WARNING CONCERNING COPYRIGHT RESTRICTIONS

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproduction of copyrighted material.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be used for any purpose other than private study, scholarship, or research. If electronic transmission of reserve material is used for purposes in excess of what constitutes “fair use”, that user may be liable for copyright infringement.
Our Sonic Environment and

THE SOUNDSCAPE

the Tuning of the World

R. MURRAY S'CHAER

DESTINY BOOKS
Rochester, Vermont
Introduction

Now I will do nothing but listen . . .
I hear all sounds running together, combined,
 fused or following,
Sounds of the city and sounds out of the city, sounds
of the day and night . . .

WALT WHITMAN, Song of Myself

The soundscape of the world is changing. Modern man is beginning to
inhabit a world with an acoustic environment radically different from any
he has hitherto known. These new sounds, which differ in quality and
intensity from those of the past, have alerted many researchers to the
dangers of an indiscriminate and imperialistic spread of more and larger
sounds into every corner of man’s life. Noise pollution is now a world
problem. It would seem that the world soundscape has reached an apex of
vulgarity in our time, and many experts have predicted universal deafness
as the ultimate consequence unless the problem can be brought quickly
under control.

In various parts of the world important research is being undertaken
in many independent areas of sonic studies: acoustics, psychoacoustics,
entoacoustics, international noise abatement practices and procedures, commu-
nications and sound recording engineering (electroacoustics and electronic
music), aural pattern perception and the structural analysis of language
and music. These researches are related: each deals with aspects of the
world soundscape. In one way or another researchers engaged on these
various themes are asking the same question: what is the relationship
between man and the sounds of his environment and what happens when
released into the environment, of studying the rich symbolism sounds have for man and of studying human behavior patterns in different sonic environments in order to use these insights in planning future environments for man. Cross-cultural evidence from around the world must be carefully assembled and interpreted. New methods of educating the public to the importance of environmental sound must be devised. The final question will be: is the soundscape of the world an indeterminate composition over which we have no control, or are we its composers and performers, responsible for giving it form and beauty?

Orchestration Is a Musician’s Business Throughout this book I am going to treat the world as a macrocosmic musical composition. This is an unusual idea but I am going to nodle it forward relentlessly. The definition of music has undergone radical change in recent years. In one of the more contemporary definitions, John Cage has declared: “Music is sounds, sounds around us whether we're in or out of concert halls or, for that matter, in our bathtub and change his behavior. From the arts, particularly music, we will learn how man creates ideal soundscapes for that other life, the life of the imagination and psychic reflection. From these studies we will begin to lay the foundations of a new interdisciplinary—acoustic design.

From Industrial Design to Acoustic Design The most important revolution is aesthetic education in the twentieth century was that accomplished by the Bauhaus, that celebrated German school of the twenties. Under the leadership of architect Walter Gropius, the Bauhaus collected some of the great painters and architects of the time (Klee, Kandinsky, Moholy-Nagy, Mies van der Rohe), together with craftsmen of distinction. At first it seemed disappointing that the graduates of this school did not rise to the challenge their mentors as artists. But out of the purpose of the school was different. From the interdisciplinary synergy of faculty skills, a whole new study field was created, for the school invented the subject of industrial design. The Bauhaus brought aesthetics to machinery and mass production. It devolves on us now to invent a subject which we might call acoustic design, an interdisciplinary in which musicians, acousticians, psychologists, sociologists and others would study the world soundscape together in order to make intelligent recommendations for its improvement. This study would consist of documenting important features, of noting differences, parallels and trends, of collecting sounds threatened with extinction, of studying the effects of new sounds before they are indiscriminately

|For definitions of ear cleaning, clairaudience and other special terms, see the glossary.
in which the contemporary musician is supposed to attach himself to this vast theme, so I am going to grind my axe on this point for a moment longer.

There are two basic ideas of what music is or ought to be. They may be seen most clearly in two Greek myths, one of which is the origin of music. Pindar's twelfth Pythian Ode tells how the art of autos playing was invented by Athena when, after the beheading of Medusa, she was soothed by the heart-rending cries of Medusa's sisters and created a special song in their honor. In a Homeric hymn to Hermes, an alternative origin of the lyre is mentioned. The lyre is said to have been invented by Hermes when he surprised that the shell of the turtle, if used as a body of resonance, could produce sound.

In the first of these myths music arises as subjective emotion; in the second it arises with the discovery of sonority properties in the materials of the universe. These are the cornerstones on which all subsequent theories of music are founded. Characteristically the lyre is the instrument of Homer, of the epics, of serene contemplation of the universe; while the autos (the reed oboe) is the instrument of exaltation and tragedy, the instrument of the dithyramb and of drama. The lyre is the instrument of Apollo, the autos that of the Dionysian festivals. In the Dionysian myth, music is conceived as internal sound breaking forth from the human breast; in the Apollonian it is external sound, God-sent to remind us of the harmony of the universe. In the Apollonian view music is an exact, serene, mathematical, associated with transcendental visions of Utopia and the Harmony of the Spheres. It is also the abode of Indian theorists. It is the basis of Pythagoras's speculations and those of the medieval theoreticians (where music was taught as a subject of the quadrivium, along with arithmetic, geometry and astronomy), as well as of Schoenberg's twelve-note method of composition. Its methods of exposition are number theories. It seeks to harmonize the world through acoustic design. In the Dionysian view music is irrational and subjective. It employs expressive devices: tempo fluctuations, dynamic shadings, timbre colorings. It is the music of the operatic stage, of bel canto, and its ready voice can also be heard in Bach's Passions. Above all, it is the music's expression of the romantic artist, prevailing throughout the nineteenth century and on into the expressionism of the twentieth century. It also directs the training of the musician today.

Because the production of sounds is so much a subjective matter with modern man, the contemporary musician is notable for his dynamic hedonism. The research I am about to describe represents a reaffirmation of music as a search for the harmonizing influence of sounds in the world about us. In Robert Fludd's (1574-1637) Latin text Georgius Redivius there is an illustration entitled "The Tuning of the World" in which the earth forms the body of an instrument across which strings are stretched and are tuned by a divine hand. We must try once again to find the secret of that tuning.

Music, the Soundscape and Social Welfare in Hermann Hesse's The Glass Bead Game there is an arresting idea. Hesse claims to be repeating a theory of the relationship between music and the state from an ancient Chinese source: "Therefore the music of a well-ordered age is calm and joyful, and so is its government. The music of a restless age is excited and fierce, and its government is perverted. The music of a decaying state is sentimental and sad, and its government is imperturbed."

Such a theory would suggest that the egalitarian and enlightened reign of Maria Theresa (for instance, as expressed in her unified criminal code of 1768) and the grace and balance of Mozart's music are not accidental. Or that the sentimental vagaries of Richard Strauss are perfectly consistent with the waning of the same Austro-Hungarian Empire. In Gustav Mahler we find, etched in an acid Jewish hand, marches and German dances of such sarcasm as to give us a presentiment of the political dance macabre soon to follow.

The thesis is also borne out well in tribal societies where, under the strict control of the flourishing community, music is tightly structured, while in detribalized areas the individual singsappallingly sentimental songs. Any ethnomusicologist will confirm this. There can be little doubt then that music is an indicator of the age, revealing, for those who know how to read its symptomatic messages, a means of fixing social and even political events.

For some time I have also believed that the general acoustic environment of a society can be read as an indicator of social conditions which produce it and may tell us much about the trending and evolution of that society. Throughout this book I will suggest many such relationships, and though it is probably in my nature to do this emphatically, I hope the reader may continue to regard the method as valid even if some of the equations seem disagreeable. They are all open to further testing.

The Notation of Soundscape (Sonography) The soundscape is any acoustic field of study. We may speak of a musical composition as a soundscape, or a radio program as a soundscape or an acoustic environment as a soundscape. We can isolate an acoustic environment as a field of study just as we can study the characteristics of a given landscape. However, it is less easy to formulate an exact impression of a soundscape than of a landscape. There is nothing in sonography corresponding to the instantaneous impression which photography can create. With a camera it is possible to catch the salient features of a visual panorama to create an impression that is immediately evident. The microphone does not operate this way. It samples details. It gives the close-up but nothing corresponding to aerial photography.
Similarly, while everyone has had some experience reading maps, and many can draw at least significant information from other schematics of maps, few can understand the maps of charts used by phoneticians, acousticians, or musicians. To give a totally convincing image of a soundscape would involve extraordinary skill and patience: thousands of recordings, tens of thousands of measurements would have to be taken; and a new means of description would have to be devised. A soundscape consists of events heard not objects seen. Beyond aural perception is the notation and photography of sound, which, being silent, presents certain problems that will be discussed in a special chapter in the Analysis section of the book. Through the misfortune of having to present data on silent pages, we will be forced to use some types of visual projection as well as musical notation, in advance of this discussion, and these will only be useful if they assist in opening ears and stimulating clairaudience.

We are also disadvantaged in the pursuit of a historical perspective. While we may have numerous photographs taken at different times, before them drawings and maps to show us how a scene changed over the ages, we must make inferences as to the changes of the soundscape. We may know exactly where new buildings went up in a given area in a decade or how the population has risen, but we do not know by how many of time. More than this, sounds may alter or disappear with scarcely a comment even from the most sensitive of historians. Thus, while we may utilize the techniques of modern recording and analysis to study contemporaneous sounds, for the foundation of historical perspectives, we will have to turn to earwitness accounts from literature and mythology, as well as to anthropological and historical records.

Earwitness The first part of the book will be particularly indebted to such accounts. I have always attempted to go directly to sources. Thus, I have never visited the place, but when Chateaubriand tells us that in 1791 he heard the roar of Niagara eight to ten miles away, he provides us with useful information about the ambient sound level, against which that of today could be measured. When a writer writes uncomplainingly about directly apprehended sights, ears may sometimes play tricks on the brain, as Erich Maria Remarque discovered in the trenches during the First World War when he heard shells exploding about him followed by the rumble of the distant guns that fired them. This aural illusion is perfectly accountable, for as the shells were traveling at super-

sonic speeds they arrived in advance of the sounds of their original detonations; but only someone trained in acoustics could have predicted this. All Quiet on the Western Front is convincing because the author was there. And we trust him when he describes other unusual sound events—for instance, the sounds made by dead bodies. "The days are hot and the dead lie unburied. We cannot fetch them all in, if we did we should not know what to do with them. The shells will bury them. Many have their bellies swollen up like balloons. They hiss, belch, and make movements. The gases in them make noises." William Faulkner also knew the noise of corpses, which he described as "little trickling bursts of silent and mummurous bubbling."

In such ways is the authenticity of the earwitness established. It is a special talent of novelists like Tolstoy, Thomas Hardy and Thomas Mann to have captured the soundscapes of their own places and times, and such descriptions constitute the best guide available in the reconstruction of soundscapes past.

Features of the Soundscape What the soundscape analyst must do first is to discover the significant features of the soundscape, those sounds which are important either because of their individuality, their numerosness or their domination. Ultimately some system or systems of generic classification will have to be devised, and this will be the subject for the third part of the book. For the first two parts it will be enough to categorize the main themes of a soundscape by distinguishing between what we call keynote sounds, signals and soundmarks. To these we might add archetypal sounds, those mysterious ancient sounds, often possessing a felicitous symbolism, which we have inherited from remote antiquity or prehistory.

Keynote is a musical term; it is the note that identifies the key or tonality of a particular composition. It is the anchor or fundamental tone and although the material may modulate around it, often obscuring its importance, it is in reference to this point that everything else takes on its special meaning. Keynote sounds do not have to be listened to consciously; they are overheard but cannot be overlooked, for keynote sounds become listening habits in spite of themselves. The psychologist of visual perception speaks of "figure" and "ground," the figure being that which is looked at while the ground exists only to give the figure its outline and mass. But the figure cannot exist without its ground; subtract it and the figure becomes shapeless, nonsensical. Even though keynote sounds may not always be heard consciously the fact that they are ubiquitously there suggests the possibility of a deep and pervasive influence on our behavior and moods. The keynote sounds of a given place are important because they help to outline the character of men living among them.

The keynote sounds of a landscape are those created by its geography...
and climate: water, wind, forests, plains, birds, insects and animals. Many of these sounds may possess archetypal significance; that is, they may have imprinted themselves so deeply on the people hearing them that life without them would be sensed as a distinct impoverishment. They may even affect the behavior or life style of a society, though for a discussion of this we will wait until the reader is more acquainted with the matter.

Signals are foreground sounds and they are listened to consciously. In terms of the psychologist, they are figure rather than ground. Any sound can be listened to consciously, and so any sound can become a figure or signal, but for the purposes of our community-oriented study we will confine ourselves to mentioning some of those signals which must be listened to because they constitute acoustic warning devices: bells, whistles, horns and sirens. Sound signals may often be organized into quite elaborate codes permitting messages of considerable complexity to be transmitted to those who can interpret them. Such, for instance, is the case with the cor de chasse, or train and ship whistles, as we shall discover.

The term soundmark is derived from landmark and refers to a community sound which is unique or possesses qualities which make it specially regarded or noticed by the people in that community. Once a soundmark has been identified, it deserves to be protected, for soundmarks make the acoustic life of the community unique. This is a subject to be taken up in Part Four of the book, where the principles of acoustic design will be discussed.

I will try to explain all other soundscape terminology as it is introduced. At the end of the book there is a short glossary of terms which are either neologistic or have been used idiosyncratically, in case doubt exists at any point in the text. I have tried not to use too many complex acoustical terms, though a knowledge of the fundamentals of acoustics and a familiarity with both musical theory and history is presupposed.

Ears and Clairaudience

We will not argue for the priority of the eye as the most important gatherer of information about the time of the Renaissance, with the development of the printing press and perspective painting. One of the most evident changes of this change is the way in which we have come to imagine God. It was not until the Renaissance that God became portraiture. Previously he had been conceived as sound or vibration. In the Zoroastrian religion, the priest Sroch (representing the genius of hearing) stands between man and the pantheon of the gods, listening for the divine messages, which he transmits to humanity. Samd is the Sufi word for audition or listening. The followers of Jalal-ud-din Rumi worked themselves into a mystical trance by chanting and whirling in slow gyrations. Their dance is thought by some scholars to have represented the solar system, recalling also the deep-rooted mystical belief in an extraterrestrial music, a Music of the Spheres, which the attuned soul may at times hear. But these

exceptional powers of hearing, what I have called clairaudience, were not attained effortlessly. The poet Saadi says in one of his lyric poems:

I will not say, my brothers, what samad is
Before I know who the listener is.

Before the days of writing, in the days of prophets and epics, the sense of hearing was more vital than the sense of sight. The word of God, the history of the tribe and all other important information was heard, not seen. In parts of the world, the aural sense still tends to predominate.

... rural Africans live largely in a world of sound—a world loaded with direct personal significance for the hearer—whereas the western European lives much more in a visual world which is on the whole indifferent to him. ... Sounds lose much of this significance in western Europe, where man often develops, and must develop, a remarkable ability to disregard them. Whereas for Europeans, in general, "seeing is believing," for rural Africans reality seems to reside far more in what is heard and what is said.... Indeed, one is constrained to believe that the eye is regarded by many Africans less as a receiving organ than as a instrument of the will, the ear being the main receiving organ.

Marshall McLuhan has suggested that since the advent of electric culture we may be moving back to such a state again, and I think he is right. The very emergence of noise pollution as a topic of public concern testifies to the fact that modern man is at last becoming concerned to clean the sludge out of his ears and regain the talent for clairaudience—clean hearing.

A Special Sense

Touch is the most personal of the senses. Hearing and touch meet where the lower frequencies of audible sound pass over to tactile vibrations (at about 20 hertz). Hearing is a way of touching at a distance and the intimacy of the first sense is fused with sociability whenever people gather together to hear something special. Reading that sentence an ethnomusicologist noted: "All the ethnic groups I know well have in common their physical closeness and an incredible sense of rhythm. These two features seem to co-exist."

The sense of hearing cannot be closed off at will. There are no earholes. When we go to sleep, our perception of sound is the last door to close and it is also the first to open when we awaken. These facts have prompted McLuhan to write: "Terror is the normal state of any oral society for in it everything affects everything all the time."

The ear's only protection is an elaborate psychological mechanism for filtering out undesirable sound in order to concentrate on what is desirable. The eye points outward; the ear draws inward. It soaks up information. Wagner said: "To the eye the appetites the outer man; the inner to the ear." The
ear is also an erotic orifice. Listening to beautiful sounds, for instance the sounds of music, is like the tongue of a lover in your ear. Of its own nature then, the ear demands that insouciant and distracting sounds would be stopped in order that it may concentrate on those which truly matter.

Ultimately, this book is about sounds that matter. In order to reveal them it may be necessary to rage against those which don’t. In Parts One and Two I will take the reader on a long excursion of soundscapes through history, with a heavy concentration on those of the Western world, though I will try to incorporate material from other parts of the world whenever it has been obtainable. In Part Three the soundscape will be subjected to critical analysis in preparation for Part Four, where the principles of acoustic design will be outlined—at least as far as they can be determined at the moment.

All research into sound must conclude with silence—a thought which must await its development in the final chapters. But the reader will clearly sense that this idea also links the first part of the book to the last, thus uniting an undertaking that is above all lyrical in character.

One final warning. Although I will at times be treating aural perception and acoustics as if they were abstractable disciplines, I do not wish to forget that the ear is but one sense receptor among many. The time has Soundscape studies do this. But even they must be integrated into that wider study of the total environment in this not yet best of all possible worlds.
Acoustic Ecology and Acoustic Design  The most important revolution in aesthetic education in the twentieth century was that accomplished by the Bauhaus. Many famous painters taught at the Bauhaus, but the students did not become famous painters, for the purpose of the school was different. By bringing together the fine arts and the industrial crafts, the Bauhaus invented the whole new subject of industrial design.

An equivalent revolution is now called for among the various fields of sonic studies. This revolution will consist of a unification of those disciplines concerned with the science of sound and those concerned with the art of sound. The result will be the development of the interdisciplines acoustic ecology and acoustic design.

Ecology is the study of the relationship between living organisms and their environment. Acoustic ecology is therefore the study of sounds in relationship to life and society. This cannot be accomplished by remaining in the laboratory. It can only be accomplished by considering on location the effects of the acoustic environment on the creatures living in it. The whole of this book up to the present chapter has had acoustic ecology as its theme, for it is the basic study which must precede acoustic design.

The best way to comprehend what I mean by acoustic design is to regard the soundscape of the world as a huge musical composition, unfolding around us ceaselessly. We are simultaneously its audience, its performers and its composers. Which sounds do we want to preserve, encourage, multiply? When we know this, the boring or destructive sounds will become conspicuous enough and we will know why we must eliminate them. Only a total appreciation of the acoustic environment can give us...
the resources for improving the orchestration of the soundscape. Acoustic design is not merely a matter for acoustic engineers. It is a task requiring the energies of many people: professionals, amateurs, young people—anyone with good ears; for the universal concert is always in progress, and seats in the auditorium are free.

Acoustic design should never become design control from above. It is rather a matter of the retrieval of a significant aural culture, and that is a task for everyone. Nevertheless, in provoking this design concern, certain figures have important roles to play. In particular, composers, who have too long remained aloof from society, must now return to give assistance to human navigation. Composers are architects of sounds. They have had the most experience devising effects to bring about specific listener responses, and the best of them are masters at modulating the flow of these effects to provide complex and variable experiences which some philosophers have described as a metaphor for the life-experience itself.

But composers are not yet ready to assume the leadership role in reorchestrating the world environment. Some are still devoting themselves with waspish bitterness to a Parnassus of two or three. Others, sensing the importance of the larger theme of environmental reconstruction, are fumbling ineptly with it, betrayed by inexperience or hedonism. I recall meeting a young Australian composer who told me he had given up writing music after becoming infatuated with the beauties of cricket songs. When asked how, when and why cricket songs sang, he couldn't say, he just liked taping them and playing them back to large audiences. I told him: a composer owes it to the cricket to know such things. Craftsmanship is knowing all about the material one works with. Here is where the composer becomes biologist, psychologist—himself cricket.

The true acoustic designer must thoroughly understand the environment he is tackling; he must have training in acoustics, psychology, sociology, music, and a great deal more besides, as the occasion demands. There are no schools where such training is possible, but their creation cannot be delayed, for as the soundscape slumps into a lo-fi state, the wired background music promoters are already commandeering acoustic design as a bellezza business.

The Modules for Acoustic Design

A module is a basic unit to be used as a guide for measuring. In the human environment it is the human being who forms the basic module. When architects organize spaces for human habitation, they use the human anatomy as their guide. The doorframe accommodates the human frame, the stair the human foot, the ceiling the human stretch. To demonstrate the binding relationship between architectural space and the human beings for whom it is created, Le Corbusier made a man with an upstretched arm his modular symbol and imprinted it on all his buildings.

The basic modules for measuring the acoustic environment are the human ear and the human voice. Throughout this book I have been thumpingly the theory that the only way we can comprehend extrahuman sounds is in relationship to sensing and producing sounds of our own. To know the world by experience is the first desideratum. Beyond that lie the wonderful exercises of the imagination—the music of the stones, the music of the dead, the Music of the Spheres—but they are only comprehensible by comparison with what we can hear or echo back ourselves.

We know a good deal about the behavior and tolerances of the ear and the voice. When, as today, environmental sound reaches such proportions that human vocal sounds are masked or overwhelmed, we have produced an inhuman environment. When sounds are forced on the ear which may endanger it physically or dehumanize its psychologically, we have produced an inhuman environment.

There are few sounds in nature that interfere with our ability to communicate vocally and almost none that in any way pose a threat to the hearing apparatus. It is interesting to consider, for instance, that while the naked voice can be raised to quite a loud level (say about 80 decibels at a distance of a few feet), it cannot be raised in normal human intercourse to a point where it might endanger the ear (over 90 decibels).* In discriminating against low-frequency sounds, the human ear conveniently filters out deep body sounds such as brainwaves and the movement of blood in our veins. Also, the human hearing threshold has been set conveniently just beyond a level which would introduce a continuous recital of air molecules crashing together. The quiet efficiency of all body movements is another stroke of genius. And has anyone speculated on how inconvenient it would be if the ears, instead of being placed on the side of the head, had been placed next to the mouth, where they would have been subjected to close-quarter vocal garrulity and soup-slurping?

God was a first-rate acoustical engineer. We have been more inept in the design of our machines. For noise represents escaped energy. The perfect machine would be a silent machine: all energy used efficiently. The human anatomy, therefore, is the best machine we know and it ought to be our model in terms of engineering perfection.

Contrary to these simple lessons in acoustic ecology, we live in a time when human sound is often suppressed while mechanical jangleware is encouraged. While some of our students were measuring the noise of a downtown construction site in Vancouver, they were entertained by some members of the Hare Krishna sect, an Eastern movement dedicated to the worship of God with song in the streets. In 1971 this group was arrested under the noise abatement by-law, was convicted, and appealed the conviction.

*From Scarborough, England, comes the news that a British fisherman won what was billed as the World Shouting Competition by raising his voice to 3 decibels at a distance of three meters.
that such noise often ran as high as 90 decibels at precisely the point where the Hare Krishna singers were arrested. True, singing or hawking in the streets is frequently annoying; but when it disappears, so does humanity.

**Ear Cleaning**

The first task of the acoustic designer is to learn how to listen. _Ear cleaning_ is the expression we use here. Many exercises can be devised to help cleanse the ears, but the most important at first are those which teach the listener to respect silence. This is especially important in a busy, nervous society. An exercise we often give our students is to declare a moratorium on speech for a full day. Stop making sounds for a while and eavesdrop on those made by others. It is a challenging and even frightening exercise and not everyone can accomplish it, but those who do speak of it afterward as a special event in their lives.

On other occasions we prepare for listening experiences with elaborate relaxation or concentration exercises. It may take an hour of preparation in order to be able to listen clairaudiently to the next.

Sometimes it is useful to seek out one sound with particular characteristics. For instance, try to find a sound with a rising starting pitch, or one that consists of a series of short nonperiodic bursts; try to find one that makes a dull thud followed by a high twitter, or one that combines a buzz and a squeak. Such sounds will not be found in every environment, of course, but the listener will be forced to listen with all his energy to the sounds in the search. There are numerous other exercises like this in my music education books. *1

Sometimes it is useful to document only single sounds in the soundscape in order to get a better impression of their frequency and patterns of occurrence. Car horns, motorcycles, airplanes can be counted by anyone with ears, and it is surprising how discriminating one becomes when isolating one sound from many. Social surveys can also be conducted simultaneously in which citizens are asked to estimate the number of such sounds they imagine occur over a given time period. In repeated exercises of this sort, we have discovered that the imagined traffic is much below the actual volume—often as much as a 90 percent. For instance, when we asked West Vancouverites to estimate the number of seaplane flights over their homes in 1969, the average estimate was 8 per day compared with an actual count of 65. In 1973 the same experiment was repeated in the same area. This time the average estimate had risen to 16, but the actual count had also risen to 106. Exercises like this extend ear cleaning to a wider public. To be reminded of a sound is to think about it; to miss it is to listen to it next time.

The tape recorder can be a useful adjunct to the ear. Trying to isolate a sound for high-fidelity recording always reminds the ear of details in the

---

We train students in soundscape recording by giving them specific sounds to record: a factory whistle, a town clock, a frog, a swallow. It is not easy if the result is to be "clean," without distracting interferences. How often has the novice recordist, sent out to record a "complete" passage of an aircraft, switched off the machine before the sound has dropped totally below the ambience? Even the life of the more experienced recordist is often hazardous. On one occasion, for example, a small boy had watched our recording team setting up their sound level equipment and tape recorders to measure and record a particular noon whistle. Just as it began, the boy, who had been carelessly left next to a microphone, said: "Is that the whistle you want, mister?"

One of the recordist's biggest problems is to devise ways of recording social settings without interrupting them. The equipment is conspicuous, and in many situations so is the recordist. Peter Huse catches this in a few lines from his poem "Waves."

we stagger into a lounge.
Bruce in my leather trenchcoat squeaks
and points the way with his goatee as I,
tweed pockets patched with tape,
floppy beret
wired with earphones, and gold-heavy
Nagra
digging into my shoulder,
cutting two tracks, I
angle the mike in the handset as if
the machine is off but
the pots are ganged together at 83,
it's on record and hidden inside the leather case
Scotch 206 crosses the heads onto
the take-up reel and we're getting
overlapping heart-shapes of late night
fluorescent ferry atmosphere, a blonde siren
looms toward us.
(Zoom-in jerky, wobbling frame. Engine rumble.
Door swinging. Close-up: her twisted face left
centre looking left. Shuffling, scraping of chairs. A
few slurred voices, hers loudest, grates the most.)
Note bleached hair. Smell her
booby breath. She's drunk, and that and hard up.
(Cut to get whole group: Tintoretto/home movie
only harsh lights, blue filter. Two men laugh.)

Weaving the Soundscape: The student of acoustic design should keep a soundscape diary, constantly noting interesting variations in sounds from place to place and time to time. The ear is always much more alert while traveling in unfamiliar environments, as proved by the richer travelogue literature of numerous writers whose normal content is acoustically less distinguished. This at least seems to be true of such authors as Thoreau, Heinrich Heine and Robert Louis Stevenson. Returning from a trip to Rio de Janeiro (1969), an American student was able to produce a much more vivid account of the Brazilian soundscape than of the city in which he lived.

Rio de Janeiro
Street hawkers
Bargaining in the marketplace
Live chickens and birds in the markets
Man going around swatting flies in restaurants
Ice being chipped from blocks (no crushed ice)
Cars and wagons on cobblestones
Street cleaners sweeping by hand
Strange dial tone, busy signal and ringing
of telephones
Predominance of old cars from 40s and 50s
Singing and dancing in the streets; music
echoing through the whole city from
amplifiers (Carnival)
Old hand-operated elevators
Steam engines in the country
Total silence in the classroom when
teacher enters
No electrical machines in businesses
and banks
250,000 people shouting together
in a stadium
Cockatoos
Monkeys
Cutting of jacaranda

When one travels, new sounds snap at the consciousness and are thereby lifted to the status of figures. But the acoustic designer must be trained to perceive all aspects of any soundscape unmistakably, otherwise how should he be able to adjudicate it properly? How should he be able
to gauge the effect of signals and soundmarks and know the function of keynotes and background sounds. It is not enough to remain a tourist in the soundscape, but it is a useful functioning in order to perceive its object of curiosity. Like tourism itself, this type of perception is a can geographer David Lowenthal has written: "Perception of scenic have no real part to play in the landscape," and William James. To Mark Twain's steamboat traveler, the sunset glows eloquently over the ripples silver water of the pilot however: "This sun means that refers to a bluff reef which is going to kill somebody's steamboat out of from a new snug." William James, an early tourist in North Carolina, was able to register the defacement of a beautiful forest by the farmers: "But, when they The chips, the girdled trees, and the vile split rail spoke of honest sweat, my mind was one of unvaried equipoise. The settler had... cut down the he had girdled and killed... and had set up a tall zigzag rail fence around 'improved' it out of existence was hideous, a sort of ulcer, without a single Because of his dependence on visual stimuli, modern man has allowed sits simply of sightseeing. But the sensitive human being knows that inspects the whole environment, critically and aesthetically. He never soundscape would demand not Sehenswürdigkeiten but Hörwürdigkeiten. In increased leisure all men could become tourists of the soundscape, remembering affectionately the entertainment of soundscapes visited. All it would take is a little travel money and sharp ears.

Soundwalks

A listening walk and a soundwalk are not quite the same thing, or at least it is useful to preserve a shade of distinction between them. A listening walk is simply a walk with a concentration on listening. This should be at a leisurely pace, and if it is undertaken by a group, a good rule is to spread out the participants so that each is just out of earshot of the footsteps of the person in front. By listening constantly for the foot- steps of the person ahead, the ears are kept alert, but at the same time a privacy for reflection is afforded. Sounds heard and missed can be dis- cussed afterward.

The soundwalk is an exploration of the soundscape of a given area using a score as a guide. The score consists of a map, drawing the listener's attention to unusual sounds and ambiguities to be heard along the way. A soundwalk might also contain ear training exercises. For instance, the pitches of different cash registers or the duration of different telephone bells could be compared. Eigen tones could be sought in different rooms and passages." Different walking surfaces (wood, gravel, grass, concrete) could be explored. "If I can hear my footsteps as I walk, I know I am in an ecological environment," said a student. When the soundwalker is instructed to listen to the soundscape, he is audience, when he is asked to participate with it, he becomes composer-performer. In one soundwalk, a student asked participants to enter a store and to tap the tops of all tinned goods, thus turning the grocery store into a Caribbean steel band. In another, participants were asked to compare the pitches of drainpipes on a city street; in another, to sing tunes around the different harmonics of neon lights.

A series of ingenious soundwalks ought to be of interest to the tourist industry, and it would be of great value also in introducing ear cleaning into schools. Exercises such as these are the root of the acoustic design program. Yet they require no expensive equipment and they do not camouflage simple acoustic facts with pictures or statistical displays which, being silent, are not acoustic information.

When a school of acoustic design worthy of the title finally comes into existence, ear cleaning must be its basic course.

*Eigen is the German word used to refer to the fundamental resonance of a room, produced by the reflection of sound waves between parallel surfaces. It can be located empirically by singing different notes. The room (particularly an empty one) will resonate quite loudly in unison with the voice when the right note is sounded.
The Acoustic Community

Acoustic Space. We have already encountered the conflict between visual and acoustic space. The influence of our visual orientation has not only left its impression on works of art, but even more emphatically in law. Property is measured in physical terms, in square meters or kilometers. Within the territorial limits of property holdings, the owner is permitted to create a desired environment with comparative freedom. When the world was quieter, privacy was effectively secured by walls, fences and vegetation. When visual and acoustic space were more congruous, the latter required no special attention.

Today acoustic space has important environmental and legal implications not fully appreciated. The acoustic space of a sounding object is that volume of space in which the sound can be heard. The maximum acoustic space inhabited by a man will be the area over which his voice can be heard. The acoustic space of a radio or a power saw will be the volume of space in which those sounds can be heard. Modern technology has given each individual the tools to activate more acoustic space. This development would seem to be running a collision course with the population increase and reduction of available physical space per individual.

A property-owner is permitted by law to restrict entry to his private garden or bedroom. What rights does he have to resist the sonic intruder? For instance, without expanding its physical premises, an airport may show a dramatically enlarged noise profile over the years, reaching out to dominate more and more of the acoustic space of the community. Present law does nothing to solve these problems. At the moment a man may own the ground only; he has no claim on the environment a meter above it and his chances of winning a case to protect it are slender.

What is needed is a reassertion of the importance, both socially and ultimately legally, of acoustic space as a different but equally important means of measurement. The following historical observations will assist in reploting this notion.

The Acoustic Community. Community can be defined in many ways: as a political, geographical, religious or social entity. But I am about to propose that the ideal community may also be defined advantageously along acoustic lines.

The house can be appreciated as an acoustic phenomenon, designed for the first community, the family. Within it they may produce private sounds of no interest outside its walls. A parish was also acoustic, and it was defined by the range of the church bells. When you could no longer hear the church bells, you had left the parish. Cockneypond is still defined as that area in East London within earshot of Bow Bells. This definition of community also applies to the Orient. In the Middle East it is the area over which the muezzin's voice can be heard as he announces the call to prayer from the minaret.

An interesting example of an acoustic community is the London of the Roman Empire, where the houses were placed within shouting distance of one another in case of a surprise attack, and the fields ran back from them in a narrow strip. The acoustic farm may still be observed along the banks of the St. Lawrence River through its raison d'être has vanished. In his model Republic, Plato quite explicitly limits the size of the ideal community to 5,040, the number that can be conveniently addressed by a single orator. That would be about the size of Weimar in the days of Goethe and Schiller. Weimar's six or seven hundred horses were for the most part still within the city walls; but it was the voice of the half-blind night watchman which, as Goethe tells us, could be heard everywhere within the walls, that expressed best the sense of human scale which the poets found so attractive in the small city-state.

A consideration of the acoustic community might also include an investigation of how vital information from outside the community reaches the ears of the inhabitants and affects their daily routine. We had an opportunity to investigate this when we undertook a soundscape study.
of the French fishing village of Lesconil, on the south coast of Brittany. Lesconil is surrounded on three sides by the sea and is subject to an onshore-offshore wind cycle known as "les vents solaires." Distant sounds are carried to the village in a clockwise sequence, beginning from the north at night, moving to the east and south during the day, and finally to the west in the evening. In the early morning, when the fishermen put out to sea, the Plobannalec church bells and nearby farming noises are heard clearly. By 9 a.m. it is the bells of Locutudy to the northeast, by 11 a.m. the "puffer" buoys off the east coast; then by noon, the motors of the trawlers out to sea at the south. (On a calm day they can be heard up to 12 kilometers away.) By 2 p.m. the sound serenade is clearly heard, and by 4 p.m. it is often possible to hear the blowhole at Point de la Torche, 12 kilometers away to the west. If the weather is foggy, the afternoon will bring the sound of the great foghorns at Portbail, on the same coast. By evening, the farm sounds return and with them the bells of Tréguier to the northwest.

This pattern is characteristic mainly of the summer months when the weather is clear and the fishing is good. Variations in it indicate weather changes: for instance, when certain buoys are heard out of sequence, there will be a squall, or when the surf is strong in the west, good weather will follow. Every fisherman and his wife knows how to read the nuances of these acoustic signals and the life of the community is regulated by them.

The acoustic community eventually found itself in collision with the spatial community, as evidenced by numerous noise abatement by-laws. This conflict is also recorded in the decline of Christianity when the parish shrunk under the bombardment of traffic noise, just as Islam waned when it became necessary to hang loudspeakers from the minarets, and the age of Goethe's humanism passed when the watchman's voice no longer reached all the inhabitants of the city-state of Weimar. (A further sign of the muzzling of Weimar humanism was a nineteenth-century by-law forbidding the making of music unless conducted behind closed windows.)

Modern man continues this retreat indoors to avoid the canceled environments of outdoor life. In the loftier soundscape of the contemporary megalopolis, acoustic definitions are harder to perceive. The sound output of the police sirens (100+ dBA) may have surpassed the faltering voice of the church bell (80+ dBA), but such an attempt to produce a new order by sheer might is today proving anachronistic, as increased anomic and social disintegration prove. Today, when the slope and span of the megalopolis invite a multiplication of sonic jambereau, the task of the acoustic designer in sorting out the mess and placing society again in a humanistic framework is no less difficult than that of the urban anthropologist and planner, but it is equally necessary. The problem of redefining the acoustic community may involve the establishment of zoning regulations; but to limit it to this, as is common today, is to mistake the trajectories of the soundscape for the property lines of the landscape. Only when the outer

The Acoustic Community

sweep and interpenetration of sonic profiles is known and accepted as the operative reality will acoustic zoning rise to the level of an intelligent undertaking.

Outdoor Versus Indoor Sounds

Space affects sound not only by modifying its perceived structure through reflection, absorption, refraction and diffraction, but it also affects the characteristics of sound production. The natural acoustics of different geographical areas of the earth may have a substantial effect on the lives of people. For instance, on the Arkansas prairies Thomas Nuttall (1819) remarked that "no echo answers the voice, and its tones die away in boundless and enfeebled undulations." On the other hand, the heavy forests of British Columbia are richly reverberant. "The dense forest around and beyond seemed to echo back the warning tones of the speaker's voice, and as the congregation united their voices in songs of praise, the very trees seemed to lend their cadence in the melody."

Outdoor sounds are different from indoor sounds. Even the same sound is modified as it changes spaces. The human voice is always raised outdoors. If one takes a portable tape recorder from an indoor room outdoors, talking constantly at the same distance from the microphone, the volume of the playback volume will register an increase. This results from the higher ambient noise as well as the fact that with decreased reverberation more vocal energy is required to give the sound the same apparent volume. But also psychologically a public place has replaced a private one and there is often an instinctive tendency to be more demonstrative in a public place. We have had occasion to note (see page 64) that people who live out of doors in hot climates tend to speak more loudly than those who live indoors. It is also significant that northern peoples seem more disturbed by noise than southern.

Any sound intentionally uttered within an enclosure is more or less private, more or less connected with the cult—whether this be the cult of the lover's bed, of the family, of religious celebration or of clandestine political plotting. Primitive man was fascinated by the special acoustic properties of the caves he inhabited. The caves of the Trois Frères and Tuc d'Audoubert in Ariège contain drawings depicting masked men exercising animals with primitive musical instruments. One imagined sacred rites being performed in these dark reverberant spaces in preparation for the hunt.

In the Neolithic cave of Hypogeum on Malta (c. 2400 B.C.), a room resembling a shrine or oracle chamber possesses remarkable acoustic properties. In one wall there is a large cavity at eye level, shaped like a big Helmholtz resonator,* with a resonance frequency of about 90 hertz. If a

*Helmholtz resonator is a cavity-type resonator, so constructed that it will vibrate only at a particular frequency. It was developed by the German physicist Hermann von Helmholtz in the nineteenth century to analyze the harmonic components of complex sounds.
man speaks there slowly in a deep voice, the low-frequency components of his speech will be considerably amplified and a deep, ringing sound will fill not only the oracle chamber itself, but also the circumjacent rooms with an awe-inspiring sound. (A child or a woman will not be able to produce this effect, the fundamental pitch of their voices being too high to activate the resonator.)

Early sound engineers sought to carry over special acoustic properties like these into the ziggurats of Babylon and the cathedrals and crypts of Christendom. Echo and reverberation accordingly carry a strong religious symbolism. But echo and reverberation do not imply the same type of enclosure, for while reverberation implies an enormous single room, echo (in which reflection is distinguishable as a repetition or partial repetition of the original sound) suggests the bouncing of sound off innumerable distant surfaces. It is thus the condition of the many-chambered palace and of the labyrinth.

But echo suggests a still deeper mystery. Acousticians will explain that the reflection of a sound off a distant surface is simply a case of the original wave bouncing back, the angles of incidence and reflection being equal. In order to understand this effect one may project a mirror image of the original sound deep behind the surface, at exactly the same distance and angle from the surface as the original. In other words, every reflection implies a doubling of the sound by its own ghost, hidden on the other side of the reflecting surface. This is the world of alter-egos, following and pacing the real world an instant later, mocking its follies. Thus, a far more potent image than Narcissus reflected in the water is that of Narcissus's alter-ego mocking his voice from unseen places behind the rocks. Lu-
necessary to consider them in comparison with their ancient colleagues. Architectual studies of the past knew a great deal about the effects of sound and worked with them positively, while their modern descendants know little about the effects of sound and are thus reduced to contending with them negatively.

The early builders built with ear as well as eye. The exceptional acoustics of the Greek amphitheaters, of which the Asclepion theater at Epidaurus is perhaps the best example, do not prove that acoustics had been totally mastered, and yet they do show that a certain philosophy of building existed in which acoustic considerations helped determine the form and siting of the structure. In the empty amphitheater at Epidaurus the sound of a pin dropping can be heard distinctly in each of the 14,000 seats—an assertion I have put to the test. That Greek actors were frequently depicted wearing masks with megaphones attached to their mouthpieces does not show that ancient theater acoustics were a failure but merely that Greek theater audiences were probably deaf.

The most beautiful building I have ever experienced is the Shah Abbas Mosque in Isfahan (completed A.D. 1640), sumptuously elegant in gold and azure tile, with its famous sevenfold echo under the main cupula. One hears this echo seven times perfectly when standing directly under the apex of the cupula; standing a foot to either side one hears nothing. Experiencing this remarkable event one cannot help thinking that the echo was no mere byproduct of visual symmetry but was intentionally engineered by designers who knew perfectly well what they were doing and perhaps even used the echo principle in determining the parabolic features of their cupulas.

Something similar apparently exists in the Temple of the Ruler of the Universe in Peking. The actual temple is a circular building, surrounded by a circular wall, inside which are two rectangular buildings, probably indicating the place of the earth within the universe. If a person stands in the center of the site and claps, a series of rapid echoes is heard, caused by reflections from the outer wall. But by moving slightly off-center, the echoes will change completely, because only every second reflection will return to the point of origin. In other places near the center, the acoustical conditions are even more complicated, and the echoes will change with even the slightest shift in the placement of the sound-producer. Within this structure it is also possible for persons to converse naturally at great distance when standing just inside the circular wall, for this flat hard-surfaced wall reflects sound around its inner surface with a minimum of transmission loss.

Unfortunately, we have no accounts of how or why acoustic specialties were incorporated into ancient buildings such as these, but since all ancient cultures were strongly auditory, they were quite probably conceived deliberately to express divine mysteries, and at any rate they were certainly not the unpredictable consequences of blueprint accidents. W. C. Sabine, the best architectural acoustician of modern times, studied the

The Acoustic Community

"whispering galleries" of some newer buildings: the Dome of St. Paul's Cathedral in London, St. Statwary Hall in the Capitol at Washington, the vases in the Salle des Caractides in the Louvre in Paris, St. John Lateran in Rome and the Cathedral of Giron. Sabine's conclusion is that "it is probable that all existing whispering galleries, it is certain that the six more famous ones, are accidents; it is equally certain that all could have been predetermined without difficulty, and like most accidents would have been improved upon." But these were expressions of a time which was exchanging its ears for its eyes, of a time when the engineering drawing was becoming the prerequisite of architectural thought. This was not so in the Asclepion Theater, in the Shah Abbas Mosque or in the Temple of the Ruler of the Universe. They cannot be "improved upon," for they resulted from the synchronous interaction of the eye and the ear.

Among the classical papers on architecture none is more voluminous or respected than the ten books of De Architectura by the Roman Vitruvius, which date from about 27 B.C. Book V adequately demonstrates the writer's familiarity with the importance of acoustics, especially in the building of theaters, where, following an extensive exposition of the principles of the Greek science, he discusses the employment of sounding vases in theaters to enhance sound production. Vitruvius writes:

"Hence in accordance with these enquiries, bronze vases are to be made in mathematical ratios corresponding with the size of the theatre. They are to be so made that, when they are touched, they can make a sound from one to another of a fourth, a fifth and so on to the second octave. Then compartments are made among the seats of the theatre, and the vases are to be so placed there that they do not touch the wall, but have an empty space around them and above. They are to be placed upside down. On the side looking towards the stage, they are to have wedges put under them not less than half a foot high. Against these cavities openings are to be left in the faces of the lower steps two feet long and half a foot high..."

Thus by this calculation the voice, spreading from the stage as from the centre and striking by its contact the hollows of the several vases, will arouse an increased cleanness of sound, and, by the concord, a consonance harmonising with itself.

That these techniques were not special to Vitruvius, we know from the author's own assertion: "Someone will say, perhaps, that many theatres are built every year at Rome without taking any account of these matters. He will be mistaken in this."

These sounding vases were what we now call Helmholtz resonators, and whether or not they originated in Rome, they appear to have been widely used throughout Europe and Asia in the following centuries. They were used in the Shah Abbas Mosque of Isfahan and have been found built into the walls in a number of old Scandinavian, Russian and French churches. In the case of the European churches, the principle appears not
to have been completely understood, for the sounding vases do not exist there in sufficient manner to produce any noticeable acoustic effect. But a recent discovery of a large quantity of sounding vases (fifty-seven in all) in the small fifteenth-century abbey church at Fleiter, between Ljubljana and Zagreb, shows that the tradition was accurately understood by the Yugoslavian builders, for the double resonance system employed in this case resulted in a high absorption over a broad frequency band from 80 to 250 hertz, an area in which the reverberation time in brick chapels is normally much too long.

From Positive to Negative Acoustic Design Architecture, like sculpture, is at the frontier between the spaces of sight and sound. Around and inside a building there are certain places that function as both visual and acoustic action points. Such points are the folc of parabolas and ellipses, or the intersecting corners of planes; and it is from here that the voice of the orator and musician will be heard to best advantage. It is here also that the metaphorical voices of sculptured figures will find their true position, not on the metope or tympanum of a porch.

Old buildings were thus acoustic as well as visual spectacles. Into the handsome spaces of the well-designed building, orators and musicians were attracted to create their strongest works; there they gained a reinforcement denied them in most natural settings. But when such buildings ceased to be the acoustic epicenters of the community and became merely functional spaces for silent labor, architecture ceased to be the art of positive acoustic design.

In a quiet world, building acoustics flourished as an art of sonic inven-
tion. In a noisy world it becomes merely the skill of muting internal shuffles and isolating incursions from the turbulent environment beyond. Thus the great high-rise towers of the world stand on timbres, looking out across the fires of the city. Belleau—mais mauvais son.

The Modern Architect as Acoustic Designer One day I was discussing matters of mutual interest with a group of architecture students. Drawing a picture of a possible future city on the blackboard I asked them what the salient features of this environment appeared to be. There were seven helicopters in the sky of my drawing, yet no student found this particularly salient. I (exasperatedly): "Have you ever heard seven helicopters?"

The modern architect is designing for the deaf.

His ears are stuffed with bacon.

Until they can be unplugged with ear cleaning exercises, modern architecture may be expected to continue its same rotten course. The study of sound enters the modern architecture school only as sound reduction, isolation and absorption.

Listen to the sounds a building makes when no one is in it. It breathes with a life of its own. Floors creak, timber snaps, radiators crack, furnaces groan. But although buildings of the past made characteristic sounds, they cannot compete with modern buildings for the strength and persistence of sound emitted. Modern ventilation, lighting, elevators and heating systems create strong internal sounds; and fans and exhaust systems disgorge staggering amounts of noise into the streets and onto the sidewalks around the buildings themselves.

Architects and acoustical engineers have often conspired to make modern buildings noisier. It is a well-known practice today to add Moozak or white noise (its proponents prefer to call it "white sound" or "acoustic perfume") to mask mechanical vibrations, footsteps and human speech.

The following thoughts from a recent textbook are typical of the present message being passed at the graduates and fluctuates of the architectural profession.

Contemporary environmental control can create a complex artificial environment in buildings that will meet all the physical, physiological, and psychological requirements of the occupants. This artificially created synthetic environment is in many respects superior to the natural one. No exterior atmosphere is comparable to an air-conditioned and humidity-controlled room. Lighting fixtures presently available will not only simulate daylight but will create an improved (shadowless) luminous environment indispensable for certain activities.

The author of these comments is Leslie L. Doelle and the book they came from appeared in 1972. Concerning noise suppression Mr. Doelle has this to say:

On the other hand, if the sound is undesirable (noise from a neighbor's television set or traffic noise), unfavorable conditions must be provided for the production, transmission, and reception of the disturbance. Measures must be taken to suppress the intensity of the noise at the source; an attempt must be made to move the noise source as far as possible from the receiver. The effectiveness of the transmission path must be reduced as much as possible, probably by the use of barriers which are adequately sound or vibration-proof, and the receiver must be protected or made tolerant to the disturbance by using noise or background music. All these measures belong to the realm of noise control.

The phenomenon of masking is properly exploited in environmental noise control. If a masking noise is uninterrupted and not too loud, and if it has no information content, it will become an acceptable background noise and will suppress other objectionable intruding noises, making them sound psychologically quieter. Ventilating and
The Acoustic Community

One of the most spectacular buildings of modern architecture is the Sydney Opera House. The sight of its huge cream-colored butterfly wings, seen from the little, elderly ferries which ply the harbor, is indeed unforgettable, even though the location of the building is convenient rather than inspirational, for the vulgarity of the Sydney skyline behind it and especially the great inelegant bridge at its side, do it no good.

Shortly before it opened in 1973, I was taken on a tour of the Opera House by its sound consultant. I was pleased to note the incorporation of large natural Helmholtz resonators in the walls of the concert hall—func-

<table>
<thead>
<tr>
<th>PLACE</th>
<th>DATE BUILT</th>
<th>TOTAL AREA IN SQUARE Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna: Grosser Musikvereinsaal</td>
<td>1870</td>
<td>1115</td>
</tr>
<tr>
<td>Leipzig: Neues Gewandhaus</td>
<td>1886</td>
<td>1020</td>
</tr>
<tr>
<td>Amsterdam: Concertgebouw</td>
<td>1887</td>
<td>1285</td>
</tr>
<tr>
<td>New York: Carnegie Hall</td>
<td>1891</td>
<td>1985</td>
</tr>
<tr>
<td>Boston: Symphony Hall</td>
<td>1900</td>
<td>1500</td>
</tr>
<tr>
<td>Chicago: Orchestra Hall</td>
<td>1906</td>
<td>1855</td>
</tr>
<tr>
<td>Tanglewood: Music Shed</td>
<td>1938</td>
<td>3066</td>
</tr>
<tr>
<td>Buffalo: Kleinhans Music Hall</td>
<td>1940</td>
<td>2150</td>
</tr>
<tr>
<td>London: Royal Festival Hall</td>
<td>1951</td>
<td>2145</td>
</tr>
<tr>
<td>Vancouver: Queen Elizabeth Theatre</td>
<td>1959</td>
<td>1975</td>
</tr>
</tbody>
</table>

tioning more or less exactly as Vitruvius described them two millennia ago—the only hall I know to boast the revival of this technique. In the lobbies, however, I noted the innumerable little speakers which betrayed the inevitable Mooze installation. "The public seems to want it," my guide said feebly.

In the restaurant, the third and smaller but still hugely arched structure of the complex, I was told that the floor was to remain uncarpeted and the kitchen was to be open and situated in the center. I picked up an eight-foot board that was lying at hand and let it fall. The reverberation compared favorably with that of Saint Sophia in Istanbul, probably exceeding eight seconds.

My guide put his finger in his ear and blinked. If you’re ever in Sydney, remember to try out the echo with your soup spoon.