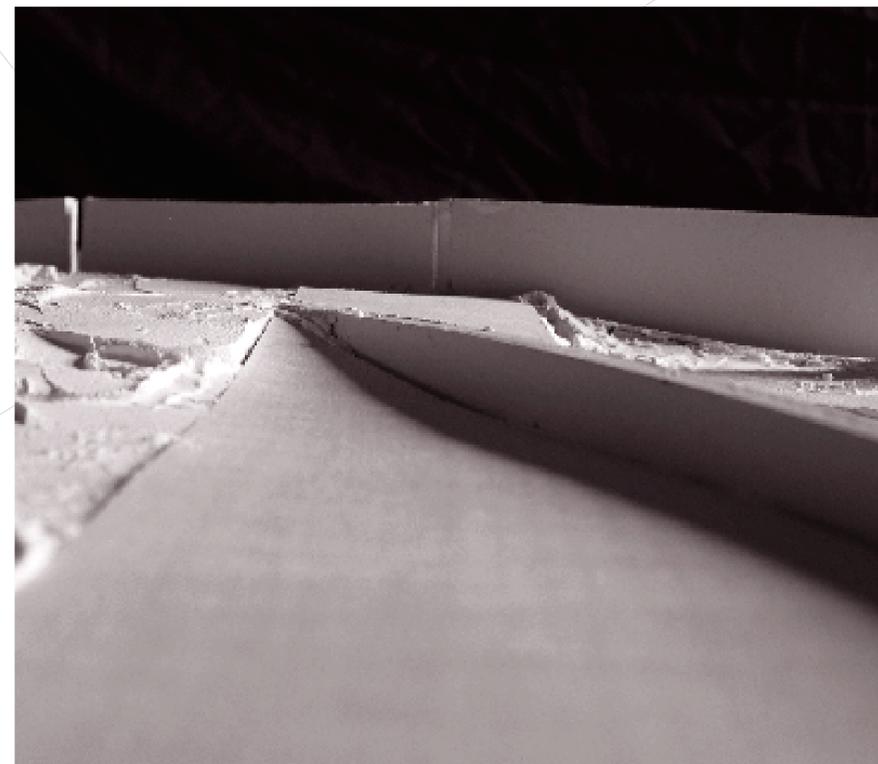
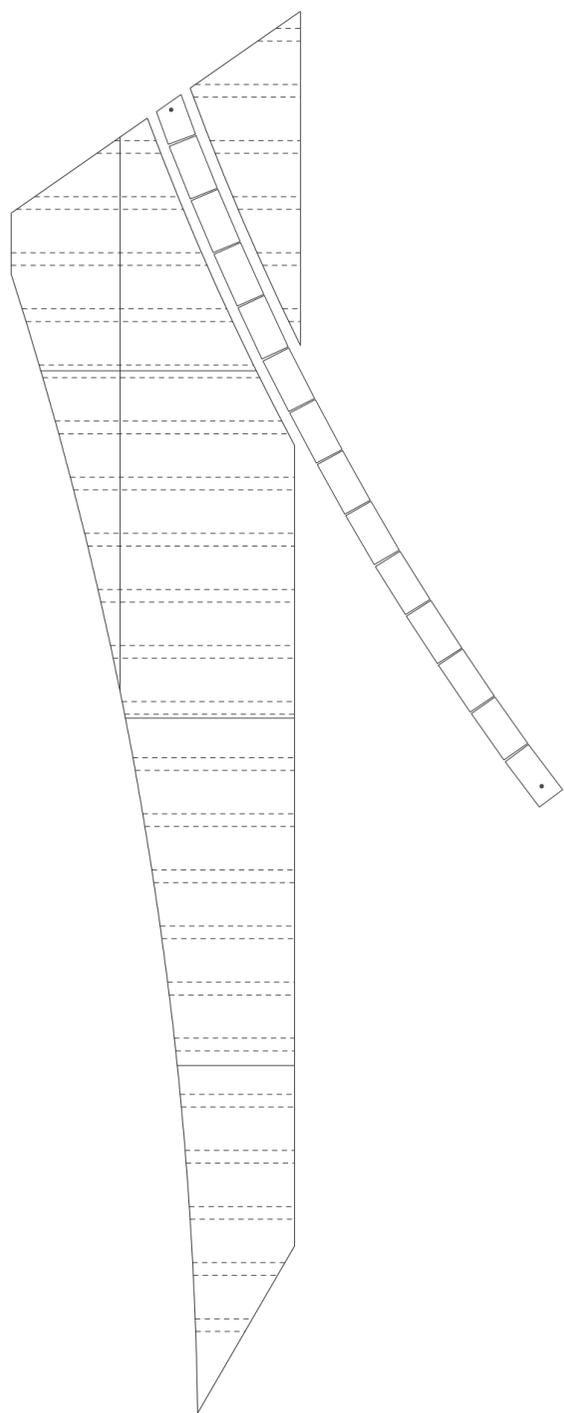
	sound absorption coefficient ⁷					
	125 hz	250 hz	500 hz	1000 hz	2000 hz	4000 hz
concrete, rough	0.01	0.02	0.04	0.06	0.08	0.10
concrete, polished	0.10	0.05	0.06	0.07	0.09	0.08
glass	0.35	0.25	0.18	0.12	0.07	0.04
grass	0.11	0.26	0.60	0.69	0.92	0.99
plywood	0.28	0.22	0.17	0.09	0.10	0.11
steel	0.05	0.10	0.10	0.10	0.07	0.02

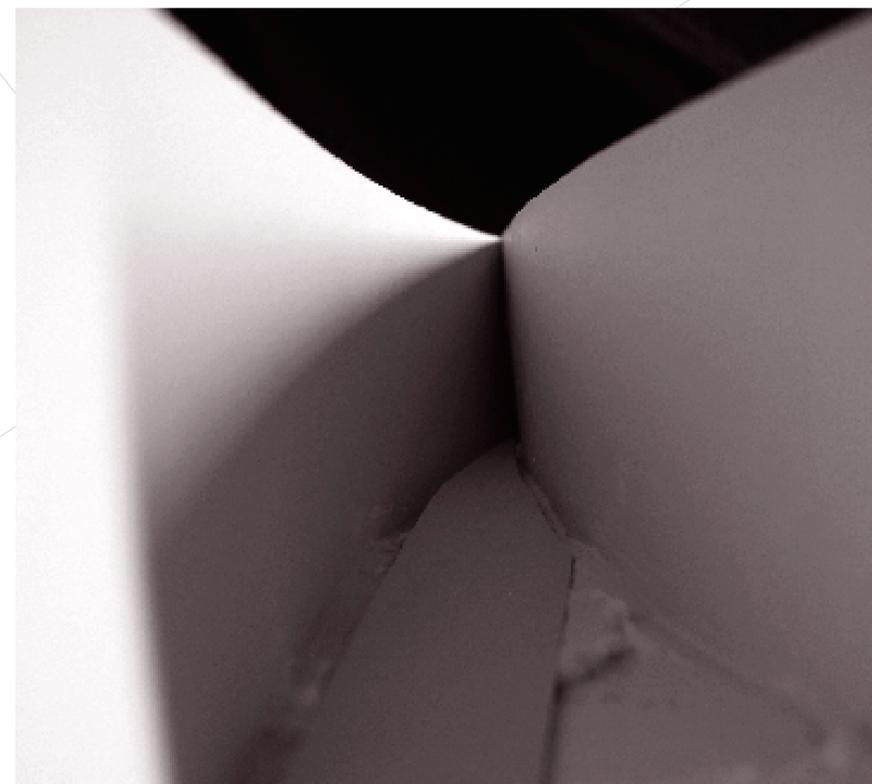
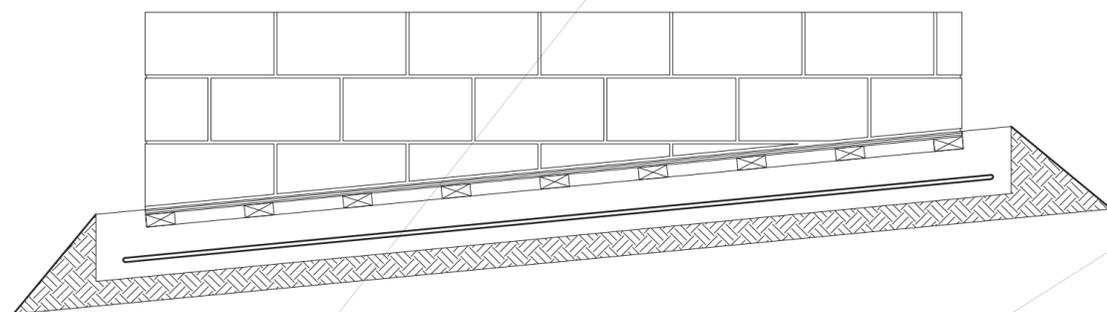
"We see the light [architecture] reflects and thereby gain an impression of form and material. In the same way, we hear the sounds it reflects and they too give us an impression of form and material."⁶

34 Absorption coefficient: the effectiveness of a sound-absorbing material, values from 0 to 1, 0 being the most reflective. 35



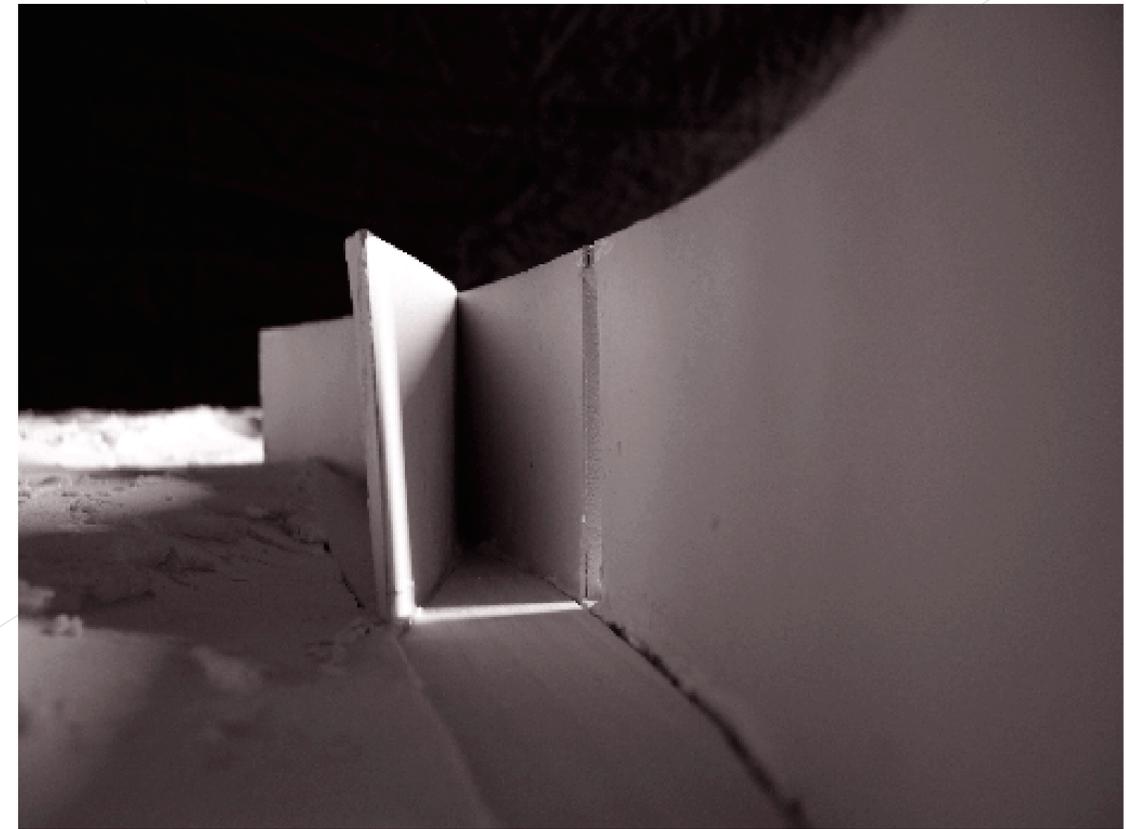
perspective v. parallel

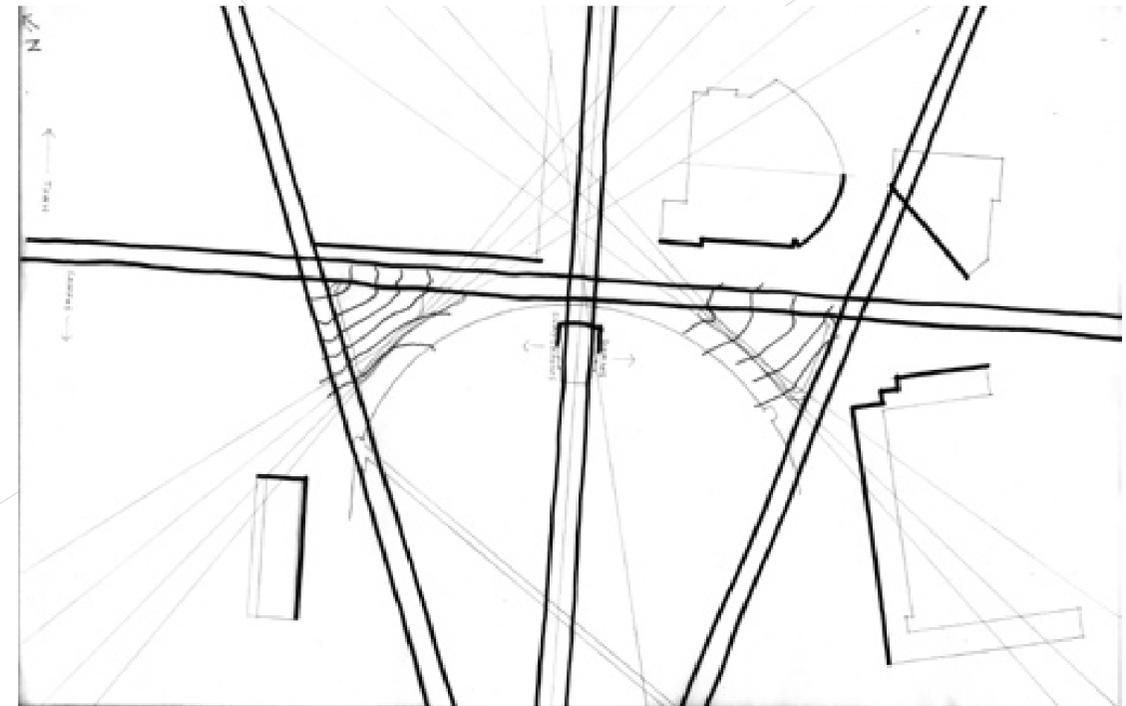






"One who has half risen to the sound of a distant train at night, and through his sleep, experienced the space of the city with its countless inhabitants scattered around its structures, knows the power of sound to the imagination; the nocturnal whistle of a train makes one conscious of the entire sleeping city. Anyone who has become entranced by the sound of water drops in the darkness of a ruin can attest to the extraordinary capacity of the ear to carve a volume into the void of darkness. The space traced by the ear becomes a cavity sculpted in the interior of the mind."⁸





This book was created using Adobe InDesign
Images on pages 3 - 11 are digital photographs taken of the full scale construct built with concrete masonry units.
Drawings on pages 16, 17, 22 - 23 were hand drawn with graphite on bristol paper 22 x 30.
Drawings on pages 15, 17, 19, 21, 25, 26 - 33, 36, 38, 40 were drawn with AutoCAD and edited in Adobe Illustrator.
Images on pages 24 - 25 are digital photographs taken of the site with chalk lines drawn on the grass.
Images on pages 37, 39, 41, 43, 45 are digital photographs taken of a site model. The site model is spackle, bass wood and chip board.

I would like to thank Tom Mcnamera for his help with the construction and realization of this project.

¹ All definitions:

Egan. *Architectural Acoustics*.

² Kahn. *Noise Water Meat* 158

³ LaBelle ed. *Site of Sound: Brewster: There or Here* 101.

⁴ Leitner. *Sound Space* 13.

⁵ Chang. *The Tao of Architecture* 32

⁶ Rasmussen. *Experiencing Architecture* 224.

⁷ Egan. *Architectural Acoustics* 52.

⁸ Pallasmaa. *Questions of Perception* 30.

Bibliography

Birdsall, Derek. *Notes on Book Design*. New Haven, CT: Yale University Press, 2004.

Bosseur, Jean-Yves, ed. *Sound and the Visual Arts: Intersections Between Music and Plastic Arts Today*. Paris: Dis Voir, 1993.

Cage, John. *Silence*. Middletown, CT: Wesleyan University Press, 1961.

Ching, Francis D.K. *A Visual Dictionary of Architecture*. New York: John Wiley and Sons, 1995.

Chang, Amos Ih Tiao. *The Tao of Architecture*. Princeton, New Jersey: Princeton University Press, 1956.

Dochantschi, Markus, ed. *Zaha Hadid: Space for Art*. Switzerland: Lars Muller Publishers, 2004.

Egan, M. David. *Architectural Acoustics*. New York: McGraw-Hill Inc, 1988.

Elkins, James. *The Poetics of Perspective*. Ithaca, New York: Cornell University Press Ithaca, 1994.

Evans, Robin. *Translations from Drawing to Building and Other Essays*. Cambridge, Massachusetts: The MIT Press, 1997.

Gruenisen, Peter. *SoundSpace: Architecture for Sound and Vision*. Boston: Birkhauser, 2003.

Hall, Edward T. *The Hidden Dimension*. New York: Anchor Books, 1969.

Haskell, Barbara. *Agnes Martin*. New York: Whitney Museum of Art, 1992.

Hochuli, Jost and Robin Kinross. *Designing Books: Practice and Theory*. London: Hyphen Press, 1996.

Holl, Steven, Juhani Pallasmaa, and Alberto Perez-Gomez. *Questions of Perception: Phenomenology of Architecture*. *Architecture and Urbanism* July 2004 Special Issue. Tokyo: A + U Publishing Co., 1994.

Kahn, Douglas. *Noise, Water, Meat: A History of Sound in the Arts*. Cambridge, Mass: MIT Press, 1999.

LaBelle, Brandon, ed. and Steve Roden, ed. *Site of Sound: Of Architecture and the Ear*. Los Angeles: Erant Bodies Press, 1999.

Leitner, Bernhard. *Sound/Space*. New York: New York University Press, 1978.

Libeskind, Daniel. *Proof of Things Invisible*. www.daniel-libeskind.com/words/index.html

Libeskind, Daniel. *Catching on Fire*. www.daniel-libeskind.com/words/index.html

Libeskind, Daniel. *Countersign*. New York: Rizzoli International Publications, 1992.

Martin, Elizabeth, ed. *Architecture as a Translation of Music*. New York: Princeton Architectural Press, 1994.

Noever, Peter, ed. *Zaha Hadid Architektur*. Austria: Hatje Cantz Verlag, 2003.

Pallasmaa, Juhani. *Polemics: The Eyes of the Skin: Architecture and the Senses*. London: Academy Editions, 1996.

Rasmussen, Steen Eiler. *Experiencing Architecture*. Cambridge, Mass: MIT Press, 1964.

Scanning: The Aberrant Architectures of Diller + Scofidio. New York: Whitney Museum of Art, 2003.

Tschichold, Jan. *The Form of the Book: Essays on the Morality of Good Design*. Vancouver, B.C.: Hartley & Marks, 1991.

Roth, Leland M. *Understanding Architecture: Its Elements, History, and Meaning*. New York: Icon Editions, 1993.

Woolman, Matt. *Sonic Graphics: Seeing Sound*. New York: Rizzoli, 2000.

Wright, Lawrence. *Perspective in Perspective*. London: Routledge & Kegan Paul, 1983.