The Sonic Environment of Cities

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THE SONIC ENVIRONMENT OF CITIES

MICHAEL SOUTHWORTH *received a Master's degree in City Planning from MIT, where he specialized in the visual arts, city design, and environmental psychology. He was design coordinator and research advisor for a "Signs and Lights" project in Boston. He is the coauthor, with Alan Melting, of* Detroit 1990: A Design Proposal for the Inner City, *and has given several exhibits in light painting.*

At a time when technological progress is bringing city sounds to the threshold of bedlam it is no longer sufficient to design environments that satisfy the eye alone. Today's city dweller is bombarded by a continuous stream of invisible but highly attention-demanding sounds, smells, and microclimates. His experience of the city is a crazy quilt of sense impressions, each of which contributes to the total picture. It is important to explore the consequences of this invasion of nonvisual sensations on the quality of city life and to ask how manipulation of them might improve that quality. This study explores two aspects of the problem: What is the perceived variety and character of city sounds? How do sounds influence perception of the visible city? Our research is not a scientific experiment, but an exploratory study in which we have attempted to identify those issues that deserve more careful attention in later experimental research and city design.

PERCEPTION OF SOUND

A field study on perception of the Boston soundscape has yielded most of our information on the problem, but before presenting the findings, it will be useful to consider the problem of auditory perception and its relation to vision. Case studies of blind and deaf persons have been particularly helpful. Most of the material in this section is from reports of Warren Brodey's seminars with the blind (1960-1964) and Peter Knapp's work with the deaf (1948)

The Blind

For the blind, sound is an important means of obtaining information about the world. Necessity forces them to hear things which seeing persons ignore. But the images which they build of the sonic environment are much

more generalized than the images constructed of the visible environment by the sighted, for the sonic environment is less informative and the ear is far less effective than the eye in gathering information. Blind persons in fact rarely develop stable images of cities or other large and complex environments but at best have images of common trips.

Since the sonic environment changes rapidly, new sounds continually make the familiar seem strange. Even a light rain or a layer of snow can transform a known sonic city into a foreign one. In order to navigate the blind must seek out dependable and novel sounds. These sounds identify a place more clearly if they are uniquely related to the area, such as the sounds of water and creaking boats in a harbor or slamming doors and children's voices in a residential area.

Sound is the chief way of judging space for the blind and is most informative when it is the result of their personal interactions with an environment. Floors that squeak when walked upon or lamps that wobble when a room is entered are good spatial informants. Smaller, more enclosed, and hard-surfaced spaces usually identify themselves better than do large open spaces, because the former are more resonant. In large spaces, linear forms which respond to sounds distinctively, such as hedges or stone walls, help in navigation. The masking effects of objects can also locate structures in space by forming a silhouette of the building bulk against distant sounds, although this is effective only when foreground sounds are quiet.

The blind prefer responsive and informative environments for reasons other than navigation. A setting in which his voice will spring back and in which objects rattle and sing in response to his actions, in addition to revealing the space and its contents, invites the involvement of the listener in a man-environment conversation. Such involvement is valued by persons who often feel detached from the world because of limited sensory contacts. Brodey's (1962) report on his nonverbal classroom for blind children beautifully illustrates this point. The children delight in bouncing sounds off new materials and in new kinds of spaces. The discovery of things which make novel kinds of sounds is a big event. This joy in sounds appears to continue throughout the life of blind persons, and they speak of the fondness they have for certain places with squeaky doors or rooms that resonate with their footfalls. Their preferred settings not only allow involvement, but also are more informative. Rooms with windows that can be opened are preferred by the blind because they bring in sounds from the outside, enlarging their world from the tight visual space of the room, to the expansive auditory space of the city. Their preferred sounds usually lie within the low to middle ranges of frequency and intensity and are transparent nonrepetitive sounds like the trickle of water, the rustle of wind in the trees, the hum of human voices, or the click of footsteps.

Less pleasing sound settings are more attention-demanding and less informative, such as the roar of a busy street. Higher frequency (512+ cps) and higher intensity (90+ db) sounds are the most annoying. The blind regard

the sounds of the jack hammer and siren as two of the worst. These are disorienting and cover a large territory, affecting the blind much as bright flashing lights affect the sighted. Annoyance with this type of sound does not appear to decrease with familiarity, but becomes greater as the sound continues. The unexpectedness of many loud sounds such as sirens also increases annoyance.

The Deaf

While study of blind persons contributes to our understanding of auditory perception, study of deaf persons suggests some effects sound may have on visual perception. Imagine a city without sound. At first the silence may be a welcome relief, but social and psychological problems would probably develop soon. The tendency would be to ignore such an environment and to withdraw into one's private world. Things would seem static and unchanging and would become boring since little would demand attention. Social relationships would break down and the flow of time would not be marked by the sounds of activity. Life would seem frozen and would not have its urgency, its progression, or its interest. While auditory space encompasses one and extends perception beyond many physical and visual barriers, the space in this visual city would be different. It would be almost separate from the individual, set out in front of him and limited by the visible forms. Everything outside his visual field would be unknown.

Deaf persons live in this kind of world. Studies of patients at the Deshon Army Hospital (Knapp, 1948), most of whom had become deaf suddenly, clarify the problem. Their life was a ceaseless pantomine in which it was difficult to maintain the feeling of being a part of the world. Loss of sound had cut important links with life and they felt detached. The world seemed dead and had lost its forward motion; it was much less demanding and nervous. All of them felt a poignant loss of background sounds, especially of nature, which had been almost unnoticed before deafness. They experienced great anxiety in crowds or traffic because important auditory danger cues were absent. The psychological effects of sudden deafness were more severe than those suffered by persons who had suddenly become blind. Deep depression resulted, characterized by undefined feelings of loss, lack of alertness, sadness, loneliness, and paranoid tendencies. The tension of perpetual silence created severe headaches in many. It was hard to grasp the passage of time and patients frequently fell asleep because life had few contrasts.

Psychological Experiments

In addition to studies of the blind and deaf, several experiments aid the understanding of visual-auditory relationships. Some work has shown that auditory perception improves when accompanied by related visual displays; similarly, sounds can direct attention to related visual elements (Broadbent, 1958). Seeing a word helps one hear it when it is embedded in a collage of

spoken words; without the sight, the sound would pass unnoticed along with the other background sounds. Experiments have also indicated that verbal material presented to both eye and ear is remembered better than presentations to either sense alone; however, auditory presentations are better remembered than visual presentations (Dewick, 1935 and Elliot 1936).

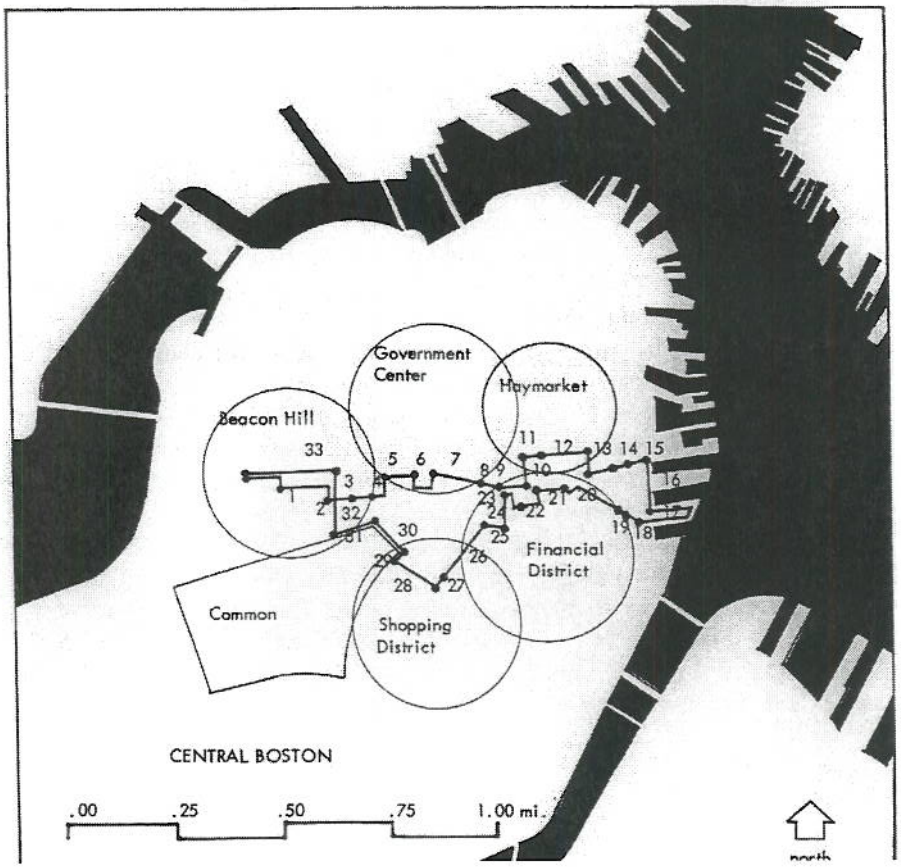
If a visual image is accompanied by attention-demanding sounds which are incongruous with the visual information, interference results and less information is transmitted. Novel sounds show more detrimental effects than common sounds because the onset or stopping of the novel sound conveys more information; also, a unique event has higher priority in the perceptual system. For this reason, intermittent and irregular sounds may be more annoying than regular sounds of the same quality and intensity. Incongruous sounds which can be identified and localized are apparently less annoying than those which continue to mystify (Broadbent, 1958).

Sound appears then to provide an important link to reality and has a protective and enriching function. Without sound, visual perception is different: less contrastful, less attention-demanding, and less informative—a fact discovered decades ago by the film industry when sound was added to silent movies. Similarly, auditory perception would be expected to be far different without simultaneous sight. Sound and sight interact, and they can support or interfere with one another, depending on the nature of the match. Compared with independent vision and audition, one may gain or lose when the two are paired, depending upon the amount of correlation between both channels of information. A place which seems pleasing must do much more than appeal to the eye, a fact which designers often ignore. Spaces of a grand scale that have closet sounds, which are visually animated but sonically dead, or spatially attractive but saturated with noise, lack much for hearing people and could be better appreciated by the deaf.

THE PERCEIVED SOUNDSCAPE OF BOSTON

To expand our knowledge of the urban soundscape we performed a field study. This involved several subjects and tested perception of sounds and sights in a sector of central Boston between Beacon Hill and India Wharf. Two aspects of the soundscape that appear particularly important in city perception were central to the study. First, we evaluated the identity of the sounds, including (a) the uniqueness or singularity of local sounds in relation to those of other city settings and (b) their informativeness or the extent to which a place's activity and spatial form were communicated by sound. Second, we analyzed the delightfulness of the sounds, that is, the qualities of sounds which caused them to be liked or disliked. In addition to studying the soundscape, a major concern was ascertaining the correlation between visual and auditory perception or the extent to which the identity and delightfulness of the sonic environment were supported by a setting's visible activity and spatial form.

The first part of the study investigated changes in the soundscape over time and under varied weather conditions. We took five blindfolded subjects on a wheelchair trip in the city at different times of day and week. The



1. Pinckney Street
2. Joy Street
3. State House Tunnel
4. State House parking lot
5. Ashburton Place
6. Pemberton Square
7. Scollay Square
8. Court Street
9. Old State House
10. Change Avenue
11. Faneuil Hall
12. South Market Street
13. U.S. Customs Tower area
14. Central Artery
15. State Street
16. Atlantic Avenue
17. India Wharf
18. Central Artery
19. India Street garage
20. U.S. Customs Tower area
21. Doane Street
22. Exchange Place
23. Quaker Lane
24. Devonshire Street
25. Spring Lane
26. Washington Street
27. Filene's Corner
28. Winter Street
29. Park Station
30. Park Street
31. State House
32. Joy Street
33. Myrtle Street

Figure 1 The Trip

second part explored three questions: What can one tell about the city merely by listening to it? What types of sonic settings do people prefer and dislike? How well do the sonic and visual environments correlate? To test the interactions between seeing and hearing in this part, fifteen subjects took the trip in groups of three on a Saturday. Each trio consisted of (a) auditory subjects, who could hear but not see; (b) visual subjects, who could see but not hear; and (c) visual-auditory subjects, with normal seeing and hearing. Auditory subjects wore blindfolds and visual subjects wore a special combination of ear plugs and ear muffs which eliminated most sounds. Separating auditory and visual perception facilitated analysis of interactions between vision and audition. The subjects who could both see and hear acted as controls on the specialized subjects. Since this is an area where vocabulary and experience are limited, subjects were selected who could be relied upon for reasonably articulate expressions of their perceptions. All were college educated and somewhat familiar with Boston and most were familiar with environmental design.

The trip contained a diversity of sonic settings as well as a variety of visible activity and spatial form. We began near the center of the Boston Peninsula in the historic and tightly spaced Beacon Hill residential area and then went to India Wharf, passing through the new, more open, and bulky government center and then through the lively Haymarket area. After leaving the bleak expansive waterfront, we returned to Beacon Hill, passing through the almost empty and cavernous financial district, the frenzy of Filene's corner in the commercial district, and the active and spacious Boston Common. The two-and-three-fourths-mile trip took about one hour. All subjects were given portable transistor tape recorders before the trip and were asked to describe spontaneously their impressions of the places through which they travelled. No questions were asked during the trip. Afterwards subjects drew maps of the sequence as they remembered it and then recalled and described their most memorable and most- and least-liked settings.

Sonic Identity

Most sound settings in the sequence lack uniqueness and informativeness. Auditory subjects either misinterpreted settings or confused them with one another. But they did remember five outstanding unique and informative sound settings. These places contrast with all other settings in the trip. They also inform one of the spatial and activity character and have more novel sounds. In order of dominance for auditory and visual-auditory subjects combined, these settings are:

(A) Washington Street and Filene's corner and their crush of people sounds, whistles, cars, and Musak (settings 26,27,28)

(B) India Wharf and its quiet openness penetrated intermittently by distant planes, bells, ship horns, and sometimes gulls and water (setting 17)

Figure 2A Filene's Corner

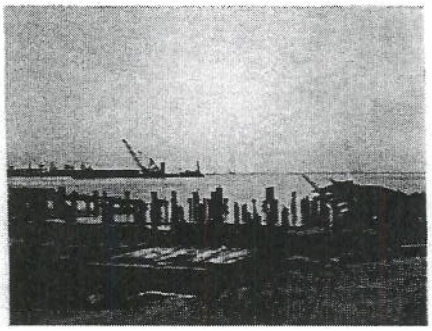


Figure 2B India Wharf

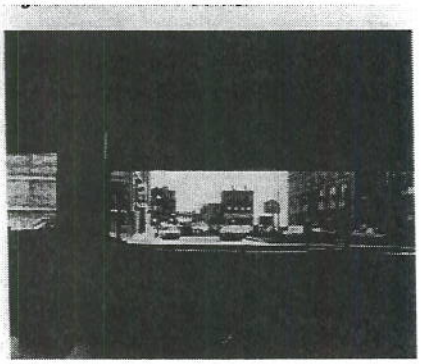


Figure 2C Central Artery

(C) The elevated Central Artery and its constant echoing roar (settings 14 and 18.

(D) Beacon Hill and its array of residential sounds (settings 1,33,34).

(E) The Common and its church bells, people, birds, and open feeling (settings 29,30,31).

Auditory and visual-auditory subjects both agreed that (A),(B), and (D) were memorable but they disagreed on (C) and (E). Visual-auditory subjects remembered the Common better than auditory subjects, probably because it communicates more to the eye than to the ear. Similarly, the Central Artery was much less memorable for auditory subjects than for visual-auditory subjects. Although its sound is strong, it tends to blend with the many other car sounds for auditory subjects. But when the sound was coupled with its menacing appearance, the visual-auditory subjects singled it out.

The most identifiable sound districts contain visible exterior activity and often have unique spatial characteristics, such as the tight, narrow, hard street spaces of Beacon Hill; the confined spaces of the alleys and State House tunnel; or the openness of the waterfront and Common. In the words of one subject: "the best sounds are immediate like gossip and banging doors that call up the character of a place so you can know what is happening more easily and can tell the scale of the space."

Spaces seemed more meaningful and could be perceived more clearly when subjects could hear echoes of their own sounds. Spaces with ambiguous form confused subjects and they judged them differently. Opaque foreground sounds caused similar effects and camouflaged important information. This is

Figure 2D Beacon Hill

Figure 2E Boston Common

particularly true of busy streets, such as Tremont, Court, or Washington. Subjects generally judged Boston to be more spacious when listening than looking.

Of all the settings, Beacon Hill informs one best of its location in relation to the city. The foreground sounds are quiet and since it is a hill it brings in sound views from other parts of the city. Among the most uninformative settings are the U.S. Customs Tower area and the entire sequence from the Customs Tower to Washington Street, with the exceptions of the alleys, which convey spatial information. This greyness probably results from the lacking of visible and hidden activity in these areas, especially on the Saturday when the second experiment took place.

Analysis of the number and distribution of sound mentions by type gives an indication of the variety and frequency of particular sounds. It is not surprising that auditory subjects mentioned sound far more than visual-auditory subjects, since they had fewer demands on their attention. The most prevalent sounds, traffic and people, communicate the least valuable information but demand attention the most. They mask the informative sounds which are usually weaker and less frequent. Nearly all sounds occur as the result of visible exterior activity rather than by intention, exceptions being the bells of the Common and Filene's Musak. Except for airplanes, thunder, and sometimes boat or train whistles, few sounds cover the entire city. They have local territory only, the bells of the Common being one of the few with district appeal. These reach into Beacon Hill and as far out as Atlantic Avenue.

Contrast influenced attention to particular sounds. When sounds stood out from the background, like a fan on quiet Doane Street or the pigeons at Quaker Lane, they meant more to subjects. Contrasts with events immediately before or after also helped determine an event's significance. The quietness of Doane Street and the noisy Central Artery reinforced one another, being in close sequence and of high contrast.

Novel or unexpected sounds informed more than the redundant ones, and subjects also paid more attention to them. The typical sounds of cars or of people walking and talking conveyed little information, other than about

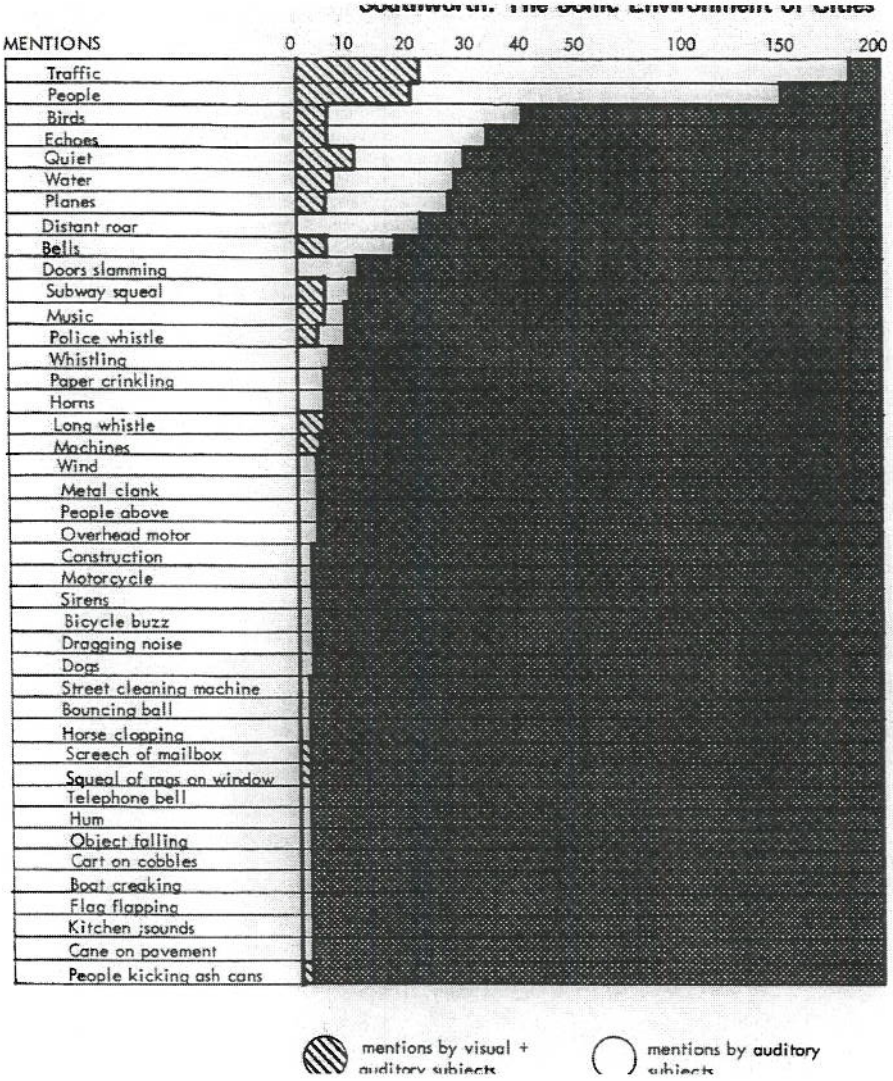


Figure 3 Variety and Frequency of Mentions of Sound

general activity. But the music on Filene's corner, the blind man playing the guitar, the policeman's whistle on Washington Street, the creaking boat at India Wharf, and the old men talking in front of Beacon Chambers on Myrtle Street were all remarkable and memorable and told much about the settings and helped to identify them.

The results of the first part of the study indicate that sounds vary much depending upon the time of day and week and the weather. One finds few continuities but many contrasts between settings over time. Settings have more clarity or identity on early mornings, evenings, or weekends, while on weekdays traffic sounds homogenize and mask informative sounds. Snow and

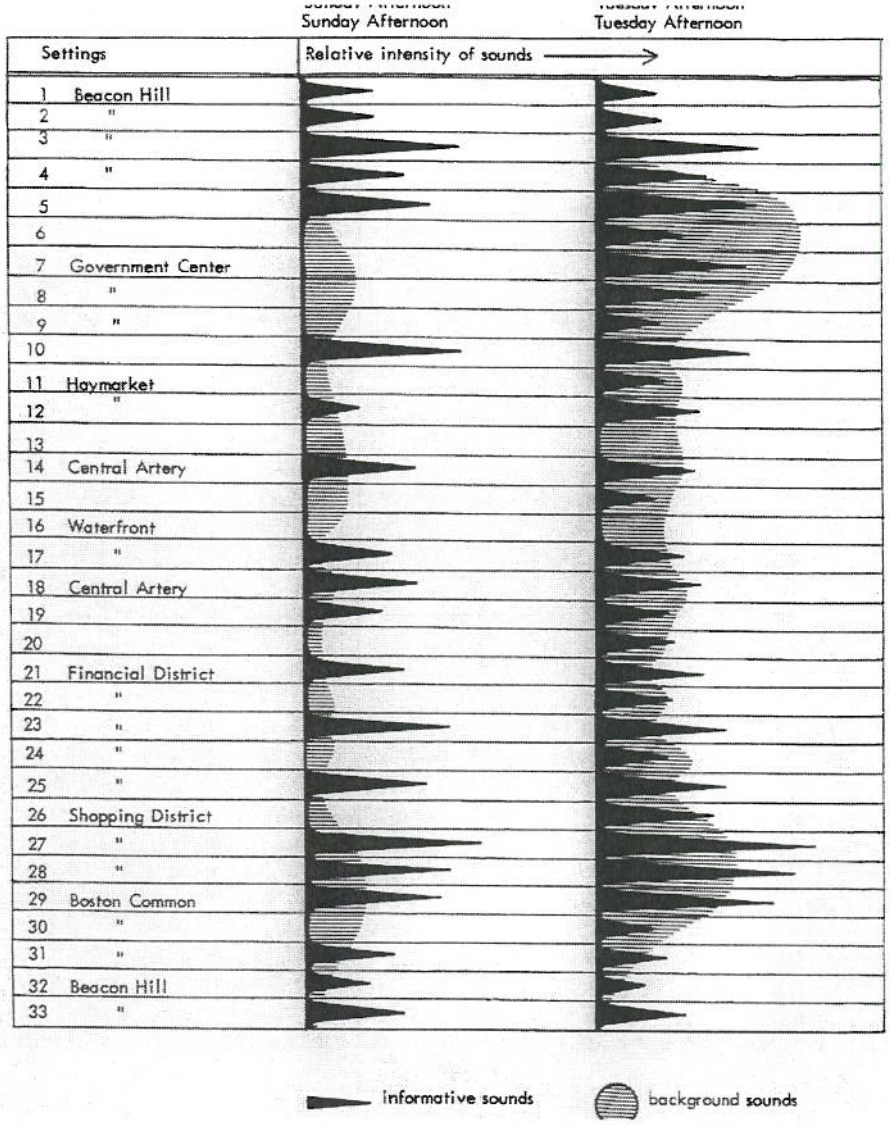


Figure 4 Temporal Change in Sounds

rain shrink the apparent sonic spaciousness of the city, eliminate many high frequencies, and make the city quieter. The most recognizable settings over time and in different weathers include Beacon Hill, whose doors and windows constantly give clues; Filene's corner, which fades but never seems to lose its Musak and people; the Central Artery, which either roars or whines; and the alleys, which always sound quiet and more echoing than other places. India Wharf contrasts dramatically. On weekdays it fills with parked cars and people and does not seem to be on the water. For many subjects it became instead a residential area on the basis of but a few clues: friendly voices, slamming car doors, and occasional broken glass or paper which passersby kicked when walking.

Sonic Delight

Pleasingness of sounds appears to depend on much more than the physical qualities of the sound. Low to middle frequency and intensity sounds were preferred, but delight increased when sounds were novel, informative, responsive to personal action, and culturally approved, as are birds and bells. All subjects liked quiet but informative places like Beacon Hill, India Wharf, or the alleys, and preferred constantly varying soft personal sounds, such as footfalls, fragments of conversations, whistling, or shuffling. The "big, long, cool sounds" of the waterfront symbolized tranquility as did most nature sounds and nearly all subjects liked them but considered them too weak. The echoes of the alleys and narrow streets of Beacon Hill pleased because they allow personal involvement; here one can play with the sounds of his own footsteps, voice, and whistling. The quiet spaces also offer escape from the menacing roar of traffic and give one a sense of independence. In the subjects' words:

> *I like the neighborhood sounds on Beacon Hill because I have a sense of myself and of the people around me as people.*
>
> *Sounds of people are nice because they give me the feeling of involvement.*
>
> *Identification of each sound pleases me, as opposed to a fuzzy roar.*

The warm human sounds of Filene's corner delighted all auditory subjects, one of whom remarked that it seemed as though he were "being luxuriously bathed in humanity," an image which would probably have evaporated had his blindfold been removed!

Sounds of moving cars and trucks particulary annoyed the auditory subjects.

> *The sounds with a rush and roar make me nervous.*
>
> *The traffic sounds, the steady roar, I disliked more than the individual motor noises or slow speed vehicles.*
>
> *The bigger the motor, the more frightening it is.*
>
> *The approach of cars dominates everything; I can hear nothing when they come past.*
>
> *Foreground traffic is completely disorienting.*

These sounds are usually loud, close, and uninformative, and also cover a large territory and have high masking effects. Unfortunately, they invade most city

experiences and blanket large districts from which there is little escape. Conversation is often difficult or impossible and consequently prevents most chances for any other kind of sonic involvement. Sirens, jack hammers, and airplanes also disturbed auditory subjects, but occurred infrequently. Subjects did not always judge cars as bad, but sometimes admired them if "they didn't move but stood near, chugging quietly." They also sounded pleasant when distant and fast-moving, producing a wave-like sound, as does the traffic on the Central Artery when heard from the Haymarket.

Visual-Auditory Correlations

The settings which have sounds supportive of the sights are few, but for all subjects—auditory, visual, and visual-auditory—Washington Street and India Wharf placed highest in memorability. These settings also had the most mentions of sounds which related to the same visible activity and spatial characteristics noted by visual subjects. In addition to these two settings, Beacon Hill's sounds made it memorable for people who could hear and the appearance of the Common made it dominant for people who could see. For auditory subjects, the selected settings exhibit high sonic, spatial, and activity identity. The selections of visual subjects, however, have stronger visual than sound qualities, such as the Common and Quaker Lane, with its forest of black fire escapes. The responses of visual-auditory subjects blended both visual and sound qualities.

In stating setting preferences, the auditory and visual-auditory subjects agreed, and chose Washington Street, Beacon Hill, and India Wharf, which generally have activity and spatial and sonic identity. But the visual subjects disagreed and selected Quaker Lane, Spring Lane, and the Common. Again, these selections have far stronger spatial form than activity or sound.

For least preferred setting, the Central Artery ranked highest with auditory and visual-auditory subjects. Visual subjects, however, barely noticed it. The visual form had much less meaning without the sounds. Visual subjects seemed almost oblivious of its presence; since it didn't roar in their ears and they couldn't see the traffic, they didn't expect its sound to be unpleasant. The evaluative criteria of the visual subjects were consistently extraordinary. They selected India Wharf and Atlantic Avenue as least preferred settings, the Wharf being among the most preferred places of the other subjects.

Examination of the trip commentary of those who could not hear gives clues to this behavior. Just as the blindfolded subjects made far more mentions and closer observation of sounds than did the visual-auditory subjects, the visual subjects scrutinized the visual form of settings. Their eyes seemed to search continuously for new forms to explore, since little other novel sensory input existed for them. Sunlight demanded attention, because it created a contrasting setting and made the forms differentiated and informative. Three-dimensional projections, such as bay windows, fire escapes, or awnings received many mentions by them, as did moving things, like blinking

signs or dripping water. Signs received very high mentions, and in addition to providing entertainment, informed them of activity and danger which they couldn't pick up with their ears. They were also more conscious of textures and colors than the other subjects. They looked for the hidden and curious and usually found it, since they had few distractions.

The cityscape appeared "surrealistic in its peacefulness" and in the way "moving things seemed to float quietly by." But the city was also a very sad place for most of them and lacked contrast—it was almost two-dimensional. For the first time they could scrutinize it without the healing salve of sound. They found much more imperfection in its form than did the other subjects, especially in settings with little visible activity. The openness, the inactivity, the shoddiness, the expansiveness, and the monotony of the waterfront along Atlantic Avenue and at India Wharf combined to make a supremely ugly experience. The following comparison of typical comments of visual subjects with those of auditory and visual-auditory subjects illustrates the point. All comments were made at India Wharf (setting 17).

VISUAL SUBJECTS

Atlantic Avenue is very, very ugly; I don't want to be here. . . . This really isn't very nice even at the water's edge. . . . It's so sad, so very sad.

The water area is quite dull . . . the sad emptiness with nothing in the foreground to look at is very disturbing.

There's a sightseeing boat; I can't imagine why anyone would want to go out and sightsee here.

The view across the harbor is of some kind of turquoise dime store building and there doesn't seem to be any open sea. As far as you look out, there is some kind of land on the other side . . . . You can see the top of the tower off to the right—that's the only healthy looking building in sight—all the rest seem to be getting torn down; it's just a rubble pile . . . . There's a barge that has something on it—smells like they've brought up everything with them . . . the water's edge is green, uninviting, scummy, dirty just like the parking lot we're standing in.

AUDITORY SUBJECTS

I really do think we're near the ocean; I love it—I've always liked the sea. They should build apartments down here where it's kind of peaceful and restful where you don't hear the traffic and that kind of thing and you have natural sounds of some kind like gulls and the feel of the wind. This is really neat—won't you stop for a while so that I can enjoy it.

This is so pleasant because it is considerably quieter than where we were before.

I like hearing those gulls calling, and those long sounds and strong sounds are great.

VISUAL-AUDITORY SUBJECTS

I can see the airport in the distance. . . . There's an airplane taking off—coming straight at us—beautiful! It's nice to be close to the airport.

Now it smells really good . . . marvellous little old boats. . . . I hear the sound of gulls and church bells.

Washington Street, too, sounded much better than it looked, and the cheap and garish commercialism of this street offended the visual subjects, but the others preferred it. The following comments were made near Filene's Corner on Washington Street (setting 27).

VISUAL SUBJECTS

It's just gaudy and vulgar. . . . . There's a very beautiful facade up above and unrelated to all this gaudiness. . . . A marquee says "sensational"—everything should say "sensational, cheap" . . . ugh, the smell of people . . . . These people look awfully funny when you can't hear them.

People appear to be very alone . . . . I miss hearing the sound of selling.

Oh, there are some lovely daffodils in the middle of this horrible lower-middle-class area.

The street is dominated by neon signs and faded colored things . . . . That subway entrance was completely dirty and uninviting . . . typical dingy faded commercial facades . . . absolutely horrible alley full of garbage—no light, no anything!

Disorganized facades, garish colors, cheap goods displayed in the windows . . . .

AUDITORY SUBJECTS

I like this area; it's so alive—it's pleasant . . . quite nice and warm in the sun . . . the smell of food, people around.

Women's voices everywhere . . . well, this is a hot shopping area! People are shouting, bags are crumpling . . . . I'm sure this is an open market

. . . now it's getting intense; it's really exciting.

Ah, we're coming to something big! Now this is living—all of the sounds coming together at once down on top of you—that's just marvellous being in the middle of all these people. That's it—that's great when you have a lot of people around!

VISUAL-AUDITORY SUBJECTS

Right here the street is wide—lots of activity: noise, people walking, people looking, people with cameras. . . . I like this small part. . . . Washington Street is a very satisfying experience after the meandering path that we took previously when there were few people.

Nice view of Bromfield Street . . . interesting activity . . . .

The most interesting thing about Washington Street is the people. . . . The area is jazzy compared to anything we've seen—people here are lively and uninhibited.

At other places in the trip garbage, dirt, cheap merchandise, buildings, and even people were criticized by the visual subjects. Intimate places like alleys were preferred, because they were novel and tended to change quickly as one walked through them. The form qualities of structures against the sky were often admired, probably because the absence of street-level sound freed their eyes to the sky. As an example, visual subjects noticed and remembered the U.S. Customs Tower much more than the visual-auditory subjects. Figure 5 illustrates the sharp attention which the visual subjects paid to details of the cityscape.

Judging from the commentary, the visual-auditory subjects were much more involved in the activity of settings, the activity sounds being a strong magnet to their visual attention. They had less time for visual exploration. Their commentary synthesized in broad outlines the information drawn from several sensory channels. They did not attend carefully to any one of the modes, except in the places where the messages of all modes matched, as on Filene's corner, and which thus demanded less overall attention than necessary when there was no match.

Another illustration of the apparent search for information by auditory and visual subjects is their perception of nonvisual elements other than sound. Figure 6 indicates that the auditory subjects, who received least information, mentioned them most; visual-auditory subjects, who received most information, were least attentive to them.

In conclusion, it appears that memorable sound settings communicated more about spatial and activity character and were also unique with respect to other settings in the sequence. Most settings were sonically uninformative in

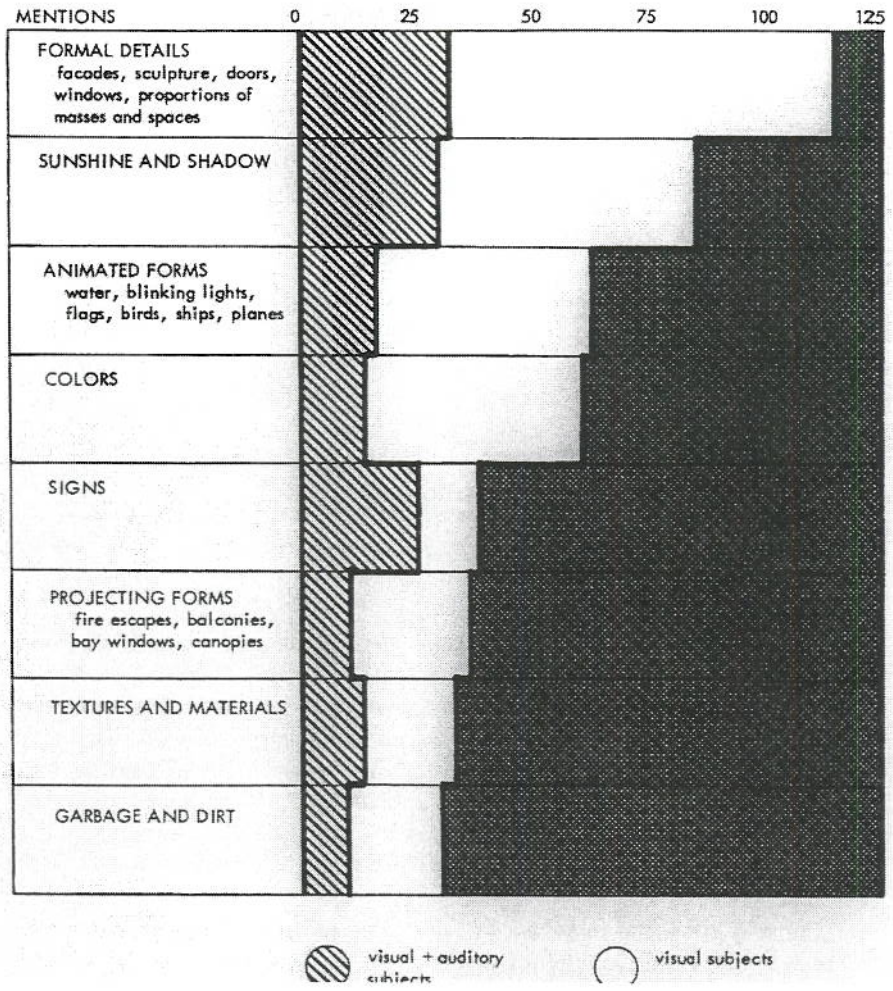


Figure 5 Mentions of Detailed Visible Form

terms of both spatial and activity form, and consequently lacked identity; they also changed greatly over time. The diversity of sounds perceived was narrow. In addition to being unique and informative, preferred settings were responsive. Least preferred settings were uninformative, redundant, and usually very stressful, having sounds of high frequency and intensity, and thus distracted from other interests.

When sonic and visual settings were coupled, attention to the visual form reduced the conscious perception of sound, and vice versa. But the added dimension of sound made city experience more intense by building up contrasts and by increasing sense of involvement and of the flow and rhythm of events, particularly if the sounds related to the scenes, and if the scenes

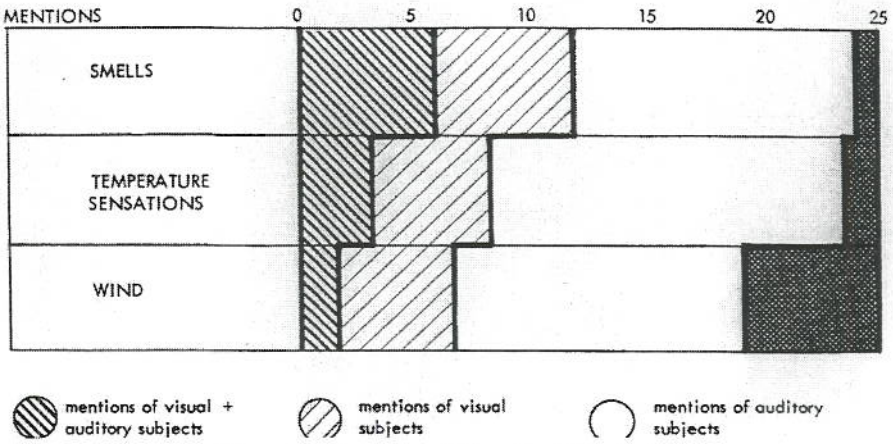


Figure 6 Mentions of Nonvisual Qualities

were animated. Settings were more dominant when the sounds correlated with activity that was visible and spatial form that had identity. Visual-auditory settings that subjects judged as more pleasing were also more informative and unique and lower in attention-demandingness, thus allowing more choices for interaction.

SONIC DESIGN

This study has suggested that the visual experience of cities is closely related to the sounds that accompany it. If this point is supported by further research, it has real significance for city design; visible form conceived as an isolate can never be experienced as intended by the designer when the sonic form, or even other nonvisual factors such as the microclimate or olfactory environments are not designed in correlation. Studies of the blind and deaf have suggested that sound also has important emotional and social consequences; the sonic environment may have effects on an entire community's mental health, although it has not yet been established that this is the case. In many situations design of the soundscape alone may be a way of making the city less stressful, but more delightful and informative to its users. Sonic planning would be more economical than massive and costly face-liftings or total redevelopment. Visually dull sections of the city might become vital if a new dimension of sound were overlaid, or a chaotic setting may become more orderly when paired with harmonious rather than raucous sounds. Or if it were desired to increase attention to visual material or to certain types of information, novel sounds in the strategic places might direct vision, as they seemed to do for the subjects in this study. But until more extensive and controlled research has been done, we will not be in a position to say with assurance how important sonic design would be to cities, nor can we confidently prescribe the necessary changes or predict their consequences. However, it will be worthwhile to make some guesses, based upon our first exposure to

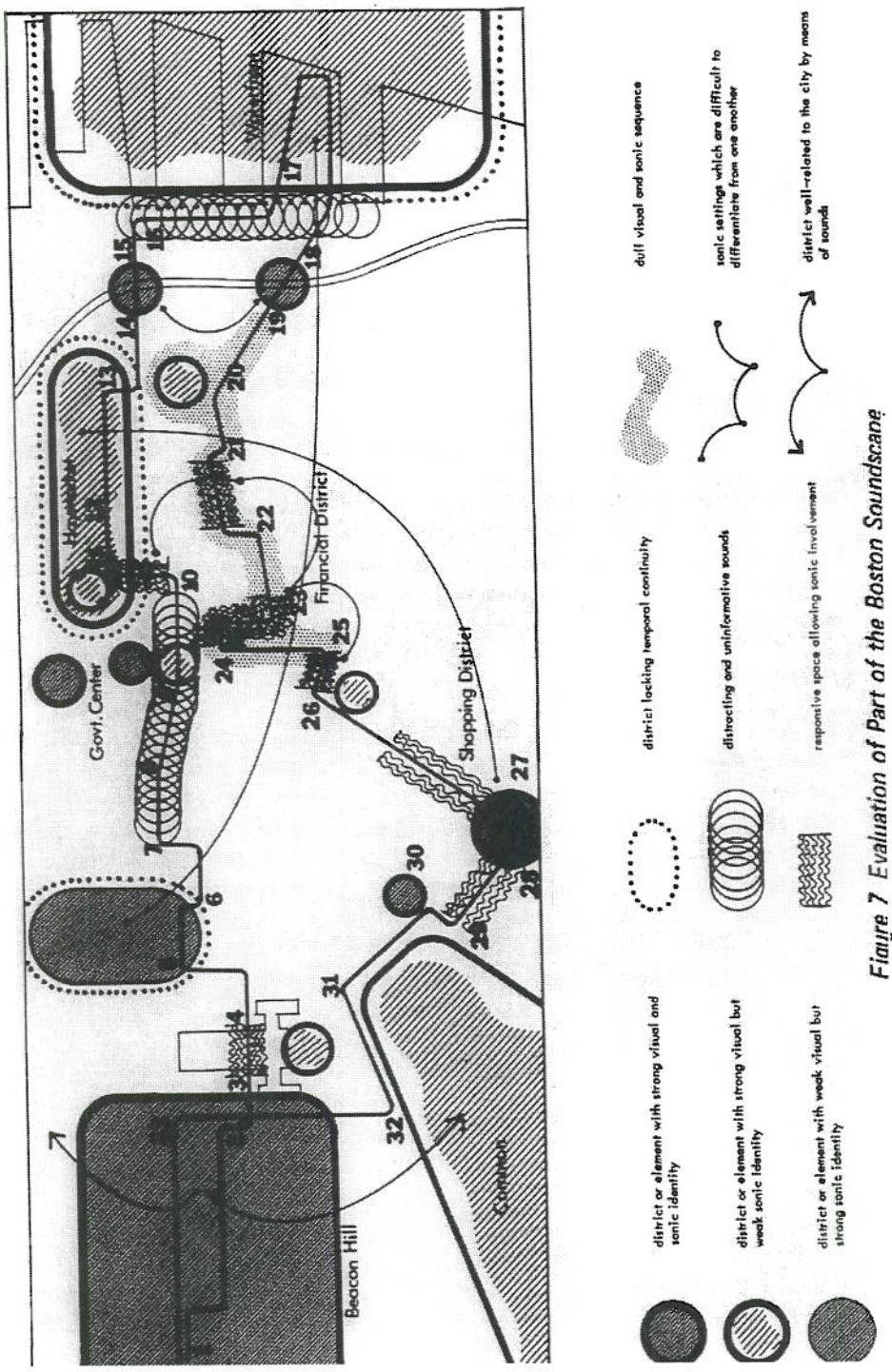


Figure 7 Evaluation of Part of the Boston Soundscape

the problem, as to the directions sonic design should take. The suggestions that follow should be viewed then as our hypotheses of the critical elements and behavioral consequences of sonic design.

First, it seems that even before attempting sonic design, it will be necessary to confront the problem of existing city noise. Noise is sound that is unwanted for any of several reasons: it can be sound that is not culturally approved, that is dull and uninformative, that interferes with human activities, or that is attention-demanding because of high frequency or intensity. The impression of noise can therefore be created by many more factors than high decibel levels alone. The addition of new sounds will not increase the perceived noise level of the city in most cases, in fact it may reduce annoyance, if the character of the new sound is carefully designed. However, there are several sections of the city in which existing noise is so great that it should be reduced before any new sounds are added. Motor vehicles create most of the noise in these areas. Four solutions to the problem of traffic noise seem possible: careful location of noisy activities, new types of highway and street design, special vehicle design, and masking of existing noise by added sound. Sounds produced by activities should be considered in locating them. Noisy traffic interchanges, streets, or airplane takeoff and landing routes should not interfere with concentrations of interacting people or residential and open-space areas where repose is desired. New types of road surfaces may reduce noise just as fresh snow quiets grinding traffic. The shape of spaces and wall materials along the street are also critical in noise control and if badly designed, create a resonating chamber and amplify noise. Attention to muffler, engine, and tire design could reduce vehicle noise. This is especially important for trucks, buses, and subways. Quiet subway trains would revolutionize the entire subway environment and could increase the number of riders. It may also be possible to mask or distract attention from low- to middle-intensity noise by overlaying interesting sounds. Added sounds need not be continuous but could occur often enough to break the monotony of noise. In addition to noise control, a positive attempt should be made to provide several sound- and climate-controlled public oases in the center of the city which would ensure quiet. City users would welcome the silence of such settings, particularly between stressful city trips.

Beyond noise reduction, we hypothesize that changes in the soundscape are needed to increase (a) the identity of the soundscape, (b) the number of opportunities for delight in sounds and to provide responsive settings which contain novel sounds, and (c) the correlation between sound and the visible spatial and activity form. Three types of form elements would seem to have strategic design potential in terms of the three hypothesized needs. These are (a) large open spaces, (b) small sonically responsive spaces, and (c) sonic signs.

Open Spaces

Large open spaces, such as the Common and the waterfront, are sonically ambiguous and do not have sounds to support the activity and visual

form. Because of the openness and high transparency of these settings, they offer ideal testing grounds for the addition of new and informative sounds. The waterfront particularly needs such sounds because of its visual monotony, noted by the visual subjects. The existing airplane sounds, when combined with the sight of the planes taking off, are among the most delightful events on the waterfront, but the weakness of the water and gull sounds and the infrequency of moving ships and ship horns are disappointing. Added natural nature-like sounds could intensify the character. Splashing water geysers and boats with horns that call out destination-coded sounds would be intriguing. Other possibilities would be bells and other big sounds that could ring out periodically from opposite shores. Such large spaces would be ideal sites for festivals and celebrations; opposite shores could feature light shows, fireworks, or luminous floating tivolis which could play over the harbor and could be combined with alluring sounds and recreational activities. Large territory sounds in general are needed to dramatize the scale of the spaces.

Responsive Spaces

The alley spaces, or other small hard-surfaced areas are a potential because they are usually quiet, sonically responsive, and visually strong—characteristics which were important in subjects' preferences. Since these spaces rarely contain activity, they have few distractions and would be ideal for staging events for pure delight. This could be an important technique for making people more attentive to the soundscape. They might be among the first elements to consider in the execution of a sonic design and could be used to test public reactions for policy development. Such spaces could be sensitized with hidden lights and speakers, activated by photoelectric cells planted along paths. A new sound-light sequence could be formed each time a person walked through, and groups of persons could create an explosion of light, color, and novel sounds; sounds could be amplified, distored, reflected, and repeated at the receiver's command. Atlantic Avenue or Quaker Lane would probably be most suited to this type of experiment, although similar spaces in urban residential areas could provide a new kind of playground for children. The information need not be frivolous but could have educational value. The responsiveness of other spaces could be increased by the addition of large sound and light reflectors that would focus sound, color, and images at strategic points. This may be an appropriate device for clarifying sonically the blurred Washington Street space at Filene's corner. In other areas, sequences of sonically differentiated floor materials which squeak, rumble, squish, or pop when walked upon would be fun and could be used to provide interest or distraction in dull or ugly visual settings. Large animated sculptures which make sound when people move around them would also be attractive. Clearly, the notion of responsiveness must be applied with caution to preserve individual needs for privacy and in most cases the individual should have control over the responding environment.

SONIC SIGNS

Sonic signs have the advantage of being more attention-demanding than visual communications, and in many cases are less distracting to tasks such as driving. They can often evoke images of the thing to which they refer more successfully than would visual material. The sounds of steaks sizzling or of people drinking in a tavern are more provocative advertisements than most verbal signs and convey far more information, as did similar sounds in the study sequence. Sonic signs would be most effective when coupled with related visual images and as an example, the sounds of people in Filene's basement could be played back at street level along with an image of the activity. This treatment would be particularly relevant in areas where much of the activity is hidden, as with office districts or the upper stories of buildings.

Sounds to communicate public information would also be useful. Just as chiming clocks tell the time of day, or sirens warn of an emergency, symbolic sounds could be used to inform one of the weather, approaching buses or trolleys, or of special events, such as baseball games, concerts, or sales. Street singers and criers could entertain as well as relay important public information and commercial advertisements. The public sounds of certain districts, such as police whistles or bells, could even be given special character and would strengthen the identity of a locale.

The experiments also indicate the need for sounds as signs to draw attention to certain parts of the visual scene that often go unnoticed. The U.S. Customs Tower, a major Boston landmark, is a good example of this, having been ignored by most visual-auditory subjects who passed it because of its rather ambiguous base. If the clock at its top would chime frequently, people would have been attentive to its form and would have noticed, remembered, and delighted in it.

Entire networks of commonly used streets could be programmed with sonic signs of hidden activities and with sounds which prepare one for major events and decision points, which orient one, and which reinforce or explain the visual or historic highlights of the sequence. Such informative environments would of course be appreciated by the blind, but would appeal to seeing persons as well. Users of districts must be considered, and special sounds and messages could be provided for children, tourists, or shoppers. Sonic signs would be particularly useful to help children use the city and learn from it. Such sounds need not be broadcast continuously, but could be activated by the individual. Sonic signs would also be valuable in tunnel sequences, such as subway tubes and stations or in the interiors of large building complexes which are hidden from the outside world. If subway trains were quieted, sounds which identify places could be piped in and would orient one as well as relieve the monotony of most underground travel.

Our first actions toward escaping the visual bondage of the contemporary city would be twofold: (a) to reduce and control noise and (b) to

increase the informativeness of the soundscape. These steps toward the sonic city would not only enhance city life by helping to overcome the stress and anonymity of today's visual city, but would be one measure for developing the sensory awareness of city residents and would provide an environment more responsive to human action and purpose.

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