UNIVERSITY OF CINCINNATI

Date: 5-Apr-2010

I, Andrei K Konsen, hereby submit this original work as part of the requirements for the degree of:

Master of Architecture
in Architecture (Master of)

It is entitled:

Shaping Sound | Tuning Architecture in the Soniferous Garden

Student Signature: Andrei K Konsen

This work and its defense approved by:

Committee Chair: Rebecca Williamson, PhD
George Bible, MCiv.Eng
Shaping Sound
Tuning Architecture In The Soniferous Garden

A thesis submitted to the
Graduate School
of the University of Cincinnati
in partial fulfillment of the
requirements for the degree of

MASTEr OF ARChITECTURE
in the School of Architecture and Interior Design
in the College of Design, Architecture, Art, & Planning by

ANDREI KALEV KONSEN
B.S. Architecture, University of Cincinnati
November 2010

Committee Chair: Rebecca Williamson
Committee Co-Chair: G. Thomas Bible
Abstract

“It is thought-provoking that the mental loss of the sense of centre in the contemporary world could be attributed, at least in part, to the disappearance of the integrity of the audible world.”

-Juhani Pallasmaa

Mankind is endowed with a range of senses. These senses combine to influence humans’ perception of the world around them. The role of vision, however, has come to dominate other sense modalities in western culture. The technology that people interact with on a daily basis—cell phone displays, computer screens, televisions—alienates them from their surroundings and one another. Relying solely on the visual format impoverishes the remaining sensory realms, and instantaneous dissemination of imagery detaches people from the realities of time and distance.

Architecture is predominantly designed and critiqued based on a visual syntax. Many designs rely entirely on aesthetic metaphors to communicate their underlying theories, and are experienced, solely through distilled snapshots in printed and digital media. Contemporary architecture’s inclination toward the visual detaches the body from its environment, confounding the role of architecture as the art of mediation and reconciliation between man and his environment.

Architecture cannot be simplified into a purely visual medium; buildings have an inherently sensual nature. The intent of this study is to investigate the reality of architecture, not merely through the traditional inquiry of sight but through the engagement of auditory encounters. This study will catalog and analyze a variety of aural architectural scenarios, and synthesize the analysis into an aural architectural design process. This methodology will be applied to the design of an aural edifice. The resultant project will consist of architectural interventions in the abandoned Cincinnati subway tunnels that manipulate the urban soundscape to emphasize and challenge auditory perception.
# Table of Contents

## Abstract

**Abstract** ii

## 1. Introduction

**1. Introduction** 1

## 2. Aural Architecture

**2. Aural Architecture** 5
- Sound-Space Relationships Throughout History 7
- Difficulties in Aural Architecture 15
- Implementations of Aural Architecture 19

## 3. The Soniferous Garden

**3. The Soniferous Garden** 24
- Site 26
- Design 37

## Works Cited

**Works Cited** 54
List of Illustrations

Cover Image: Athanasius Kircher - reflection of sound.

2.1: Vitruvius - The Tensioning of War Machines

2.2: Major musical intervals and Palladio’s harmonious proportions.
Created by author.

2.3: Athanasius Kircher - sound transmission devices

2.4: Athanasius Kircher - elliptical whispering gallery

2.5: Athanasius Kircher - Aeolian harp

2.6: Le Corbusier/Iannis Xenakis - Philips Pavilion

2.7: Not Used

2.8: Iannis Xenakis - portion of score for Metastasis
http://membres.multimania.fr/musicand/INSTRUMENT/DIGITAL/UPIC/UPIC.htm

2.9: Stephen Holl - Stretto House
http://www.stevenholl.com/project-detail.php?type=houses&id=26&page=1

2.10: Spectrogram
http://www.icsi.berkeley.edu/Speech/mr/nearfar.html

2.11: Nox Architecture - Son-O-House
http://www.nox-art-architecture.com/

2.12: Nox Architecture - Son-O-House
http://www.nox-art-architecture.com/

2.13: Karen Van Lengen, Joel Sanders, and Ben Rubin - Mix House
http://www.artcenter.edu/openhouse/pdf/mixhouse.pdf

2.14: Mix House - sonic window section
http://www.artcenter.edu/openhouse/pdf/mixhouse.pdf
2.15: Luke Jerram - Aeolus
http://www.lukejerram.com/projects/aeolus_acoustic_wind_pavillion

2.16: Ted Sheridan - parabolic reflector walls

2.17: Ted Sheridan - xylophonic roof

2.18: Ted Sheridan - lamellophonic tower

2.19: Ted Sheridan - Aeolian coil

3.1: “A Dream of the Graphic”

3.2: The Miami-Erie Canal in winter at the turn of the 20th century.

3.3: Map of the proposed rapid transit system c.1912


3.5: The underground Brighton Station, under construction on March 15, 1922.
3.6: The water main running through the otherwise unused subway tunnels.

3.7: Central Parkway shortly after its completion in 1928.

3.8: Designs for typical concrete tube sections.

3.9: Race Street Station, looking East from West end of platform.
   [Link](http://www.mcflash.4000loavesanhour.com/QCDgallery/UrbanExploration/Cincy/CincinnatisAbandonedSubway/)

3.10: Race Street Station, looking East from center of platform.
   [Link](http://www.mcflash.4000loavesanhour.com/QCDgallery/UrbanExploration/Cincy/CincinnatisAbandonedSubway/)

3.11: Race Street Station under construction in 1921.

3.12: Central Parkway in 1928 with rectangular ventilation constructions for the subway.

3.13: Cincinnati Music Hall

3.14: Erich Kunzel Center for Arts Education (SCPA) under construction.

3.15: Parkway Median above Race St. Station (center) and new SCPA building (left).
   Photo by author.

3.16: Site plan showing existing conditions at Race Street Station.
   Created by author.

3.17: Longitudinal Section of proposed soniferous garden.
   Created by author.

3.18: Tunnel level plan of proposed soniferous garden.
   Created by author.
3.19: Anechoic Chamber with suspended metal floor.
   http://www.symbiosis-music.com/int_jh.html

3.20: Transverse section of anechoic chamber.
   Created by author.

   http://tricorder.at/?p=2284

3.22: Acoustic Radar - Germany, 1940’s.
   http://tricorder.at/?p=2284

   http://tricorder.at/?p=2284

3.24: Transverse section showing sound gathering/directing devices and parabolic reflector.
   Created by author.

3.25: Aeolian Harp, Athanasius Kircher.
   http://britlitwiki.wikispaces.com/Aeolian+Harps+and+the+Romantics

3.26: Transverse section of a typical two-level elliptical chamber with aeolian harp on parkway level.
   Created by author.

3.27: Transverse section showing elliptical reflectors and elliptical tunnel.
   Created by author.

3.28: Transverse section showing typical spherical whispering galleries.
   Created by author.

3.29: Process collage of the subterranean soniferous garden.
   Created by author.
1. Introduction

Contemporary society, with its abundance of virtual and visual imagery, has undermined the importance of multi-sensory experience. Consumerist culture is rife with the purely visual stimuli of signage, internet ads, and facades of big-box chain stores. This serves to overshadow the importance of non-visual stimuli. Society is dependent on virtual interaction, through cell phones, computers, and other electronic devices. The multifaceted sensory experience of a face-to-face meeting is being replaced with flattened images on video-chat screens, voices transmitted through cell phones, and 160-character text messages. Although technological innovation has led to the convenience of instantaneous access to information and people across the world, it has led many to neglect the importance of their physical surroundings. Now, instead of simply opening a window to sense the weather, one may just as easily access a weather report on the internet or TV. The complex, sensuous reality of the weather outside is diluted to a series of pictorial symbols.

Similarly, the participatory experience of inhabiting architecture is being replaced by remote criticism of architectural photographs. Even when experienced in person, the designs of many contemporary architectural projects appear to be driven by visual, intellectual metaphors rather than the embodied multi-sensory experience of inhabitation. “Real architecture is architecture especially ready for its direct experience,”
says Michael Benedikt, who strives for “an architecture that does not disappoint us by turning out in the light of that experience to be little more than a vehicle contrived to bear meanings.” There is a need to refocus on the sensuous realities of surrounding spaces and objects. Architecture is not understood solely through a visual syntax, but rather through situations and encounters of bodily experience. People should feel like dynamic participants within the built environment, rather than static spectators.

The impetus for the activation of non-visual senses is heightened understanding of one’s place, time, and self. Maurice Merleau-Ponty writes, “I perceive in a total way with my whole being: I grasp a unique structure of the thing, a unique way of being, which speaks to all my senses at once.” The task of architecture should be to consider more than just the visual realm in order to increase inhabitants’ consciousness of their existence in the world. Architecture, in the words of Juhani Pallasmaa, “is the art of reconciliation between ourselves and the world, and this mediation takes place through the senses.”

Focusing on the design of the sonic environment may seem counter intuitive in light of the importance of multi sensory experience. Consideration of the auditory was
chosen as a counterpoint to the visual. Pallasmaa highlights the difference between sound and vision by stating that: \(^4\)

“Sight isolates, whereas sound incorporates; vision is directional, whereas sound is omnidirectional. The sense of sight implies exteriority, but sound creates an experience of interiority. I regard an object, but sound approaches me; the eye reaches, but the ear receives. Buildings do not react to our gaze, but they do return our sounds back to our ears.”

Designing for sound inherently activates other dimensions of embodied experience. Finish materials chosen for acoustic qualities have innate tactile characteristics (reflective materials are smooth, while diffusive materials are rough or articulated). These characteristics invite exploration through touch. The intrinsically fleeting, ephemeral nature of sound activates the temporal element of experience which visually-based designs often lack.

This thesis seeks to explore the ways that sound results from interactions with built form, and in turn, how those sounds reinforce understanding of one’s self in relation to the environment. Informed by examination of sound, hearing, and perception as they relate to architecture, the resultant design proposal will manipulate aural architecture to raise mindfulness of the sonic environment.

2. Aural Architecture

Architecture, as it manifests itself in our physical environment, engages all of the senses. An encounter with the built environment includes seeing, feeling, smelling, and hearing. The prevailing methodologies of architectural design, however, consider the visual dimension of space almost exclusively. The use of drawings to generate architecture inherently facilitates the visual articulation of the built environment while the innate human ability to sense space aurally is overlooked.

Auditory navigation is not an ability that is unique to species like dolphins and bats. Ordinary humans can sense passive objects as well as spatial characteristics through sound. According to Ted Sheridan and Karen Van Lengen, “the aural perception of space contributes to the experiential identity of an environment[…] auditory cues suggest orientation, scale, and subtleties of human interaction.”1 In “Spaces Speak: Are You Listening?” Barry Blesser and Linda-Ruth Salter demonstrate the ability to hear one’s surroundings by considering a single wall. When a single hand-clap is reflected from this wall, the delay of the echo defines its distance from the listener, the intensity of the echo demonstrates the surface area, and the frequency content of the echo gives clues as to the material texture of the wall. In this example, “the echo is the aural means by which

we become aware of the wall and its properties[...] the wall has an audible manifestation even though it is not itself the original source of sound energy.” 2 In this way, spaces can sonically communicate spatial attributes to an attentive inhabitant, supporting a more robust perception of the environment than vision alone.

Actual environments, whether natural or constructed, are considerably more complex than a single wall in isolation. A forest and a city street alike encompass multiple surfaces, objects, distances, and proportions--the combination of which Blesser and Salter call aural architecture. The authors state that, “as we hear how sounds from multiple sources interact with the various spatial elements, we assign an identifiable personality to the aural architecture, in much the same way we interpret an echo as the aural personality of a wall.” 3 Aural Architecture has the power to influence our moods and emotions. It can make spaces seem warm or cold, inviting or forbidding, independent of their appearances. Aural architecture can incite social associations such as privacy or publicity. Intentional manipulation of sound in the design of environments provides users with richer experiences.

3 ibid.
Sound-Space Relationships Throughout History

The history of the discourse of sound and space is often traced back to Vitruvius, whose writings on sound can be classified two ways according to Ted Sheridan and Karen Van Lengen. These two classifications are the proportional mode and the actual mode. The proportional mode, “relates the spatiovisual experience of width, height, and depth with the tonal experience of harmonic musical notes,” while the actual mode, “relays specific advice, derived from experience and experimentation, on how sound behaves under certain physical condition.” The actual mode is concerned with the experience of space through sound, while the proportional mode is merely another method that reinforces visual hegemony in architecture. In book ten of his Ten Books on Architecture, Vitruvius describes the stringing and tuning of catapults, stating that the strings should be, “stretched taut on the windlasses by means of the handspikes until they give the same sound. Thus with tight wedging, catapults are tuned to the proper pitch by musical sense of hearing.” Although not specifically pertaining to architecture, this passage illuminates the actual mode in the intersection of construction and sound, and the idea that it is not only possible to tune objects other than musical instruments, but it may


2 Ibid.

be necessary to achieve an ideal outcome.

Medieval Cathedrals have often been cited for their influence on the sonic traditions carried out within them. The bare walls, mosaic floors, marble columns, and huge, empty volumes of the cathedrals caused sound to reverberate for long periods of time. Even if a speaker’s voice was loud enough to be heard throughout the space, each syllable would be confused by the overlapping reflections of those before and after it. Thus, as Steen Rasmussen points out, “The priest began on the reciting note and then let his voice fall away in a cadence, going up and down so that the main syllables were distinctly heard and then died away, while the others followed them as modulations.” In this manner, the environmental realities of the cathedral turned the texts of prayers and psalms into songs. The songs, in turn, “in a soul-stirring manner turned the great edifice [of the cathedral] into a musical experience.” Rasmussen describes the continuation of historical church types affecting schools of music. He cites post-Reformation churches, with wood cladding, numerous wooden galleries, and ornate, baroque detailing. The greater articulation of form and ornament coupled with more absorptive materials greatly reduced reverberation time in the churches. This allowed a new form of music—the quick and complicated baroque style—to be clearly heard in the space.

5 Ibid., 228-230.
6 Ibid., 231.
Renaissance thinking involved a preoccupation with vision as exemplified by Filippo Brunelleschi’s development of perspectival representation. The work of Leon Battista Alberti and Andrea Palladio, however, considered the intersection of music and architecture. Alberti stated that, “We shall therefore borrow all our Rules for the Finishing of our Proportions from the Musicians, who are the greatest Masters of this Sort of Numbers.”

Six of Palladio’s seven sets of harmonious proportions to be used in the construction of rooms correspond to consonant musical intervals of the major scale.

These inquiries distilled sonic realities into visual, mathematical abstractions. The work of Alberti and Palladio translated sound into the language of the Vitruvian proportional mode.

There are contributions to the “actual” aural architectural discourse from the period. In his seminal works on musicology, *Musurgia Universalis* and *Phonurgia Nova*, Athanasius Kircher proposed a number of devices for sound transfer at an architectural scale. These proposals primarily consider the use of tubes and horns to convey sound between rooms, buildings, and even towns. The reflection of sound is a recurring theme in his work, including experimentation with curved surfaces to focus and reinforce sounds. Kircher also attempted to explain the phenomenon of the Aeolian harp, an ancient instrument with all strings tuned to the same pitch. When played by the wind, however, the harp produces a wide variety of tones and harmonies. Kircher’s work serves as a precedent for this thesis, in that it examines the sonic interactions between built form, its inhabitants, and the environment at large.

At the turn of the twentieth century, poor listening conditions in the lecture hall of the Fogg Art Museum led Wallace Sabine, a professor at Harvard’s applied physics department, to conduct rigorous investigations of its acoustics. The semicircular room had clear sight lines from all seats to the podium (the historical basis for establishing clarity of sound); however, the audience could not clearly hear the speaker. Through detailed experiments and observations, Sabine discovered the inverse relationship between reverberation time and acoustically absorptive surface materials. The problem

10 Ibid.
in the lecture hall had been excessive reverberation. The sound of the speakers voice did not dissipate quickly enough, causing consecutive syllables to overlap and lose clarity. Sabine discovered that bringing absorptive cushions into the lecture hall decreased the reverberation time.\textsuperscript{12} By quantifying reverberation and absorption, Sabine’s work led to a new focus on surface material, and established a number of formulae that act as a basis for acoustic science.

The International Style modernism of the early twentieth century created spaces devoid of auditory consideration. The modernist tenets of “functionality, economy of construction, and expression of structure[…] lead to widespread use of the frame as a tectonic base and visual paradigm for design work.”\textsuperscript{13} Within these frames were flat, parallel surfaces usually consisting of acoustically reflective materials such as glass metal and concrete which created modular volumes. With no means to absorb or diffuse sound energy, these spaces were often characterized by excessive reverberation. The establishment of this aesthetic and tectonic language superseded auditory considerations, reducing acoustic design to a corrective mediation taking place after the design process.

An exception to the lack of acoustic care in modernist buildings was the Philips Pavilion at the Exposition Universelle et Internationale de Bruxelles in 1958. The

pavilion was designed by Le Corbusier and Iannis Xenakis. It was envisioned as a nexus of aural, visual, and spatial elements from its conception. The edifice acted as the environmental medium for Edgard Varese’s composition, *Poème électronique*, which took advantage of the advent of electronic technologies for the production and transmission of sound. *Poème électronique* was composed so that musical parts would be constantly transferred across an array of 350 loudspeakers, giving the illusion that the music’s source was swirling around the visitors. Despite the Philips Pavilion’s role as one of the most clearly defined works of aural architecture, it is not an ideal precedent for this thesis due to its dependence on electronic reproduction of sound. Electronic sound does not reinforce one’s understanding of their physical environment, it confounds it with false information.

The Philips Pavilion’s form consisted of hyperbolic paraboloidal forms. Xenakis’ score for the composition *Metastasis* is also based on hyperbolic paraboloids. The use of a single, underlying formal logic to create both music and architecture introduces a third, formal mode, to the aforementioned Vitruvian modes of sound-space relationships (proportional and actual). The formal mode is similar to the proportional mode, in that it is based on visual elements, rather than the actual experience of sound itself.

The twentieth century saw the relationship between sound and space explored not only by architects and acousticians, but by musicians as well. John Cage’s 1952 composition, *4’33”*, calls for the performers to not play their instruments for four minutes
and thirty-three seconds. The result is not silence, but the “music” of the breaths and utterances of the audience and their interactions with the space they inhabit. The piece is more an examination of its performance space than a performance.\textsuperscript{14} In 1969, Alvin Lucier’s, “I am Sitting in a Room” examined the sonic character of space through a recursive recording method. A passage was read aloud by Lucier in a particular room and recorded. The recording was then played back in the same room and re-recorded. This process was repeated several times. The end result is a distorted version of the original passage, but gives a clear indication of the resonances, reverberation, and overall sonic character of the space.\textsuperscript{15}

Recently, a number of publications by architects have been issued, calling for the inclusion of the non-visual senses in the architectural design process. Juhani Pallasmaa’s \textit{The Eyes of the Skin} (2005) and Stephen Holl’s \textit{Questions of Perception: Phenomenology of Architecture} (2006) demonstrate a need to approach architecture with the phenomenology of multi sensory experience in mind. Barry Blesser and Linda Ruth Salter’s \textit{Spaces Speak--Are You Listening?} (2007) focuses specifically on the auditory dimension. Despite the abundance of literature, the past few decades have seen little built work in the “actual” mode of the sound-space relationship. The Holl designed “Stretto House” (1991) utilizes the language of music. A stretto is the repetition of a

\textsuperscript{14} “4’33”” In \textit{Non stop flight}. Deep Listening Band. CD. 1998.
\textsuperscript{15} \textit{I Am Sitting in a Room}. CD. Alvin Lucier, 1969.
musical subject in close succession, so that an answer enters before the original subject is completed. Holl’s design, however, does not recreate the auditory musical effect. Working in the formal mode, Holl applies the idea of stretto to the visual metaphor of repetitive roof forms.

Architects have often employed proportional and formal modes of sound-space relationships in pursuit of meaningful architecture, but the result is not a richer auditory or multi-sensory experience, just another manifestation of the visual bias in the design process. Designers must work in the actual mode of the sound-space relationship, utilizing experience and experimentation with the behavior of sound in space to achieve true aural architecture that strengthens its inhabitants’ connections to their time, place, and peers.
Difficulties in Aural Architecture

The language of aural architecture has been called, “sparse, fragmented, and embryonic,”\(^{16}\) compared to the symbolic language related to visual explorations of architecture. Blesser and Salter cite four reasons for this disparity, (1) the lack of means for archiving the fleeting, temporal nature of sound, (2) the lack of appropriate vocabulary to describe sound, (3) the lack of importance placed on hearing in a visually-biased society, and (4) the lack of legitimacy for intellectual discourse.\(^{17}\) Colin Ripley defines two main barriers to an architecture of sound: “the problem of representation” and the “fraught condition[…] due to an extreme dissimilarity between sound-making and the construction of buildings.”\(^{18}\) The dissimilarity, according to Ripley, is that “sound is lightweight, inexpensive (or free) and leaves no (or few) lasting traces, while buildings are heavy, expensive, and more or less permanent.”\(^{19}\)

The work of Ted Sheridan and Karen Van Lengen addresses the aforementioned obstacles. They assert that, “consideration of the sonic and musical qualities of buildings[…] would open up the acoustical environment as a kind of ‘material’ for intentional architectural development and articulation[…] and create the possibility for

17 Ibid.
19 Ibid.
new architectural forms that, like the forms of musical instruments, could evolve without preconceived visual ends.”

**Analysis and Representation of Aural Architecture**

New modes of representation for aural architecture are needed to overcome the obstacles outlined in the previous passage. Graphic, audible, and linguistic methods of cataloging, analyzing, and comparing sounds could facilitate the articulation of aural architecture, allowing for academic discourse, and potentially a societal shift away from ocularcentrism.

The tools commonly used for acoustic design may benefit the expression of aural architecture. The use of a decibel meter to measure sound intensities within various spaces could produce a series of data that would facilitate comparison of spatial characteristics as they relate to sound intensity. Audio recordings could then be analyzed and represented in a spectrogram. A spectrogram shows the variation of spectral density (frequency, distribution, and density) of a signal over time. The horizontal axis typically represents time and the vertical axis describes frequency. The intensity of the given frequencies over time can either be represented by intensity of color, or a three-dimensional third axis. A spectrogram is analogous to an audio fingerprint that describes

---

the unique interactions of sound waves and the physical environment. The comparison of spectrograms could result in the identification of frequency and intensity responses that are exceptional to specific architectural characteristics.

Aural architecture cannot be expressed exclusively in visual abstractions of physics, such as sonograms. In the fall of 2000, Sheridan and Van Lengen sponsored a studio at the University of Virginia using sound as a generative thesis for design. In their studio, they attempted to represent both the “mechanical and cultural” aspects of aural architecture. The mechanical approach involved students mapping dimensional relationships on the site, then taking inventory of types, intensities, and proximities of sounds at various times. These aural representation techniques involve the translation of an auditory phenomenon into a visual or literary mode of communication. A completely auditory approach to representing aural architecture may be more appropriate.

The recursive recording technique utilized by Alvin Lucier results in certain frequencies being emphasized as they resonate in a room. Eventually, the words spoken by the performer become unintelligible, replaced by the pure resonant harmonies and tones of the room itself. The process results in an analysis of sound and space that maintains audible rather than visual form. Sheridan and Van Lengen’s students

22 Ibid., 42.
23 I Am Sitting in a Room. CD. Alvin Lucier, 1969.
utilized the recursive recording method to analyze, “the natural acoustic contours of space.” The progressively stronger sonic interactions with space clarify the effect that architecture has on sound. Students in the studio were “significantly more aware of how the room modulated normal sounds like their voices, the sounds of movement, and the structurally transmitted sounds of mechanical equipment […] and were able to identify the different rooms through sonic identification.” The recursive recording approach would prove useful in creating an audible lexicon for the design of aural architecture.

25 Ibid.
Implementations of Aural Architecture

Though the realm of aural architecture remains largely unexplored, a number of architects are designing environments driven by sonic interactions. Nox Architecture’s Son-O-House is an inhabitable artwork which is, “continuously generating new sound patterns activated by sensors picking up actual movements of the visitors.”26 The conceptual basis for the Son-O-House is that each physical interaction with space has a unique sonic outcome, which may be used to gain greater understanding of one’s interactions with his or her surroundings. The use of electronics for motion sensing and sound reproduction exaggerates and recontextualizes the resultant sound from bodily encounters. In the terms of aural architecture, sound inherently results from interactions with the environment. Thus, the introduction of artificial sound as a result of spatial interaction is a subversion of natural auditory perception of space.

The “Mix House” by Karen Van Lengen, Ben Rubin, and Joel Sanders is a, “residential dwelling conceived of as a dynamic space enriched by an acoustic link to its external environment.”27 The Mix House is composed of two volumes that frame audiovisual scenes adjacent to the house. At the end of each volume is a curved sonic window with a microphone and video camera at its center. The microphones and cameras relay signals to an electronic command center in the house, “where the synchronized

sights and sounds of the surrounding landscapes may be activated and arranged” by the occupant. The Mix House is guided by a desire to relate the interior of the house to its exterior through sonic relationships. Unfortunately, much like the condition in the Philips Pavilion and the Son-O-House, the ability of the inhabitant to naturally perceive their sonic surroundings is confounded by the use of electronic recontextualization.

Luke Jerram’s architectural installation, “Aeolus,” attempts to “sonify the three dimensional landscape of wind, using a web of Aeolian harps.” The spherical construction is penetrated by hundreds of pipes, that will resonate with the frequencies of the Aeolian harps. The designer envisions the radial constructions as, “cats’ whiskers picking up the shifting landscape around the building,” and relaying them in the form of sound to inhabitants of the installation. Translating wind into sound can be an effective tool in helping people understand the world around them through an alternate form of perception. When it is constructed, if the installation functions according to the designers intentions, Aeolus may be an effective tool in relating people, architecture, and the outside environment that they share.

In “Multiple Scales: Sounding Forms from Instruments to Skylines,” Ted Sheridan proposes that architecture can act as a musical instrument. “While buildings

30 Ibid.
are larger than conventional musical instruments,” says Sheridan, “the wavelengths of audible sound from 17mm at 20KHz to 17m at 20Hz easily overlap the bulk of instruments and architectural spaces.”

He proposes a sequence of four musical architectural constructions in a processional zone in New York City’s Lower East Side.

The following are Sheridan’s descriptions of the constructions:

“The first element is a set of parabolic reflector walls that can fold up into a flat roof structure when not in use. The second element is a xylophonic roof consisting of a set of laminated glass panels supported at quarter-points to allow free vibration. The third element is a lamellophonic tower comprised of a reverberation shaft with sets of steel tines affixed to the sides. The fourth element is an Aeolian coil suspended from the adjacent buildings on the lot. The support cables are wind and motion activated, with their tensions dependent on the weight of people walking up the helical form of the coil.”

Sheridan’s proposals form a unique contribution to the discourse of aural architecture. If the constructions would perform as intended, the designs would become an architecture of sound, based on the interactions of both users and the environment at large. The parabolic reflector walls would modulate the sounds of footsteps and conversations in unexpected ways, while the lamellophonic tower would amplify physical interactions between people and the construction itself. The Aeolian coil is an especially interesting case in that it is dependent on the wind to play the harp-like cables as well as

32 Ibid., 186.
the users inhabiting the coil to tension them.

These examples demonstrate an increased interest in designing aural environments in the last decade. Compared to other project types, however, the number of aural architectural designs is severely limited. Understanding of aural architecture is limited further by a lack of built work. Of the preceding four examples, only the Son-O-House has been built. Although interaction with any edifice—natural or constructed—has a distinct aural quality, few existing buildings were designed for specific aural characteristics. The understanding and practice of aural architecture would benefit greatly from the construction of an experimental building designed to encompass a series of diverse aural characteristics. By experiencing and testing various auditory scenarios, designers could achieve greater knowledge of aural aesthetics and refinement in aural design. One such aural edifice is proposed in the following chapter.
3. The Soniferous Garden

"Interiors are like large instruments, collecting sound, amplifying it, transmitting it elsewhere."\(^1\)

-Peter Zumthor

This thesis seeks to explore the ways that sound results from interactions with built form, and in turn, how those sounds reinforce understanding of one’s self in relation to the environment. Sound is often overlooked in the design of space, and often unnoticed in experiencing it. This proposal is designed as a means to emphasize and challenge auditory perception, in order to draw attention to the role that hearing plays in the understanding of one’s surroundings.

The proposal will consist of a series of architectural interventions which create a public “soniferous garden.” A soniferous garden is, “a garden, and by analogy any place, of acoustic delights,” according to R. Murray Schafer, and, “may be a natural soundscape, or one submitted to the principles of acoustic design.”\(^2\) The interventions will be undertaken as a series, with each utilizing different strategies for sound modulation.

Approaches to the design of aural environments may be characterized as either active or passive. Blesser and Salter define the distinction between active and passive in aural architecture as follows:

“A space we encounter might contain water spouting from a fountain, birds singing in a cage, or wind chimes ringing in a summer breeze--active sound sources functioning as active aural embellishments for that space[...] In contrast, passive aural embellishments, such as interleaved reflecting and absorbing panels that produce spatial aural texture, curved surfaces that focus sounds or resonant alcoves that emphasize some frequencies over others, create distinct and unusual acoustics by passively influencing incident sounds.”

In order to illuminate the auditory perception of space, this proposal seeks to utilize the passive method to affect aural characteristics. Active sound sources, especially the electronic reproduction of sound (as referenced in the architectural precedents), only serve to muddle perception of the environment through false stimuli. The proposal seeks to utilize material and form to affect sounds that originate from the human body and its interaction with architecture.

Site

The proposed aural edifice is designed as a series of architectural interventions in the abandoned subway tunnels under Central Parkway in Cincinnati, Ohio. The subterranean environment is used intentionally to emphasize the auditory capacity of architecture. Sonically, the underground tunnels are inherently disconnected from the urban soundscape of Cincinnati. The everyday sounds made by people and vehicles in the city are experienced in the tunnels only as altered, muffled remnants of the original sound. Many sounds from above ground cannot be heard at all, or enter the subterranean environment as structure-borne vibrations. By building underground, natural light can be restricted as necessary to subdue the visual experience and accentuate the aural characteristics of the spaces.

Subway to Nowhere

The Cincinnati subway began as an idea in the September 27, 1884 issue of a Cincinnati magazine, the Graphic. “The Dream of the Graphic,” as the illustration came to be known, depicted a grand boulevard, under which ran a subterranean train system, in the place of the existing Miami-Erie Canal that ran through the city. After its construction in 1825, the canal allowed for affordable and dependable transportation of cargo and passengers. By the mid 1850’s, however, steam railroads and electric

interurban trains had made the canal obsolete and unprofitable by providing a faster and more luxurious means of transport. The city of Cincinnati officially abandoned the canal in 1877, and it became a stagnant and polluted health hazard. The *Graphic* referred to the canal as a “dead old ditch,” and called for a change from the “malarial headaches of hundreds who must suffer from its influences.” In the mid 19th century Cincinnati had already expanded far enough that casual walking between suburban homes and downtown workplaces was not always possible. By the turn of the twentieth century, Cincinnatians started considering rapid transit options to alleviate congestion due to streetcars, automobiles, and horse-drawn carriages.

In 1910, Mayor Henry Hunt proposed a 15 mile belt railway to relieve slow-moving streetcar and automobile traffic and help commuters reach interurban railways on the outskirts of the city. In 1911 the Ohio State Legislature stated that, “permission shall be given to the city of Cincinnati to enter upon, improve and occupy forever, as a public street or boulevard, and for sewerage, conduit and, if desired, for subway purposes, all that part of the Miami-Erie Canal.” In 1912 the political machine-controlled City Council authorized Mayor Hunt to appoint an Interurban Rapid Transit Commission, that was empowered by the State to issue bonds, plan a beltway, and construct it as well. The

6 Ibid.
7 Ibid., 35.
8 Ibid.
subway project continued in 1917, with the City Council’s approval of a six million dollar bond request, and the citizens’ vote to construct the rapid transit system.\(^9\) Soon after, the United States went to war.

During World War I, no capital issues of bonds were permitted, and construction of Cincinnati’s subways were put on hold. City Council issued $80,000 to proceed with contract drawings in May of 1918, and by July, the funding had already run out.\(^10\) Construction costs doubled during the war, and after it ended, Moses Blau (the Chief of the State Bureau of Inspection and Supervision of Public Offices) found that the construction of the proposed rapid transit system would cost $13 million.\(^11\) For $6 million, the Interurban Rapid Transit Commission decided to construct half of the originally proposed loop, from Walnut Street, along the canal, through St. Bernard, Norwood, and Oakley.\(^12\) Construction of the rapid transit system began in January of 1920, but mismanagement by the Commission resulted in the depletion of funds with the work partially completed.\(^13\)

In 1925, the Charterite Party (supporters of a new city charter to quell bossism and political corruption in Cincinnati) took over city hall with Murray Seangood as mayor. Mayor Seangood uncovered a number of reports that revealed dishonesty,

\(^10\) Ibid., 45.
\(^11\) Ibid.
\(^12\) Ibid.
\(^13\) Ibid., 46, 71.
waste, and corruption in the Interurban Rapid Transit Commission’s handling of the subway project. The mayor intentionally delayed subway construction until the commission was dissolved on January 1, 1929. Later that year, the stock market crash and the Great Depression killed the project altogether.

The completed construction of the rapid transit system included a two mile subway tunnel in the canal trench and three short tunnels in the suburbs, as well as seven miles of above ground grading and overpasses. Subterranean stations were built at Race Street, Liberty Street, and Brighton Corner along with above ground stations at Marshall Avenue, Ludlow Avenue, and Clifton Avenue. This nine mile stretch of construction was still incomplete, with no tracks, trains, or electrical equipment. The stations hadn’t been finished with tiles, railings, or signage either. A 1936 study of the rapid transit project by the Engineers’ Club of Cincinnati demonstrated no practical value in using the subway tubes for rapid transit, parking garages, freight lines, merchandise storage, or the running of automobiles and stated that, “it should be forgotten--as part of the toll of progress.”

15 Ibid.
17 Ibid.
18 Ibid.
By the 1940’s, the City Planning Commission decided to focus on surface improvements, such as interstates.\textsuperscript{20} “As the experience of other cities plainly shows,” the Cincinnati \emph{Enquirer} stated on December 26, 1948, “the expressway program will come much closer than the subway to doing the whole job that needs desperately to be done.”\textsuperscript{21} The Mill Creek Expressway (Interstate 75) and the Norwood Lateral (route 562) were completed by 1962.\textsuperscript{22} Both highways use portions of the right-of-way from the original rapid transit loop.

The Cincinnati Subway tunnels have been utilized for few functions since their construction. In 1956, City Council approved a measure to lay a forty-eight inch water main in the unused subway tubes.\textsuperscript{23} The water main remains in the tunnels to this day, and as of 2000, conduit containing fiber-optic cabling runs through as well. Cincinnati turned the subway station at Liberty Street into a prototype community fallout shelter in 1962.\textsuperscript{24} The shelter featured a wood floor, lights, cots, toilets, showers, stockpiles of rations and sanitation supplies, decontamination showers, and an office with a working telephone.\textsuperscript{25} The shelter was abandoned in the 1980’s and has since been emptied.\textsuperscript{26}

Numerous proposals have been made for light rail systems to occupy the tunnels, along

\textsuperscript{20} Allen J. Singer, \emph{The Cincinnati Subway: History of Rapid Transit} (Chicago, IL: Arcadia Pub., 2003), 98.
\textsuperscript{21} Ibid., 99.
\textsuperscript{22} Ibid., 103.
\textsuperscript{23} Ibid., 102.
\textsuperscript{24} Ibid., 109.
\textsuperscript{25} Ibid.
\textsuperscript{26} Ibid.
with unique proposals for everything from an underground shopping village to an urban wine cellar to a wind-tunnel research facility. None have come to fruition.

Central Parkway and the Downtown Tunnels

The longest remaining tunnel under Cincinnati runs about two miles underneath Central Parkway. The idea of a grand boulevard in Cincinnati is as old as that of the subway, and can also be traced back to “The Dream of the Graphic.” Such a boulevard was first officially proposed in the 1907 Report of Park Commissioners, which called for “a wide passage into the very heart of the business district.” The plan called for roads “on each side of a continuous central park space,” with walks, benches, gardens, and fountains. After the construction of the subway tunnels (and in other places, the draining and filling of the canal), Central Parkway was built along the old Miami-Erie canal right-of-way.

The downtown subway tunnel begins under the intersection of Central Parkway and Walnut Street. From there the tunnel passes through underground stations at Race Street, Liberty Street, and Brighton as it follows Central Parkway west and north to portals near the Western Hills Viaduct, adjacent to Interstate 75. The rapid transit system was planned to run primarily above ground from this point on. Portions of three other

28 Ibid., 19.
29 Ibid.
small tunnels still exist where the train was meant to run underneath surface roads.

The subway tunnels are constructed from reinforced concrete in a double tube configuration. Two thirteen-foot-wide by fifteen-foot-tall tubes run side by side, divided by a ten inch wide concrete wall. The walls spread at the top to support the roof of the tunnel, making the upper corners of the tubes round.

**Race Street Station and Neighborhood Context**

The underground station at Race Street is considerably more complicated than the typical subway tube. At Liberty Street and Brighton Corner, the subway stations consist of a typical double tube with a simple platform on either side. At Race Street, however, the station was envisioned as a hub for interurban trains as well as rapid transit. The result is a much wider, more complex station. Here, the roof of the tunnel is supported by columns and a grid of concrete beams, as opposed to the semi-vaulted architecture of other tunnels and stations. This structural system allows the station to accommodate the width of three tracks and a large central island platform long enough for two trains to stop at one time. The station is designed for one track to run along each side of the platform (inbound and outbound rapid transit), while stub tracks (interurban terminals) enter the East and West ends of the platform and terminate in the center of the platform. Between the four separate tracks, six trains could be stopped at Race Street Station at one time. The Race Street platform is located directly below the landscaped median in Central
Parkway. The station was built with stairways connecting the platform to the median and several box-shaped vent constructions allowed light and fresh air to enter the station. The ventilators were removed when Central Parkway was widened in the 1950’s, but the (now smaller) landscaped median still lies directly over the platform. Race Street Station offers an ideal location for a soniferous garden due to its size and isolation from the sights and sounds of Cincinnati above, but is still near active neighborhoods and institutions that could make use of it.

In the 19th century, German immigrants began referring to the Miami-Erie Canal as “The Rhine.” Even though the Canal has been replaced by subway tunnels and a parkway, the area “Over The Rhine” has kept its name. Today, Central Parkway is still the boundary between the downtown Cincinnati business district and residential Over-the-Rhine. Although the Over-the-Rhine district now houses only about seven percent of the population it did at its height, it is redeveloping with active support from the Over-the-Rhine Chamber of Commerce. Cincinnati Music Hall and the Cincinnati School for Creative and Performing Arts, both in Over-the-Rhine, could make use of the soniferous garden in the nearby Race Street subway station.

Cincinnati Music Hall, completed in 1878, is both concert hall and exposition

It was designed to maintain and increase Cincinnati’s esteem as the “Queen City” of the United States. Activities in Music Hall, “have ranged from traditional symphony concerts and theatrical performances to the Democratic National Convention of 1880, the Cincinnati Industrial Expositions, home shows, air shows, automobile shows, basketball games, tennis matches, [and] wrestling matches.”

Today, the hall is still known for its acclaimed Springer Auditorium, where Cincinnati’s Symphony Orchestra, May Festival, Opera, and Ballet Companies hold performances. Located only two blocks from the Race Street subway, there is great possibility for experimentation in the soniferous garden by musicians and patrons from Cincinnati Music Hall.

The potential for sonic investigation in the soniferous garden is even greater with the recent completion of the Erich Kunzel Center for Arts and Education. The facility is located on Central Parkway immediately adjacent to the Race Street subway station and will be the new home of the School for Creative and Performing Arts (SCPA) and Schiel Primary School for Arts Enrichment beginning in the autumn of 2010. The new school will act as “the cornerstone of a vibrant arts and culture district,” according to the SCPA, “and the doors will be open to ensure the surrounding neighborhood and the entire

3.16: Site plan showing existing location of tunnels and platforms at Race Street Station. Landscaped parkway medians are shown in green.
community will have access to, and derive pleasure from the arts.”\textsuperscript{33} The proposed soniferous garden would make a worthy addition to an arts and culture district, allowing students and guests of the SCPA a chance to interact with music and sound in new and unexpected ways.

The area near the Race Street Station site sees a lot of foot traffic. In the morning, people from nearby residences walk their dogs along the grassy Central Parkway Median. During lunch, the parkway is teeming with employees of downtown businesses walking to purchase a meal. People leisurely enjoy the outdoors at Washington Park (adjacent to Music Hall) at all times of day. With this amount of activity in the vicinity, it would not be difficult for the above-ground constructions of the soniferous garden to incite curiosity in passersby and influence them to enter the subterranean follies.

Design

The soniferous garden is designed to be experienced in a linear series. As participants advance through the tunnel, they will experience a progression of auditory experiences. A visit can begin at either the Elm Street or Vine Street entrance. Upon entering, visitors will enter a silent chamber that acts as a sonic “palate cleanser.” From this point, the architectural interventions will isolate and emphasize elements of the soundscape, so that one may consider the way architecture affects everyday sounds that are usually unnoticed or ignored. Near the Elm Street entrance are constructions that focus ambient sounds from the city, while those nearer to Vine Street focus on the sounds generated by individual inhabitants. The following passage describes the constructions and related experiences proceeding from Elm Street toward Vine in the subterranean soniferous garden.

Sonic Encounters

The sloped, landscaped roof on the entrance to the soniferous garden rises gradually from the median in Central Parkway. The result is a perplexing portal that leads away from the Cincinnati streetscape to a concealed destination. Along with a few large horns and concrete monoliths—the above ground manifestations of the subterranean soniferous garden—the portal is an indication that something unusual exists under the streets of Cincinnati.
3.17: Longitudinal Section of proposed soniferous garden.

3.18: Tunnel level plan of proposed soniferous garden.
As people—possibly employees of nearby businesses on break, or students leaving the nearby SCPA—pass through the portal, they wind their way down a ramp. As the visitors move nearer and farther from the entrance the intensity and character of the city soundscape wavers. Upon entering a small chamber at the end of the ramp, all outside sound stops. Even the sound of the occupants’ footsteps, which had previously sounded from the ramp and echoed off of concrete walls, can hardly be heard. Each individual is left alone with the sound of his own breaths and heartbeats. The interlopers find it hard to maintain equilibrium.

The visitors have entered the anechoic chamber, the first in a series of follies designed to raise awareness of perception of space through sound. On a casual walk through the city, one does not usually consider the rapidity and effectiveness with which the perceptual system identifies his surroundings. In addition to identifying sound sources and their locations, the human sensory apparatus is capable of understanding the environment that relates the source to the sensor; a task that most would associate with the eye.

The anechoic chamber (identified as “A” on the plan and longitudinal section) is an independent concrete structure within the tunnel, separated from it by neoprene vibration isolators. The vibration isolation results in virtually no outside noise entering the enclosure. The walls, ceiling, and floor (above which a walkway is suspended) are fitted with fiberglass wedges, two feet in length. By preventing any large, acoustically
The anechoic chamber absorbs most of the sound energy from within, as well as being isolated from structure-borne vibrations in the surrounding tunnel.

- A suspended walkway allows the wedges to cover all surfaces of the chamber.
- 2" Deep fiberglass wedges diffuse and absorb sound from within the chamber.
- Concrete structure, separate from surrounding tunnel.
- Neoprene vibration isolators separate the two structures.
- Existing tunnel.

3.20: Transverse section of anechoic chamber.
reflective areas, these wedges absorb and diffuse most of the sound occurring within the chamber. People inhabiting anechoic chambers often become disoriented due to the lack of auditory spatial cues received by the perceptual system. In addition to its ability to cleanse the “aural palate” of ambient sound, the anechoic chamber makes participants aware of their dependency on sound for wayfinding, making it an ideal starting point for the soniferous garden.

After leaving the anechoic chamber, and regaining the benefit of reflected sound, the inhabitants of the soniferous garden notice disconnected sounds originating from the city above. As they move through a large hall among tubes suspended from the ceiling (labeled “B” on the plan and longitudinal section), they hear the sound of bus-stop conversations, automobile engines, and bird songs build and fade. Dish and horn-shaped sonic collectors above ground funnel sound waves into the tubes. Based on acoustic locators—a predecessor of radar systems—these collectors can be operated from within the soniferous garden, and aimed to transfer sounds into the subterranean hall. Acoustic locators were used before and during World War II to detect incoming bomber flights. By gathering and focusing sound waves from a particular trajectory, operators could determine the location of aircraft based on the sound of their engines. The unusual sensation of experiencing terrestrial sounds in the underground hall demonstrates the importance of environmental context in the everyday perception of sound.

At either end of the sound collector hall is a concrete, parabolic wall. These
The parabolic reflector focuses parallel sound waves at a single point. When operable ‘sound periscopes’ are aimed towards the reflector, the disparate sounds are combined into a new soundscape.

Collectors gather sound from the streetscape and transmit it below ground through tubes.

Sounds arriving at the parabolic dish perpendicularly are all focused to a single point.

Concrete Base.

Fiberglass top.

Water Main.

3.24: Transverse section showing sound gathering/directing devices and parabolic reflector.
reflectors are designed to reflect all sound waves traveling the length of the hall (perpendicular to the directrix of the parabolas) to a single point at head height. This allows occupants of the soniferous garden to direct the suspended sound tubes toward or away from the parabolic reflector. In this manner, they can compose and immerse themselves in alternative soundscapes using a palette of sounds from above ground.

Passing through an opening in the back of the parabolic reflector, the visitors hear an other-worldly harmonic drone. The source of the sound is a set of giant aeolian harps, or wind harps. Athanasius Kircher is often credited with the first design of an Aeolian harp, however, “the spontaneous resonance of certain musical instruments when exposed to a current of air had struck the observers of nature in times of remotest antiquity.”

Kircher’s harp consists of a wooden box with sound holes. Bridges at both ends of the box stretch the strings, which are tuned to the same pitch with tuning pegs. As wind blows across the consecutively placed strings, turbulent air causes them to resonate at multiple frequencies. The result is an ethereal fabric of tones and overtones that is constantly changing. Through experimentation, Kircher found that a wind concentrator helped to, “increase the force of the wind, and to obtain all the advantage possible from the current of air that was directed against the strings.” He suspended his harp at the end of a wooden chute to intensify the resulting sound.

35 Ibid.
The Aeolian Harp is played by the wind, creating an ethereal set of overlapping tones. This construction creates a new way of hearing the environment.

- Slotted opening creates laminar airflow over the strings.
- Steel strings of varying gauges, all tuned by hand to the same pitch.
- Strings are tied into the suspended walkway, which acts as a resonator.
- The elliptical chamber allows the harp's sounds to resonate, as well as focusing speech to the heads of visitors above and below ground.

3.26: Transverse section of a typical two-level elliptical chamber with aeolian harp on parkway level.
The Aeolian harps are used in the soniferous garden as an exaggeration of the sounds that weather makes in the environment around us. Subconsciously, one gains understanding of his surroundings by hearing interactions of weather and surrounding objects, such as wind rustling leaves, or whistling through an alleyway. By emphasizing this interaction in an unexpected way, the harps cause visitors to consciously regard this phenomenon that is often ignored.

The Aeolian harps (labeled “C” on the plan and longitudinal section) in the soniferous garden are housed in a two-level ellipsoidal chamber formed from reinforced concrete. The ellipsoids serve as reverberation chambers. Sound generated by the harps continually bounces off of the smooth, acoustically reflective walls of the enclosure, extending the length of each note and enriching the tapestry of overlapping tones. Each ellipsoid is bisected by an open slot which acts as a chute to direct wind across the strings. Each of the four harp constructions is slotted in a different orientation—east-west, northeast-southwest, north-south, and northwest-southwest—this ensures that at least one harp will be active most of the time.

The string assembly consists of vertical steel cables, in series along the direction of the slot. They are fixed to tuning posts at the top of the concrete shell, and a metal footbridge at ground level. The bridge, suspended within the ellipsoid, acts as a resonator—amplifying the vibrations in the cables. The bridges allow people to inhabit the Aeolian harp chambers from the level of Central Parkway, in addition to the
underground tunnel. The unusual appearance and sound of the concrete monoliths above ground would potentially draw more participants underground.

The ellipsoidal form of the harp chambers sonically connects the upper and lower levels. Sound waves originating at one focus of the ellipse (head height in the underground tunnel) are reinforced at the other focus (head height on the parkway level). Sound waves travelling directly between these points are blocked by the suspended walkway, but waves that hit any spot on the chamber walls will be reflected. The length of time it takes for a sound wave originating at one focus to bounce once and reach the other focus is the same for all points on the chamber wall. The result is the reinforcement (increased intensity) of the sound. Since the sound is reinforced from all directions, a listener at one focus will experience the voice of a speaker at the other focus as if they occupied the same space; however, the speaker will not experience the reinforcement. The concrete shells heighten the experience by partially blocking ambient sounds from reaching the inhabitants.

As visitors proceed through the soniferous garden, they encounter three parallel aisles (labeled “D” on the plan and longitudinal section). Walking down the left or right path, an individual intermittently hears others breathing and speaking as if they were standing next to one another. As the individual moves on, the phenomenon abruptly stops. Elliptical, steel reflector panels are suspended along side and over top of the passages, positioned so that their foci are located at head height in the center of the path.
As people occupy the focus of a panel, they hear sounds made by someone at the opposite focus—either in front, behind, or across from them. In many cases, the occupants cannot see each other, but can hear each other clearly. As one executes a daily routine, especially in urban settings, he often disregards the voices of others and pays little attention to the sounds that he generates. The reflector gallery makes these issues hard to ignore as interpersonal interactions occur abruptly and unexpectedly.

Running through the center of the reflector gallery is an elliptical concrete tube. As participants advance through the tunnel, the sound of their own footsteps on the suspended walkway sounds as if it is occurring within their heads. This is accomplished by constructing the tube in such a way that its foci occur at the center of the walkway and head height above it. By interpreting the sound of footsteps, the auditory perceptual system automatically determines characteristics of space. The sonic intensity and timbre of a footstep indicate solidity and material of construction, while the resultant web of sonic reflections helps one understand the scale and proportions of the environment as well as its material makeup. By exaggerating the footstep, the elliptical passageway makes the visitors cognizant of their dependency on aural perception for understanding their surroundings.

After traversing one or more of the three passages, participants encounter a network of spherical whispering galleries (labeled “E” on the plan and longitudinal section). The galleries consist of a concrete bowl, on top of which is bolted a fiberglass
Sound originating from one focus of an ellipse bounces off all surfaces and is concentrated again at the other focus.

Fiberglass reflector panels direct sound from the focus on one side of the platform to the opposite focus.

The elliptical concrete tunnel reinforces the sound of a visitor’s footsteps at the other focus at head level.

A lightweight suspended walkway creates the potential for louder footsteps to be reflected.

3.27: Transverse section showing elliptical reflectors and elliptical tunnel.
dome. The center of the sphere is located at head height when one stands on the lowest point of the bowl. Standing at this point, the sound of the participant’s own breathing and speaking is reinforced, while ambient noises are shielded by the enclosure. Awareness of environmental sounds returns as one leaves a gallery. An occupant, advancing along the web of paths that connect the spheres, becomes aware of others making curious sounds as they listen to their own voice in a new and unusual way. The spherical whispering galleries foster understanding of, and attention to, the sounds that an individual makes.

A trip through the soniferous garden ends as it began, with an experience in the anechoic chamber. Here, the sounds of the garden are purged before participants proceed up the ramp, becoming reacquainted with the soundscape of downtown Cincinnati. After visitors emerge from the subterranean darkness, hopefully the experience of the soniferous garden will remind them that sound is crucial to their understanding of the environment. The soniferous garden reveals the capacity for aural architecture to be used as a tool in mediating the sounds of ourselves, others, and our world.
Section E-E: Spherical Whispering Galleries

Scale: 1/4"=1'-0"

Spherical whispering galleries reflect sounds originating from the center and reinforce them at that spot. These chambers emphasize the visitor's voice, while subduing other sounds.

3.28: Transverse section showing typical spherical whispering galleries.
3.29: Process collage of the subterranean soniferous garden.
SUBWAY TUNNELS MANIPULATE THE URBAN SOUNDSCAPE TO EMPHASIZE AND CHALLENGE AUDITORY PERCEPTION.
Works Cited


