1 Introduction to Aural Architecture

We shape our buildings, and afterward our buildings shape us.
—Winston Churchill, 1943

Architecture, which has been called the ''mother of all arts,'' is concerned with the design, arrangement, and manipulation of the physical properties of a space. Unlike other art forms, architecture provides spaces for the daily activities of life; when more than simply utilitarian, it also appeals to our aesthetic sensibilities. By choosing and combining materials, colors, and shapes, architects embed their respective artistic messages in structures that we see, hear, and feel. Like poets with their specialized language, architects communicate their worldview with a vocabulary of spatial elements that often contain symbolic meaning reflecting their culture.

To communicate the artistic, social, emotional, and historical context of a space, however, architects almost exclusively consider the visual aspects of a structure. Only rarely do they consider the acoustic aspects. The native ability of human beings to sense space by listening is rarely recognized; indeed, some people think such an ability is unique to bats and dolphins. But sensing spatial attributes does not require special skills—all human beings do it: a rudimentary spatial ability is a hardwired part of our genetic inheritance. For example, when blindfolded, nearly all of us can approach a wall without touching it just by attending to the way the wall changes the frequency balance of the background noise. Similarly, the sounds of our footsteps hint at the location of stairs, walls, low ceilings, and open doors. To make this more obvious, walk through your home while listening to loud music through headphones; then do it again without the headphones. Notice how the clear sounds of your shoes on uncarpeted stairs provide navigational confidence, especially when your eyes are focused elsewhere. When crawling through underground caves, spelunkers can gauge the depth of a dark passageway by its resonances. But even nonspelunkers have acoustic awareness. It is available to all of us.

Observing that ordinary people can hear passive objects and sense spatial geometry requires an explanation. As a simple illustration of how we hear an object that itself

does not produce any sound, consider a flat wall located at some distance. When the sound wave from a hand clap is reflected from that distant wall, we hear the reflection as a discernible echo. The distance to the wall determines the delay for the arrival of the echo, the area of the wall determines the intensity, and the material of the wall's surface determines the frequency content. These physical facts relate only indirectly to perception. Our auditory cortex converts these physical attributes into perceptual cues, which we then use to synthesize an experience of the external world. On the one hand, we can simply hear the echo as an additional sound (sonic perception) in the same way that we hear the original hand clap (sonic event). On the other hand, we can interpret the echo as a wall (passive acoustic object). The echo is the aural means by which we become aware of the wall and its properties, such as size, location, and surface materials. The wall becomes audible, or rather, the wall has an audible manifestation even though it is not itself the original source of sound energy. When our ability to decode spatial attributes is sufficiently developed using a wide range of acoustic cues, we can readily visualize objects and spatial geometry: we can ''see'' with our ears.

A real environment, such as an urban street, a concert hall, or a dense jungle, is sonically far more complex than a single wall. The composite of numerous surfaces, objects, and geometries in a complicated environment creates an *aural architecture*. 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. To illustrate that we are aware of aural architecture, consider displacing familiar sounds to unfamiliar environments. Transported to an open desert, urban traffic would not have the aural personality of a dense city environment. Moved to a forest, a symphony concert would not have the aural impact, intimacy, and immediacy of a concert hall. Nor could the aural personality of singing in the bathroom, which takes advantage of the resonances of small spaces, be duplicated in a large living room. In each contrasting space, even if the sound sources were to remain unchanged, the aural architecture would change. Every space has an aural architecture, which will be defined more extensively in chapter 2.

In addition to providing acoustic cues that can be interpreted as objects and surfaces, aural architecture can also influence our moods and associations. Although we may not be consciously aware that aural architecture is itself a sensory stimulus, we react to it. We may experience a living room as cold or warm independent of its actual temperature, or a train station as lonely and forbidding independent of its actual appearance. The acoustics of a grand cathedral can create an exalted mood; those of a chapel can enhance the privacy of quiet contemplation; those of an elevator can produce the feeling of encapsulation and, in the extreme, claustrophobia. The acoustics of an open area can produce feelings of either freedom or insecurity.

Aural architecture can also have a social meaning. For example, the bare marble floors and walls of an office lobby loudly announce the arrival of visitors by the resounding echoes of their footsteps. In contrast, thick carpeting, upholstered furniture, and heavy draperies, all of which suppress incident or reflected sounds, would mute that announcement. The aural architecture of the lobby thus determines whether entering is a public or private event. When applied to a living room, those same acoustic attributes convey a different sense: cold, hard, and barren, as contrasted with warm, soft, and intimate. In a musical performance space, acoustic attributes can produce a blending of sequential notes, almost like chords. In certain religious spaces, they can produce a reverberation that conveys a sense of awe and reverence. As with all sensory aspects of architecture, cultural values and social functions determine the experiential consequences of spatial attributes. In different social settings, the same acoustic features have different meanings, which then influence the mood and behavior of the people in those settings.

Aural architecture, with its own beauty, aesthetics, and symbolism, parallels visual architecture. Visual and aural meanings often align and reinforce each other. For example, the visual vastness of a cathedral communicates through the eyes, while its enveloping reverberation communicates through the ears. For those with ardent religious beliefs, both senses create a feeling of being in the earthly home of their deity. Similarly, the visual elegance of a grand opera hall contributes to the artistry of the performance, and the aura of power in a governmental chamber contributes to the importance of speeches presented there. In these examples, because the aural and visual elements in the space are congruent, symbols and associations are shared.

Although we expect the visual and aural experience of a space to be mutually supportive, this is not always the case. Consider dining at an expensive restaurant whose decorations evoke a sense of relaxed and pampered elegance, but whose reverberating clatter produces stress, anxiety, isolation, and psychological tension, undermining the possibility of easy social exchange. The visual and aural attributes produce a conflicting response.[1]

Although multiple senses contribute to the formation of an internal experience of an external reality, the contribution made by listening varies greatly among individuals and cultures (Classen, 1993). Since listening with understanding depends on culture, rather than on the biology of hearing, auditory spatial awareness must be considered the province of sensory anthropology. To evaluate aural architecture in its cultural context, we must ascertain how acoustic attributes are perceived: by whom, under what conditions, for what purposes, and with what meanings. Understanding aural architecture requires an acceptance of the cultural relativism for all sensory experiences.

Sensory anthropology studies how social structures determine the use of the senses and the meaning of the resulting perceptions (Howes, 1991). In our scientific society with its emphasis on physical explanations, the categories for sensing the external

world are mostly sorted by the combination of biological organs and physical stimuli: ears are for hearing sound, eyes are for seeing light, and skin is for touching surfaces (Ackerman, 1990). Yet even with this bias toward concrete labeling, our culture takes no notice of the many different kinds of information processing that actually compose a single sensory modality. For example, the tactile modality—touch—includes independent sensors for vibration, texture, temperature, movement, and so on. Our very concept of the senses arises from our cultural biases.

To illustrate the wide range of choices for labeling the senses and for understanding their relationship to social functions, consider a few examples from other cultures and subcultures. The Hausa people recognize only two senses: seeing and experiencing (Ritchie, 1991). In this culture, the vision sense is only a means for navigating the environment, and the experience sense encompasses intuition, emotion, smell, touch, taste, and hearing. The anthropologist Anthony Seeger (1981), in addressing cultural meaning of sensation, commented: ''Just as time and space are not perceived by the vast majority of human societies as a regular continuum and grid, so the [sensorium] is rarely thought of in strictly biological terms. . . . The five senses are given different emphasis and different meanings in different societies. A certain sense may be privileged as a sensory mode.'' For example, Aivilik Eskimo natives do not describe space in visual terms (Carpenter, 1955) because their environment is an open expanse without visual markers. For this group, the nonvisual senses play a stronger role in their experience of space. Similarly, in many religious subcultures, their gods speak to their disciples rather than leave them written messages. Rehabilitation workers often report that blindness is less socially and emotionally burdensome than deafness. Some cultures revere the role of the blind seer who has learned to accentuate the gift of listening as a better means for ''seeing'' the future.

From this broad perspective, it is clear that hearing contributes to a wide range of experiences and functions. Hearing, together with its active complement, listening, is a means by which we sense the events of life, aurally visualize spatial geometry, propagate cultural symbols, stimulate emotions, communicate aural information, experience the movement of time, build social relationships, and retain a memory of experiences. To a significant but underappreciated degree, aural architecture influences all of these functions.

Let us digress briefly to clarify a few common words and concepts relating to sound. Over the years, some words have acquired meanings and associations that deviate from their dictionary definitions. *Acoustics*, from the Greek *akoustikos* and meaning that which pertains to hearing, now refers mostly to the behavior of sound waves (vibrations) in solids, liquids, or gases. Listening is not required, and may not even be possible, for underwater, ultrasonic, or high-pressure acoustics. Even when listening is expected, acoustic architecture uses the language of physics to describe sonic

processes as phenomena that can be measured. To clarify how key terms are used in this book, the adjective *aural*, which parallels *visual*, refers exclusively to the human *experience* of a sonic process; *hearing*, to the detection of sound; and *listening*, to active attention or reaction to the meaning, emotions, and symbolism contained within sound.

Accordingly, *aural architecture* refers to the properties of a space that can be *experienced* by listening. An *aural architect*, acting as both an artist and a social engineer, is therefore someone who selects specific aural attributes of a space based on what is desirable in a particular cultural framework. With skill and knowledge, an aural architect can create a space that induces such feelings as exhilaration, contemplative tranquillity, heightened arousal, or a harmonious and mystical connection to the cosmos. An aural architect can create a space that encourages or discourages social cohesion among its inhabitants. In describing the aural attributes of a space, an aural architect uses a language, sometimes ambiguous, derived from the values, concepts, symbols, and vocabulary of a particular culture.

In contrast, an *acoustic architect* is a builder, engineer, or physical scientist who implements the aural attributes previously selected by an aural architect. Acoustic design manipulates physical objects, spatial geometries, and mathematical equations using the scientific language of physics. Because of differences in their perspectives, acoustic architects focus on the way that the space changes the physical properties of sound waves (*spatial acoustics*), whereas aural architects focus on the way that listeners experience the space (*cultural acoustics*). Although some individuals function as both aural and acoustic architects, the fundamental difference in the two functions is the distinction between choosing aural attributes and implementing a space with previously defined attributes.

We can sometimes identify the aural architect of a space, but far more frequently, aural architecture is the incidental consequence of unrelated sociocultural forces. Ancient cathedrals possess an aural architecture, without having had aural architects. Towns have an aural architecture that arises from their natural geography and topography, as well as from the uncoordinated construction of streets and buildings. Residential dwellings have an aural architecture determined by design traditions and construction budgets. The aural architecture of many modern spaces is created by architects, space planners, and interior designers with little appreciation for the aural impact of their choices. Living rooms, restaurants, and automobiles are examples of such spaces. Aural architecture thus exists regardless of how the acoustic attributes of a space came into existence: naturally, incidentally, unwittingly, or intentionally. For these reasons, the aural architect is most often not an actual person.

Even when the architects *are* actual people, however, aural architecture is not the exclusive domain of a handful of acoustic professionals who have an opportunity to

design classrooms, concert halls, or churches. In a very real sense, we are all aural architects. We function as aural architects when we select a seat at a restaurant, organize a living space, or position loudspeakers.

To broaden the concept still further, aural architecture includes the creation of spatial experiences where a physical space does not actually exist, so-called virtual, phantom, and illusory spaces. While listening to recorded music in our homes, we experience a virtual space created by a mixing engineer who manipulated a spatial synthesizer in a recording studio. There never was a performance space. Defined as the design or selection of a spatial experience, without regard to the means of implementing that experience, aural architecture is as old as civilization, embracing the widest diversity of social and artistic examples in cultures that span thousands of years.

Even though aural architects are most often sociocultural forces rather than actual people, we can still examine how these forces influence spatial designs. Over the millennia, a series of progressive changes in the relationship between aural architecture and its social uses resulted from changes in artistic attitudes, in the prevailing theology, and in how the senses were used to experience physical and social environments. The difference between adapting a cave for a religious ceremony and designing a consumer home theater surround-sound system reflects not only advances in technology, but also changes in culture. Those who built cathedrals and those who designed virtual electroacoustic spaces were seldom aware of how their social context influenced their spatial creations.

Thousands of visual artists, civil engineers, architectural historians, and social scientists have created a comprehensive symbolic language and an extensive literature for visual architecture, whose intellectual foundation draws on archaeology, engineering, history, sociology, anthropology, evolution, psychology, and science. In contrast, even though aural architecture shares the same intellectual foundation, its language and literature are sparse, fragmented, and embryonic.

There are four principal reasons why this might be so. First, aural experiences of space are fleeting, and we lack means for storing their cultural and intellectual legacy in museums, journals, and archives. Second, for both cultural and biological reasons, the language for describing sound is weak and inadequate. Third, being fundamentally oriented toward visual communications, modern culture has little appreciation for the emotional importance of hearing, and thus attaches little value to the art of auditory spatial awareness. And fourth, questions about aural architecture are not generally recognized as a legitimate domain for intellectual inquiry; professional schools provide little or no training in physical acoustics, aural aesthetics, or sensory sociology.

Because aural architecture is not a recognized discipline, its concepts are not a significant part of our cultural and intellectual mainstream. When professional architects focus exclusively on the visual and utilitarian attributes of a space, they are reflecting

a tradition that devalues listening. More significant, when listeners tolerate an environment whose acoustics damage their ears, their social relations, or both, they, too, are devaluing the aural experience.

There are, however, segments of our culture that take an interest in aural architecture. When given the freedom to choose the aural attributes of a spatial experience, audio engineers, composers, acoustic scientists, and spatial designers function as aural architects. There are conspicuous and representative examples of artists and architects who explicitly focus on aural architecture. The Finnish architect Juhani Pallasmaa (1996), who rejected the assumption of visual dominance, considered sensory architecture as an umbrella theme that explicitly included aural architecture. R. Murray Schafer (1977), in formulating the concept of the soundscape as a mixture of aural architecture and sound sources, created disciples who have passionately extended and applied his initial concept. Thomas Sheridan and Karen van Lengen (2003) argued that architectural schools should intentionally include aural considerations in order ''to achieve a richer, more satisfying built environment.'' In their treatise on spatial acoustics, Hope Bagenal and Alex Wood (1931) recognized the social and cultural aspects of aural architecture.

The aural architecture of musical spaces, unlike that of religious, political, and social spaces, is well recognized and extensively researched. When a musical space is considered to be an extension of musical instruments, rather than an independent manifestation of aural architecture, it becomes a tool to be used by composers, musicians, and conductors. Musical spaces are intentionally designed for specific audiences that have acquired sensitivity and appreciation for spatial acoustics, as these bear on their experience of music and voice. Musical spaces are also an interesting application of aural architecture because music has played a role far beyond that of entertainment, a role anchored in history, culture, evolution, and neurobiology. Like architecture, music is also a language of aesthetics, spirituality, patriotism, and especially the emotions of joy, love, pride, and sorrow. Although they do not identify themselves as such, many aural architects are found within audio and musical subcultures. Fortunately, we can apply our knowledge of musical spaces to other kinds of space as well.

Even within a given culture, listeners are not homogeneous with regard to how they use their sense of hearing. When, however, listeners share a similar relationship to some aspect of aural architecture, they become a relatively homogeneous group, an *auditory subculture*. We find auditory subcultures both within a culture and across cultures. Active users of particular kinds of acoustic space who share goals, motivation, genetic ability, and opportunities often become a unique auditory subculture. They teach themselves to attend to the particular spatial attributes they consider important. From this perspective, those with an active interest in music—performers, composers, and listeners—form an auditory subculture with an enhanced sensitivity to the aspects of

aural architecture that apply to their music. Those blind individuals who orient and navigate a space by listening to objects and geometries form another auditory subculture. The experience of aural architecture depends on the individual's subculture.

A related kind of social grouping is the professional subculture whose members study, design, or manipulate spatial attributes for the purpose of creating aural experiences for others. Often these professionals do not realize they are functioning as aural architects. To name but a few, such subcultures include ancient shamans who performed ceremonies in caves, recording engineers who use virtual space simulators as part of the production process, cinema film directors who match or contrast the visual and auditory experience of space, social psychologists who study human behavior, and designers of religious ceremonial spaces who want the congregation to feel a connection with their deities and their heavenly cosmos. Each of these professional subcultures is unique in terms of its educational training, cultural beliefs, specialized goals, economic rewards, and private agendas. Aural architecture is mostly the result of the values and biases in these professional subcultures.

In one sense, the concept of aural architecture is nothing more than an intellectual edifice built from bricks of knowledge, borrowed from dozens of disciplinary subcultures and thousands of scholars and researchers. I did not create these bricks, all of which appear in published papers. When fused together into a single concept, however, the marriage of aural architecture and auditory spatial awareness provides a way to explore our aural connection to the spaces built by humans and to those provided us by nature. This book is the story of that marriage over the centuries in a variety of cultures and subcultures, and today's artists and scientists are its children.

Individuals who use spaces for a particular purpose, and individuals who design spaces for a particular use, often acquire a heightened sensitivity to particular aspects of aural architecture. Auditory spatial awareness is a multiplicity of related but independent abilities. Although evolution provided our species with the basic neurobiology for hearing space, each sensory and professional subculture emphasizes only a subset of this endowment. Conversely, those who are neither users nor designers of aural architecture are unlikely to display more than the basic abilities to hear space. Furthermore, cultures without any appreciation for aural experiences are unlikely to develop and support those subcultures with an interest in aural architecture.

Spaces Speak is written for three types of reader. First, for those professionals who possess an expertise in one of the supporting disciplines, the discussions provide an overview into related, and possibly unfamiliar, areas. Second, for those with a general curiosity, the discussion integrates the collective knowledge of many artists, designers, and scientists into an accessible presentation of aural architecture. And finally, for those with a love of music, the discussions explore aural architecture as an extension of the auditory arts.

As an intellectual mosaic, *Spaces Speak* explores auditory spatial awareness and its relationship to aural architecture. Discussions move from cave acoustics to home theater audio systems, from evolution to neurobiology, from physics to perception, from science to engineering, from physical to virtual spaces, and from physical sound to emotional response. This book does not require expertise in any of the relevant specialties, and it will not make its readers experts. Rather, it is intended to provide a means of capturing and fusing disparate knowledge into a common framework: the human condition as seen through one particular prism, the aural architecture of spaces.