THE SONIC ENVIRONMENT OF CITIES

by

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B.A., University of Minnesota
(1962)

B. Arch., University of Minnesota
(1965)

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF

CITY PLANNING

at the

MASSACHUSETTS INSTITUTE OF

TECHNOLOGY

June, 1967

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Submitted to the Department of City and Regional Planning on May 19, 1967, in partial fulfillment of the requirements for the degree of Master of City Planning.

ABSTRACT

The perceptual form of the soundscape is investigated by means of a field analysis and two experiments involving several subjects. The main purposes were:

1. To analyze the perceptual form of the soundscape and to develop techniques and language for recording it. The main concerns were the types and qualities of sounds, their spatial distributions, the extent to which they identify settings, the changes in the soundscape over time, and the interactions between sound, visible activity, and spatial form.

2. To study these characteristics of the soundscape as perceived by people and to develop experimental techniques for analyzing the public soundscape.

3. To investigate the possibilities and relevance of sonic design for cities and to establish some criteria for design.

For purposes of the analysis and experimentation, a sequence in Central Boston from Beacon Hill to India Wharf was selected. The study uses the sequence as an experimental setting to investigate three hypotheses which are derived from research on the perception of the blind and deaf, and also from the literature of experimental psychology. These are:

1. The most dominant sound settings in a sequence are those which have the most informative sounds and which are unique with respect to the sequence.

2. Preferred sound settings are the most responsive, and allow sonic interaction, and the preferred sounds generally lie within the middle to low ranges of frequency and intensity, and have varied and non-repetitive patterns.

3. Dominant visual-auditory settings have visible form and activity which is supported by the sounds and are also informative and unique, visually as well as sonically.

The two experiments tested the perceptions of several subjects on the same sequence. In the first experiment, subjects were blindfolded and taken by wheelchair through the sequence and were asked to comment on the sound settings. To test visual-auditory interactions, subjects

of the second experiment consisted of three sensorially differentiated types: blindfolded, deafened, and normal seeing and hearing persons. These were taken simultaneously on the same trip and the procedures were similar to those of the first experiment. In general, the hypotheses are confirmed, but it is determined from both the analysis and the experiments that the sequence was lacking in most qualities considered desirable on the basis of the hypotheses, and sound settings lacked informativeness, uniqueness, and diversity, and the visible form was not well-correlated with the sonic form.

The sonic environment, as well as the non-visual environment in general, is concluded to be an important area for new design work because of its apparently important effects on visual perception and because it may be an economical way of increasing persons' delight and acceptance of the city without massive and costly redevelopment of the visible form. The elements which are considered to have the most potential for sonic design on the basis of the analysis and experiments are the large open spaces, signs and other communications, the sequence network, and small and responsive spaces.

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THE SONIC ENVIRONMENT OF CITIES

A city which would please all of the senses would be ideal, in terms of esthetics. To date, however, design has been visually prejudiced, and the non-visual aspects of the physical environment are among the least considered characteristics. This is partly because they are so elusive, being invisible, transitory, and difficult to talk about, and partly because of the relative newness of large scale environmental art based on perception. In addition to visible activity and spatial form, a city has sounds, smells, textures, and myriad sensations of microclimate, and the perception of these hidden dimensions may greatly affect the interpretation of the visual information presented by the cityscape. This thesis will explore one aspect of this non-visual environment which seems particularly important: the sonic environment.

The main purposes have been:

1. To analyze the perceptual form of the soundscape and to develop techniques and language for recording it, including the types and qualities of sounds, their spatial distributions, the extent to which they identify settings, the changes in the soundscape over time, and the interactions between sound, visible activity, and spatial form.

2. To study these characteristics of the soundscape as perceived by people and to develop experimental techniques for analyzing the public soundscape.

3. To investigate the possibilities and relevance of sonic design for cities and to establish some criteria for design.

Writings on the subject of city sounds go back to the time of Julius Caesar, when Roman citizens complained because street noises prevented sleep; and down through the Middle Ages, when there were complaints about the noisy new four-wheeled wagons with pivoted front axles and brakes; and up to the present, with its "Quiet Will Help Win the War" and "Ban the Boom" campaigns of the forties and the sixties. Twentieth century city users and analysts have written most profusely about city sounds, but only in terms of noise, a rather narrow but vague conception of sound. This will not be a primary concern here. Rather, the focus will be on sound in its most general and objective sense, including the sounds to which people do not often pay attention--sounds ranging from the roar of jets to the trickle of water on tin rooftops; from the stately chiming of a Big Ben, to the caricatured "Miseres" of hurdy-gurdy men; or from the quiet echoful oases of narrow back alleys, to the hum of voices, each with a different accent and cadence, as on a busy New York street. Some are informative sounds, others are repetitive and dull; some conjure up images of far away places or historically remote times, like the searching sound of a ship's horn as it comes to harbor, or the cries and songs of London street venders, which have been handed down from Elizabethan times; some are pleasant and soothing, while others grate and jangle the nerves.

In addition to analyzing the soundscape as an independent variable, that is, the quality and type of sounds and their arrangements in space and time, it will be considered in relation to the visible form of the city:

the activity form and its physical settings. Since the senses do not operate independently, sound cannot be analyzed as an isolate. What people hear is a function of many other environmental and psychological factors. A place which seems "good" must do much more than "look" good, a fact which designers usually ignore. Spaces which are of a grand scale and that have closet sounds, or sequences which are visually highly animated but which are sonically dead lack something for hearing people, and can be much better appreciated by the deaf. There are many other interactions, in addition to the visual-auditory, which could also be investigated, but they have not been considered here.

The presentation is composed of three major sections:

I. ANALYSIS: an objective analysis of the soundscape including the types and qualities of the sounds, their temporal and spatial distributions, and the relations of the sounds to the visible form and activity.

II. EXPERIMENTS: two perception experiments involving several subjects which study (a) the types and qualities of sounds as perceived at different times of the day, different days of the week, and in different weather conditions, and (b) the visual-auditory interactions.

III. DESIGN: criteria for sonic design and design possibilities.

PART I: THE ANALYSIS

I. THE ANALYSIS

The categories for the descriptive analysis of the soundscape and the design of the perception experiments have been based on hypotheses derived from two major sources: the experimental literature of psychology and reports on the perception of blind and deaf persons. The first source has four basic divisions:

1. Interactions between vision and audition
2. The effects of sound in communication and learning
3. Task performance in relation to sound
4. Psychophysical investigations of (a) frequency and intensity thresholds, (b) reactions to sonic variations, and (c) annoyance and habituation effects

Most of the literature is based upon very narrow and well-controlled laboratory experiments and its value for our purposes is therefore somewhat limited; research on topics (1) and (2) is most relevant.

The second main source of information has been a series of unpublished reports of seminars on perception which Dr. Warren Brodey conducted with a group of blind persons from 1961-64. This material is particularly useful in developing experimental hypotheses for two reasons:

1. It is concerned with the perception of whole environments in the real world.
2. The blind do not share the sensory conventions of the sighted, and have learned to sense things which the sighted do not. Since they are far more sensitized to the non-visual environment, they can clearly and perceptively articulate their responses to sound.

Similarly, studies on the deaf can teach much about the psychological effects of visual perception without sound. Unfortunately, the literature in this area is scant and fragmented.

A. THE HYPOTHESES

The following are the main hypotheses upon which this study has been based. They form the framework for the analytical categories and the experiment design. The first two hypotheses relate to perception of the sonic environment alone, and the third, to interactions between sound and vision. They will first be briefly stated and then discussed in greater detail.

SOUND

1a. IDENTITY: Uniqueness

The most dominant sonic settings in terms of subjective impressions will be those which are most contrasted or most unique relative to all other settings in a sequence and to immediately preceding and following events in a sequence. Some elements which make a sound setting unique are the type, intensity, quality, temporal pattern, movement, direction, and location of its sounds.

1b. IDENTITY: Informativeness

Dominant sonic settings will also tend to be more informative, giving a sense of the activity and spatial form of the setting itself, and also its relation to other places. Novel or unique sounds will generally be more informative than regular or redundant ones.

2. DELIGHT

Preferred sonic settings, in addition to being high in uniqueness and informativeness, will be most responsive and will allow greater receiver involvement. Settings which are least preferred will be uninformative, redundant, and generally very attention-demanding.

SOUND AND SIGHT

3. VISUAL-AUDITORY REINFORCEMENT

Visual-auditory settings which are dominant will have visible activity and spatial characteristics which are supported by the sounds, and will also be informative and unique, visually as well as sonically. Settings with non-supportive, that is, weak or contradictory visual or sonic form, will be less dominant.

The following is a more detailed discussion of the hypotheses and supporting evidence. For hypotheses one and two this evidence is derived mainly from Dr. Warren Brodey's work with the blind, and for hypothesis three, from the experimental literature.

1a. IDENTITY: Uniqueness

For the blind, the soundscape is one of the most important means of obtaining information about the world. They hear things in it which seeing people cannot, partly out of necessity, partly because they are not dominated by the more powerful sense of vision. The models which they build of the sonic environment are much more generalized than the models constructed of the visual environment by the sighted, because the sonic environment is much less informative, and also because the ears are perhaps one one-thousandth as effective as the eyes in gathering information.[1] Also, sound information tends to be much more discontinuous and transient, occurring in fragmented clumps, which are often rather indistinguishable from one another.

Most blind persons never develop a general image or sense of identification with complex environments like cities, but at most have only narrow images of common trips, and depend on unique sets of sounds for a "home"

feeling. Since the sonic environment is generally very changing, new sounds continually make the familiar strange. Even a light rain or a blanket of snow can transform a familiar city into a foreign one. Unique sounds which can be depended upon are most useful: squeaky doors or signs, rattling grates, or spaces which have distinctive echo characteristics are good clues. Irregularities of the tactual environment, such as floor textures, bumps, or cracks are also important, in addition to micro-climate and olfactory sensations, but these are not a concern here.

In identifying environments, images are constructed according to the purposes and expectations of the perceiver. For the blind, these images tend to be partial, highly conventionalized, and often erroneous. For example, blind persons, when hearing the sound of birds, often tend to go beyond the information given and image the birds in the stereotyped setting of grass and trees against a blue sky, when in actuality, the birds may be sitting on building cornices on a quiet city street.

Their images of people are also dependent upon the physical stereotypes and the associated voice types, with loud deep voices belonging to large muscular men. Successful radio broadcasting depends very much on communicating such stereotypes, while television usually relies more strongly upon the visual image. For this reason, the blind generally enjoy radio much more than television, and for example, several found the radio Matt Dillon to be a far better "tough guy" than the TV Matt Dillon, who apparently "looked" the part only.

Another characteristic of images of the blind is that they are often partial and are built only about aspects which can be perceived most

clearly or which are most relevant to their immediate purposes. A car may be imaged merely as a door with a seat behind it, since that is the way it is normally experienced. One blind subject had for years imaged a train as a number of noisy vertical pipes, much taller than himself.

In conclusion, it is expected that the most dominant sound settings will be those which are contrasted with preceding and following events in a sequence and which are rather unique with respect to the total settings experienced. Variation of several elements can establish such contrast: sound intensity, in which a quiet setting could be dominant in the middle of a generally loud sequence; pitch, in which high-pitched sounds could be contrasted to a low-pitched sequence; or type, in which a long stretch of car sounds could be interrupted with a flock of birds. The rhythm of sounds and the rate and directions of movement are also elements which could establish dominance. Settings with sounds which are unusual or least expected will have highest chances for being dominant, provided they can be easily heard.

1b. IDENTITY: Informativeness

Spatial Perception

For the blind, sound is the prime way of judging space and is consequently very important in navigation through the city. This is contrary to the old theory of "facial vision" which held that the blind perceived obstacles by sensing on the face a pressure which objects were presumed to emit.[2] According to the blind, sound is most informative when it is the result of their interactions with an environment. Floors that squeak when walked upon or lamps that wobble when a room is entered are good spatial informants. Spaces which are smaller, more enclosed, and hard

surfaced are usually better than large open spaces, because the former resonate with the sounds of one's voice and footsteps, and "sound shadows" can inform one of the size of a space, its contents, materials, and also about one's location in the space. The blind are commonly able to distinguish surface materials by their resonance qualities, for example, glass bounces back higher frequencies than does brick. Some can determine the location of a sidewalk curb from as far as thirty feet by means of echo-location.

The masking effects of objects also helps to locate structures in space by forming a sort of silhouette of the building bulk against distant sounds. This is effective only when the sound foregroud is quite transparent. In more open situations, a linear form with distinctive reflectance characteristics, like a hedge, is helpful in navigation; a busy street is also a legible edge, but a menacing one. In the absence of any good spatial guidelines in large open spaces, the blind often "read" the cracks in the sidewalk, changes in surface texture, or other micro-characteristics.

In general, one's auditory perception is most keen when the air is cool and dry; the blind hear best at temperatures of 40° - 50° F. Perception is most difficult in the rain or in humid conditions, when sounds seem much nearer, more blurred, and non-directional, and wet streets make it difficult to determine the directions of traffic.

Novelty

The blind must seek out the novelties or irregularities of the soundscape for way-finding, since these sounds tend to be higher in information content and therefore identify a place more clearly. This is par-

ticularly so if the sounds are rooted to the area, such as the sound of a boat creak in a harbor or opening and closing doors and children's voices in a residential area. Also, responses to novel sounds tend to be more efficient or attention-demanding, as Poulton (1956) has shown in the experiment with several speakers. Sounds which are highly redundant, on the other hand, are filtered out or ignored after continued exposure, and they tend to be low in information.[3]

In addition to being more attention-demanding, auditory messages have the advantage of being less affected by fatigue, have fewer coding dimensions, and are more flexible and less influenced by distracting tasks than visual material. Visual communication on the other hand has greater adaptability for presenting relational information and information can be presented at a faster rate. Also, since there are more coding dimensions, there can be more refined and more accurate discrimination.[4]

The perception of a sound message varies with its sound context or background and also with its structure in time. Message interference may result from interspersed competing messages of equal importance, irrelevant sounds, or irrelevant messages, noise being considered as a sound with a low level of information, but with high attention-demandingness. Greatest interference occurs when competing sounds show as much variety as the message. For optimal communication, the signal sound and background sound must be differentiated both in sound level and type and the informational content should be unique in relation to the context. Also, relevant information should ideally come from different sources or directions than irrelevant information, should be of differing frequencies or intensities, or should be presented to different sensory

modalities. High frequencies are more efficient carriers of information than are low frequencies. The rate of information flow of the messages is also important. Two messages which convey little information stand a much better chance of being dealt with simultaneously than do two high information messages. There is a limited capacity for the total number of signals within any time period, and interference is increased when competing signals occur within the short-term memory span, in which priority is given to the last event in a series.[5]

With respect to informativeness, then, it is expected that settings with fairly small and reflective spaces will be most informative of their spatial form. Also, settings which have low-level foreground sounds but in which distant sounds are audible will be more informative than settings with much foreground sound that blurs the shape of spaces. Sounds which are rooted to a particular setting and which typify the activity of that setting are expected to be more informative than redundant city wide sounds; the creak of a boat conveys more information about a harbor than do footsteps. Also, it is expected that people will attend more carefully to novel sounds than do those which are redundant. In conclusion, it is not expected that the parts of the present urban sonic environment will have a great deal of identity or uniqueness, nor are they expected to be very informative with respect to one another, especially for sighted people, who do not have time to attend to subtle distinctions. But the few places which are informative and unique to the cityscape as a whole, particularly if they are preceded and followed by contrasting settings, will most certainly be remarkable and memorable.

2. DELIGHT

Responsive and informative environments are generally most preferred by the blind. A setting in which one's voice will bounce back to him and in which objects rattle and sing in response to one's movement, in addition to being highly informative about the space and its contents, invites the involvement of the listener in a man-environment conversation. This type of involvement is particularly valued by people who most often feel detached from the world because of limited sensory contacts. Dr. Warren Brodey's report on his non-verbal classroom for blind children beautifully illustrates this point. The children delight in bouncing sounds off new materials and in new kinds of spaces, and the discovery of things which make novel kinds of sounds is a big event.[6] This type of joy in sounds appears to continue throughout the life of most blind persons, and they speak of the fondness they have had for certain squeaky doors or floors which resonated with their footfalls.

Preferred settings not only allow involvement, but also are more informative. Rooms with windows are preferred by the blind because they bring in sounds from the outside, enlarging the world from the tight visual space of the room to the expansive auditory space of the city. Preferred sounds generally lie within the low and middle ranges of frequency and intensity and are usually transparent sounds of a soft, rather than hard type, like the trickle of water, the rustle of wind in the leaves, the hum of human voices, or the click of footsteps. Less pleasing sound settings tend to be more attention-demanding and less informative, such as the roar of a busy street. Although the sound of a street makes its location and activity type abundantly clear, it camouflages many more subtle sounds which could tell about other

activities or the general spatial character and its relation to the context. Higher frequency (512 cps) and higher intensity (90+ db) sounds are usually most annoying, particularly those which are low in information or irrelevant to one's purposes. The blind regard the sound of the jackhammer as one of the worst because it is very disorienting and covers large territory, affecting them like a bright flashing light affects the sighted. Airplanes and sirens are also disturbing for similar reasons. Annoyance with this type of sound does not appear to decrease with familiarity, but rather tends to become worse as it continues. Also, the uncertainty or unexpectedness of attention-demanding sounds tends to increase annoyance. Extremely quiet, undemanding, and uninformative environments may also be very distressing because they are so dull.

In conclusion, it is expected that the most pleasing settings, in addition to being unique and informative, will allow more listener involvement and will be characterized by more transparent sounds which also lie within the above-mentioned frequency and intensity ranges.

3. VISUAL-AUDITORY REINFORCEMENT

Thus far, the concern has been primarily with the perception of sound alone, but one of the main purposes is to relate this to visual perception, since most city users are also seeing people. Before considering the interactions between seeing and hearing, it will be useful to consider visual perception without background sound. The literature in this area is very limited, but there are some studies on the deaf which can give clues to what a sound-less world is like, and knowing this, the relations of hearing to seeing can be better assessed.

The most valuable studies have been done on deaf patients at the Deshon Army Hospital, most of whom had suddenly become deaf. For them, the world was a ceaseless pantomime in which it was difficult to maintain a feeling of being a part of a living drama. Loss of sound had cut important links with life. The world seemed dead and had lost its "ongoingness". It was much less urgent and nervous. The psychological effects of sudden deafness seemed more severe than those suffered by persons who suddenly had become blind. Deep depression resulted, characterized by undefined feelings of loss, lack of alertness, sadness, and paranoid tendencies. It was often hard to grasp the passage of time and patients frequently fell asleep. Life had fewer contrasts, but some of the most important events were those which had animated visual qualities, such as settings with rapidly changing light patterns, moving water, or flying birds; moving pictures were almost magnetic in their attention-demandingness.[7]

Expanding upon this, it is probable that deaf persons, like the blind with sound, would gather much more visual information than do seeing and hearing people, since they have less to attend to. Although most visual experience may seem dull and monotonous, attention would probably peak at those places with strong formal or compositional qualities and dramatic coloring or lighting. Visible activity of people or things would be most attention-demanding, because of its uniqueness in contrast to the majority of settings which are static, and because movement conveys more information. As with the blind, the most preferred places would most likely be those where a person could feel more closely related to the environment and could interact with the visual scene by changing the light quality or by being involved with the animation of the forms.

Sound, then, appears to be an important link to reality, and without sound, visual perception is different--less contrastful, less attention-demanding, and less informative. (This was discovered decades ago by the movie industry). Similarly, auditory perception would be expected to be far different without simultaneous sight. Sound and sight interact, and they can reinforce or interfere with one another. Compared with independent vision and audition, one may either gain or lose when the two are paired, depending upon the correlations between both channels of information. Experiments have shown that the visual content of a setting helps in the hearing of congruous sounds or sounds that fit what is seen, based on learned expectations, and vice versa; sounds can direct attention to elements which are congruous.[8] Seeing a bird helps in hearing its sound, if the sound is not prominent against the background; without seeing it, the sound would tend to pass unnoticed along with the other background sounds.

Experiments have also shown that auditory cues can reduce search time in a visual task.[9] Among these is the FLYBAR experiment, the purpose of which was to develop a system of pilot navigation of planes which would demand less attention to dials, because visual indications had been found to be very tiring and responses to them were slow. The FLYBAR system was devised, which informed the pilot of the plane's position and speed by auditory reference. The signals were most successful when they sounded like what the plane was actually doing. If the plane was higher on the left than on the right, a high-pitched tone appeared in the left ear, or when it was travelling faster, the sound was louder. The system was most successful when used in conjunction with dials which corresponded with the auditory information.[10]

Some experiments have also shown that verbal material presented both visually and audially is best remembered, while material presented only visually is less well-remembered than auditory material.[11]

Interference, rather than reinforcement, can be expected to result when the visual image is accompanied by attention-demanding sounds which are incongruous or irrelevant with the visual information. According to Broadbent, such sound background should be treated as a constant but low rate of information which is being presented to the ear. This information requires some periodic attention and its effects on visual perception are similar to blinking. The sound distracts momentarily from the visual task and as sound distraction increases, visual perception or intake decreases. Transient or novel sounds show particularly pronounced effects because the onset or stopping of the sound conveys a higher rate of information and because a unique event has higher priority in the perceptual system. For this reason, intermittent and irregular or complex sounds may be more annoying than regular sounds of the same quality and intensity. Also, incongruous sounds which can be identified and localized are apparently less annoying than those which continue to mystify.[12] A setting high in visual information may also be expected to interfere with the perception of sounds which are not attention-demanding, that is, which are low intensity, irrelevant, or incongruous. When only the auditory information of the same setting is perceived, more will be heard.

Experimentation has also shown that one's sensitivity of peripheral vision decreases on exposure to sounds of average or above average intensity, while ultrasonic frequencies increase peripheral sensitivity.[13]

Also, brightness contrast thresholds are raised if visual stimuli are paired with annoying auditory stimuli and experimental subjects needed more information for pattern recognition when the patterns were accompanied by screeches.[14]

It is expected, then, that vision and audition together make city perception potentially more informative and contrastful, and vision without audition is more dull, and depends upon dramatic spatial form, color, lighting, and visible activity for interest. For seeing and hearing people, settings with sounds which are supportive of the visible activity and spatial form would be expected to be most dominant, provided they are also more informative and unique or contrasted with respect to other settings in a sequence. On the other hand, settings with sounds that do not fit with what is seen are expected to cause channel interference and a resulting decrease in information transmission. Preferred settings would be expected to be less attention-demanding and would allow, but not force, personal involvement, both sonically and visually.

B. THE DESCRIPTIVE CATEGORIES

The elements and characteristics of the sonic and formal environments which are considered important in auditory and visual perception with respect to the hypotheses can now be presented. There are three broad categories, each of which relates to the sensory mode by which the elements are perceived:

I. SOUND: hearing

II. VISIBLE FORM: seeing

III. CORRELATIONS BETWEEN SOUND AND VISIBLE FORM: hearing and seeing

I. SOUND

A. Form Qualities

1. Type: classification of the sound on the basis of its source

2. Location and Orientation:
   - i. the kinetic qualities, i.e. whether the sound is localized or flowing
   - ii. the spatial location or path of movement
   - iii. the direction of orientation of the sound

3. Intensity and Territory
   - i. the sound level or loudness
   - ii. the territory or region within which the sound can be heard

4. Quality:
   - i. the timbre or frequency spectrum of the sound
   - ii. the transparency or masking effects of the sound

5. Temporal Pattern:

i. occurence:

frequent to infrequent
regular to irregular

ii. duration:

long to short

iii. rhythm

repetitive to non-repetitive

B. Synthesis of the Form Qualities

1. Informativeness: the extent to which the sounds support the activity and spatial form of a local setting and its city context

2. Uniqueness: the extent to which sounds are unique or contrasting to their setting or a setting is to its context

3. Attention-Demandingness: the extent to which sounds force attention, independent of individual purposes, by their frequency, intensity, uniqueness, or informativeness

4. Responsiveness: the extent to which settings allow sonic interaction by means of individual production or control of sound and environmental response

5. Continuity: the extent to which sonic settings contrast or continue over a given time cycle

II. VISIBLE FORM

A. Activity Form

1. Type:

i. local:

activity within a setting

		ii. flowing:	movement on a path
2.	Intensity:		the amount of activity at a given point
3.	Visibility and Audibility	i. visible activity:	sound-producing and non-sound-producing activity which can be seen from a given point
		ii. hidden activity:	sound-producing activity which cannot be seen from a given point

B. Spatial Form

1.	Bulk and Spacing:	the mass of structures in relation to the intervening open spaces
2.	Topography	
3.	Surfaces:	the floor, wall, and ceiling (if any) materials and textures
4.	Transparency:	the visual penetrability of structures and the degree to which the interior is exposed
5.	Visibility:	the extent to which a given setting and the city context of a setting are exposed from a given point
6.	Light:	the quality of sun and shadow
7.	Signs:	visible explicit communications

III. SOUND AND VISIBLE FORM

1. Visible Activity and Sound:	the extent to which the analyzed qualities reinforce or interfere with one another
2. Spatial Form and Sound:	the extent to which the analyzed qualities reinforce or interfere with one another

C. THE ANALYSIS

The Area Analyzed

For the purposes of this exploratory analysis, an area was desired which would provide a diversity of sonic settings and which would also contain a variety of activity and spatial form. A second criterion was that the area be small enough to be explored within an hour's walking time, since the same area was also to be used in testing the perception of sound by several subjects in the experiments. It was concluded that a sequence rather than an area would best serve these two purposes.

The selected sequence lies on the central portion of the Boston penninsula, starting in the center and passing radially to the waterfront; more specifically, from Beacon Hill to India Wharf. This is illustrated on Map I. The total length of the sequence is 2.73 miles and it includes a variety of activity and form types, including the historic, tight-spaced Beacon Hill residential area, and the new, not-yet-completed and more open and coarse-grained Government Center; the almost empty and cavernous financial district, and the colorful and lively market area; the lonely emptiness of the waterfront, and the frenzy of Filene's corner; and the verdure and spaciousness of the Common, and the black chasm-like alleys.

The Analytical Methods

In order to facilitate analysis and experimentation, the sequence was divided into the following thirty-three settings. Numbers were generally assigned at points where the activity and/or form changed, with the exception of the more extended sections of the sequence, which were rather arbitrarily subdivided. The following are the settings:

1. Pinckney Street
2. Joy Street at Mt. Vernon
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
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

The analysis was conducted over a period of months and the settings were observed at various times of day and days of the week, and under several different weather conditions, to study temporal patterns. The information on all of the maps, except Map IV, Temporal Pattern, is based on observation between 10:00 AM and 4:00 PM on Saturday, however. This time was chosen because the sounds seemed most diverse. In addition to the author's judgement, the analyses were confirmed by two other persons who were familiar with the sequence. Sound level was measured by using an octave-band sound level meter. An attempt was made to record the sounds of the sequence with a portable recorder for further analysis, but this proved unsuccessful, except for the loudest and closest sounds. If there had been additional time, and far more extensive facilities, a recording of the entire sequence at different times would have been extremely useful.

D. EVALUATION OF THE SOUNDSCAPE FROM BEACON HILL TO INDIA WHARF

The conclusions drawn from the analysis will now be discussed with respect to the hypotheses presented in Part I.

I. IDENTITY: Uniqueness and Informativeness

Uniqueness and informativeness will be considered together since there is considerable overlap. A setting which is unique to its context, however, need not be particularly informative of the setting's spatial and activity character, and similarly, an informative setting need not be unique with respect to all other settings, but could be repeated endlessly throughout the city.

Most of the sound settings in the sequence do not seem to be singular, nor do they seem highly informative--most could be either misinterpreted or confused with others, provided they were not seen. There are some settings, however, which are outstandingly unique and informative relative to the sequence as a whole. These are Beacon Hill, with its array of residential sounds; Filene's corner, with its crush of people sounds, whistles, cars, and Musak; the Central Artery and its constant echoing roar; and the five alley-like spaces; the State House tunnel (3), Change Avenue (10), Doane Street (21), Quaker Lane (23), and Spring Lane (25). Although the allwys seem distinguishable as a general type because of their unique reflectance qualities, they are much less differentiable from one another, except for subtle sounds. The State House tunnel is more echoful than the others and often has cars in it; Change Avenue is the most quiet, but usually has footsteps; Doane Street has a second-story vent fan which runs continuously; Quaker Lane has a

flock of pigeons; and Spring Lane has an MTA stairway at one end, which sends up the sounds of trains. Of these settings, Beacon Hill and Filene's corner seem to have the greatest diversity of sounds.

The Common and India Wharf are considerably weaker, although they are more informative on some occasions than others. It is usally difficult to hear the birds or to sense the openness of the Common, and the sounds of water and gulls are usually weak at India Wharf. Washington Street up to Filene's Corner could be easily confused with the Market. 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 exception of the alleys, which convey spatial information. Most of the streets with heavy traffic, such as Tremont, Court, Atlantic, and Beacon are indistinguishable from one another, except for other sounds which connect them to a district, such as the construction sounds near Scollay Square. Although cars give a strong sense of the direction of flow of a street space, they camouflage many sounds which would give more information on the activity and spatial form. Unfortunately, vehicle sounds are by far the most prevalent and prominant. In general, the most prevalent or most prominant sounds also seem to be the least informative but most attention-demanding, and mask the high information sounds, which are usually weaker and less frequent. Most of the sounds are undesigned sounds and are produced spontaneously, the exception being the bells of the Common and Filene's Musak. Also, most sounds are associated with visible exterior activity. Places which have little visible activity or which have only visible interior activity, tend to be much weaker sonically.

The identifiable sound districts, in addition to being associated with visible exterior activity, also often have unique spatial characteristics, such as the tight, narrow, hard street spaces of Beacon Hill; the confined spaces of the alleys and tunnels; or the openness of the waterfront. Most other spaces seem quite fuzzy, often because they are formally ambiguous, and often because the foreground sound is so opaque that the space is camouflaged--this is particularly true of busy streets, such as Washington. Then there are some other spaces which sound much larger than they really are, such as Ashburton Place (5), which because of its hillside position and the general openness of the area beyond, receives sounds from as far as Charlestown and the West End commercial center. Of all the settings, Beacon Hill seems to inform one best of its location in space relative to the rest of the city. This is partly because the foreground sounds are low level, and hence more transparent, and partly because it is a hill, with spaces that bring in sound views from many directions. Except for airplanes, thunder, and sometimes boat whistles, there are few sounds which cover the city as a whole. Most sounds have only local territory, the bells of the Common being one of the few sounds which has district appeal. These are audible from within Beacon Hill to as far as Atlantic Avenue.

Thus far, the concern has been with the identity of settings relative to one another over a relatively limited time. If the same settings are compared over a longer period of time, and at many times of day and week and under different weather conditions, one finds few continuities but many contrasts. Cars blur most settings on busy weekdays, particularly between 10:00AM and 5:30 PM. There seems to be much more clarity or identity of settings on early mornings, evenings, and Sat-

urdays or Sundays, although Sundays are often extremely dull, unless there is a parade or celebration. Higher humidities, particularly rain or snow, slow the speed at which sound travels and filter high frequencies, having a shrinking effect on the soundscape.

The most continuous or constant settings with the least variation in sound seem to be 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 seem quieter than other places. Interestingly, these are the same settings mentioned as the most unique and informative at the beginning of this section. The sounds which occur most continuously over time include cars, planes, and more subtle sounds like the bells of the Common, the doors of Beacon Hill, the fan on Doane Street, and the buzzing sign on India Street. These are few indeed. Among the most changing settings are the Market area, which dies a sudden death after hours and India Wharf, which sounds like a parking lot next to a busy street on weekdays, but which can almost sound like a waterfront at midnight or on a weekend.

2. DELIGHT

The sounds of the alleys are among the most pleasing because they are quite identifiable and normally stand in high contrast to other events in the sequence, and more importantly, because they allow personal involvement. Here a person can play with the sounds of his footsteps and voice, using the space as a resonating chamber. Also, one has a greater sense of self here because the spaces are quieter than most others and are an escape from the menacing roar of traffic.

There are few other settings which permit this type of involvement, but Beacon Hill has it to some extent and one can sense the intimacy of the area, both by echoing footsteps and doors, and close voices which call back and forth. Washington Street, particularly near Filene's corner, presents a thick texture of fuzzy human sounds, punctuated by policemen's whistles, and since the sounds are close and swarm about the listener, they also involve him, but in a different way than do the alleys. The sounds are nevertheless pleasing.

Moving cars without a doubt are the least delightful sounds since they are usually loud, close, uninformative, and usually very attention-demanding. Airplanes and sirens are similar if present too long. Traffic sounds also have the highest sound levels, large territories, and high masking effects, with a sound spectrum that is quite high in intensity for all frequencies, and hence more annoying. (See sound spectra diagrams, Map III). Their presence often blankets 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.

3. VISUAL-AUDITORY CORRELATIONS

Some of the relations between sound and visible activity and spatial form have already been touched upon. To repeat, there seem to be quite high correlations between the sounds of settings with high identity, the amount and variety of visible activity, and the uniqueness of the spatial form.

According to the hypothesis stated in Part I, the most dominant visual-auditory settings would be expected to have sounds and sights which support one another, in addition to being informative and unique. Beacon Hill and the Central Artery best satisfy these requirements according to this analysis, although the movement of most of the cars on the Central Artery is not visible. Filene's corner and Washington Street follow close behind, but the spatial form is not supported as clearly in sound as is the activity. The alleys are also highly correlated, but are not highly unique with respect to one another, as has already been mentioned.

The settings which have sounds supportive of the sights are few, but the failures are many. For example, India Wharf and the Common communicate their activity and form far better visually than sonically. The same is true of the Customs Tower area, which visually is a landmark, but which has few and undistinguished sounds. And Ashburton Place is expansive to the ear, and fresh like the ocean, but in comparison to its sounds, it looks small, disordered, and junky. One can imagine that if the analysis were to be extended to attempt pleasing all of the senses, no places would be found that satisfy.

THE SEQUENCE I.

THE SETTINGS

1. Pinckney Street
2. Joy Street at Mt. Vernon
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

SCALE: 1" = 200'


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SOUND TYPES II.

1. LOCALIZED SOUNDS


people standing and talking


voices with accents


children playing


hawkers


whistling or singing


people above


dogs


birds


doors opening and closing


paper bags crinkling


music


construction or destruction sounds


boxes scraping on pavement


buzzing sound


vent fan


chimes

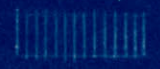

water dripping


water flowing


boat whistle


train whistle


distant roar


wind


echoes


creaking boat


distant sound

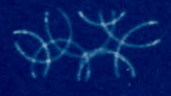

range of sound

2. FLOWING SOUNDS


vehicles: trucks, cars, buses, motorcycles


MTA


airplanes


moving people: footsteps and voices

(Symbol sizes are proportional to the subjective dominance of sounds)

1" = 200'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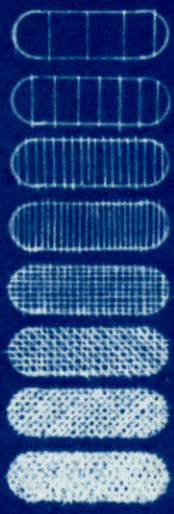
SOUND LEVEL & TERRITORY III.

1. SOUND LEVEL



10-20 db
20-30 db
30-40 db
40-50 db
50-60 db
60-70 db
70-80 db
80-90 db

high masking effects

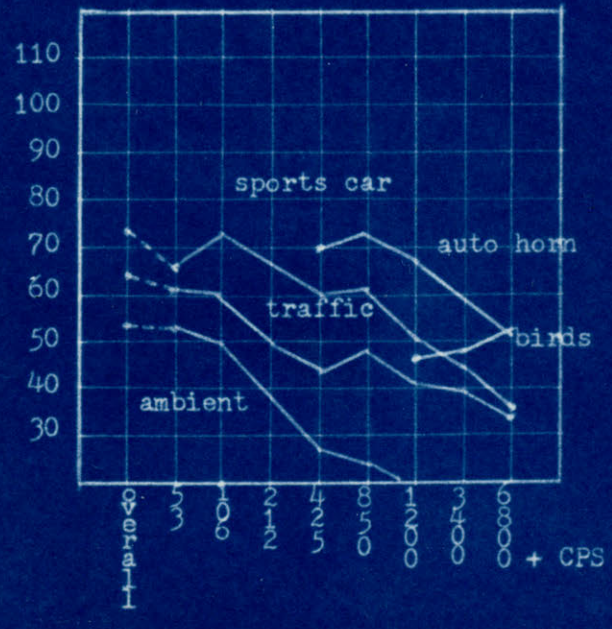
1" = 200'

2. TERRITORY

range within which sound can be distinguished

3. SELECTED SOUND SPECTRA

a.



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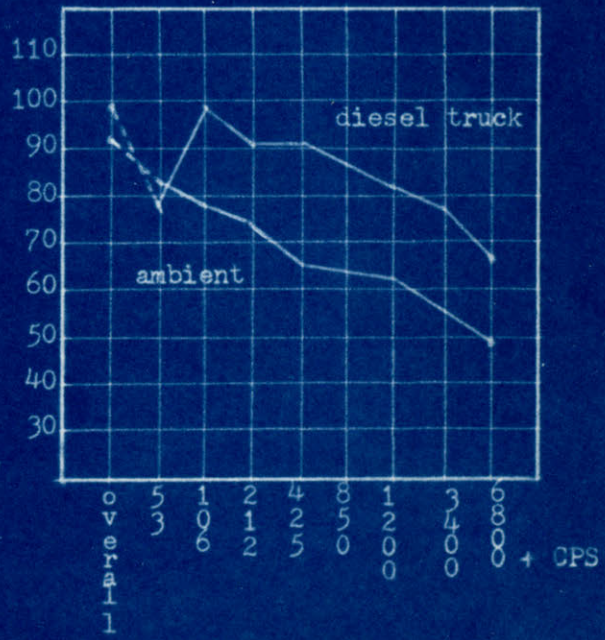

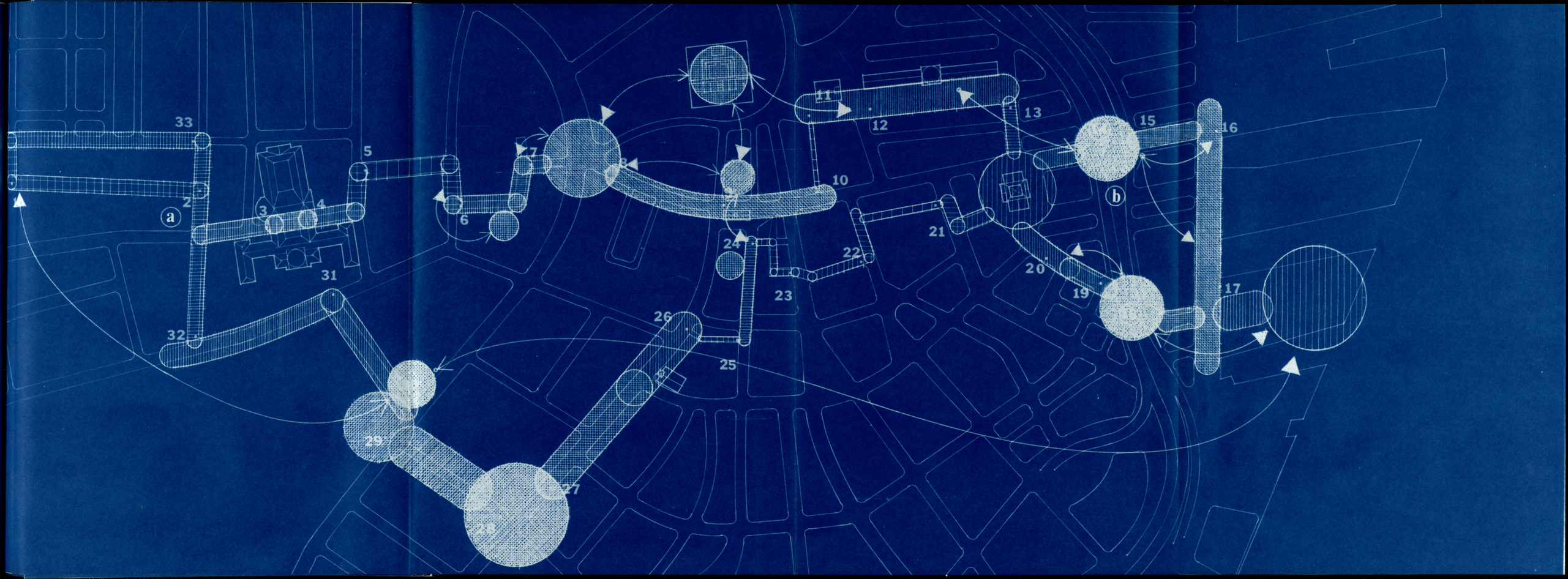
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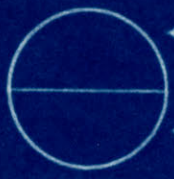
TEMPORAL PATTERN IV.



daytime occurence

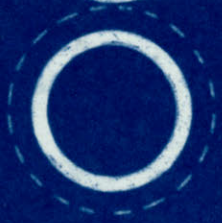
night-time occurence

year-around occurence

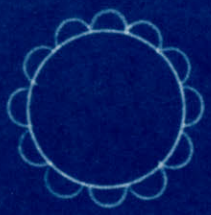
little day-to-day change except for a decrease on Sundays

year-around occurence

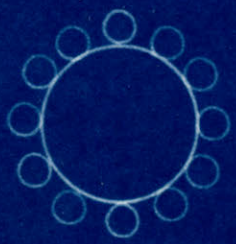
little day-to-day change



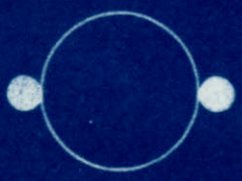
increase in sound level during weekday work hours



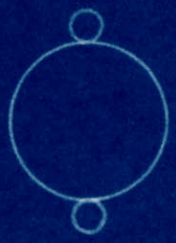
temporary occurence (several weeks to a few months)



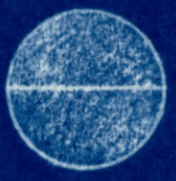
seasonal change in sound content



absent on Sundays

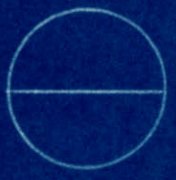


change in sound conten on Sundays



continuous flowing sounds

intricate close-spaced rhythm of sounds



few sounds

regularly recurrent sounds

one to three hour intervals

regularly recurrent sounds

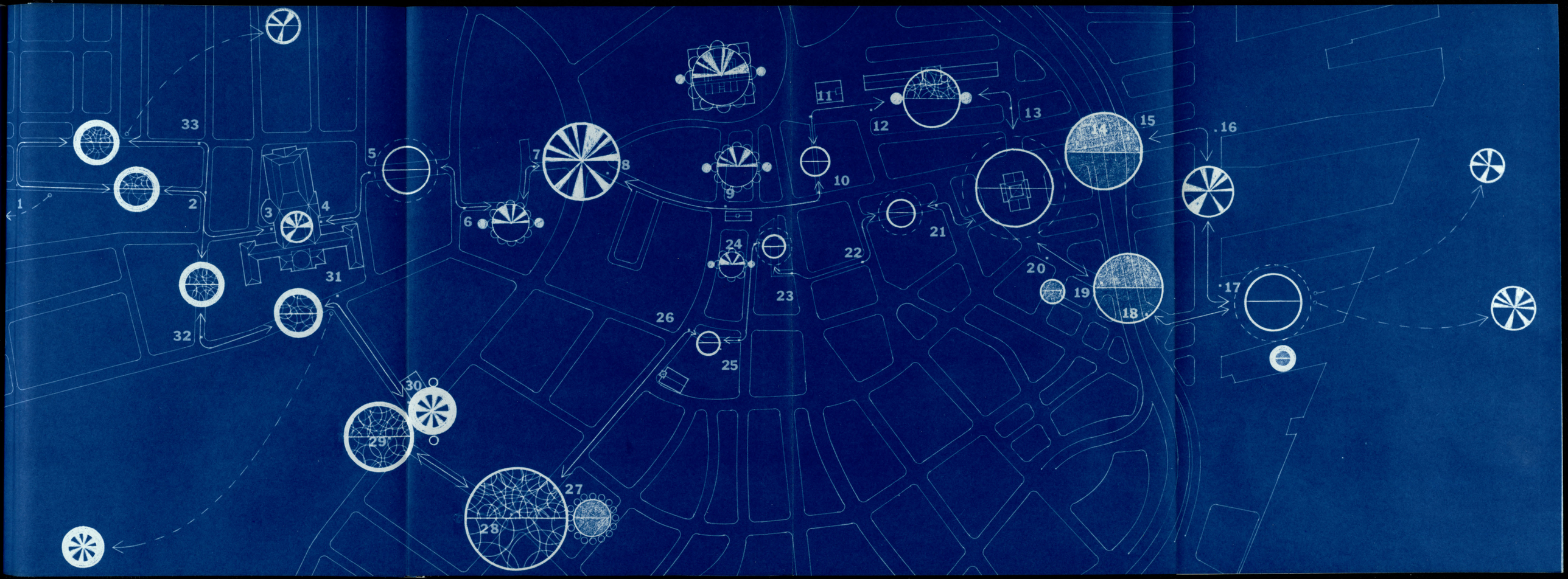
three to eight hour intervals

irregularly recurrent sounds

up to three hour intervals

irregularly recurrent sounds

three to eight hour intervals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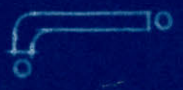
SYNTHESIS V.

1. INFORMATIVENESS

sounds which inform one of visible and hidden activity



sounds which inform one of spatial form

2. UNIQUENESS

sounds which are novel in relation to the setting and to the sequence

3. ATTENTION-DEMANDINGNESS

sounds which demand attention

4. RESPONSIVENESS

spaces which allow sonic interaction

5. TEMPORAL CONTINUITY

settings which have day-to-night, day-to-day, and seasonal continuity of sounds

1" = 200'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ACTIVITY FORM VI.

1. VISIBLE LOCALIZED ACTIVITY (audible)

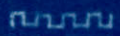
children playing

hawkers

policeman with whistle

truck loading

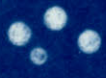
building construction or destruction



dripping water

moving fan

birds



people standing, talking, sitting, looking

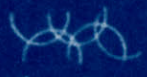
1a. VISIBLE LOCALIZED ACTIVITY (inaudible)

selling and buying in shops

flowing water

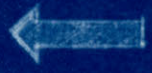
blinking sign

2. VISIBLE FLOW ACTIVITY (audible)



people walking

people shopping



vehicular traffic

airplanes overhead

view to moving traffic

view to moving ship

view to airplanes landing and taking off

3. HIDDEN LOCALIZED ACTIVITY (audible)

dwelling

4. HIDDEN FLOW ACTIVITY (audible)

MTA

Central Artery

1" = 200'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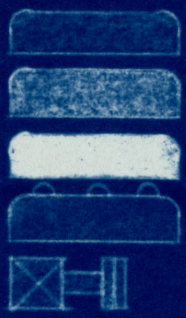
SPATIAL FORM

VII.



1. BULK & SPACING

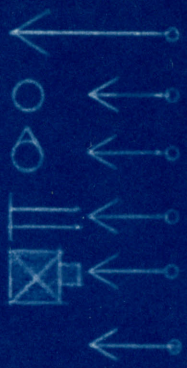
1-6 stories

7-12 stories

18-24 stories

building projections (bay windows, awnings, etc.)

landmark



5. VISIBILITY

direction of view

distant vista

distant landmark

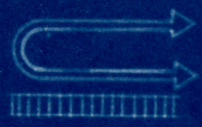
channel space with closure

landmark

open space

2. TOPOGRAPHY

10' intervals



6. LIGHT QUALITY

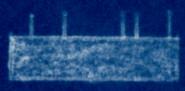
sunny

shaded

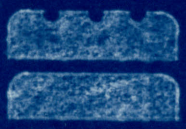
3. SURFACES

all surfaces hard except Common and the waterfront

4. TRANSPARENCY



high

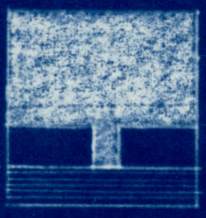


low

7. SIGNS

8. SELECTED CROSS-SECTIONS : 1" = 200'

a.



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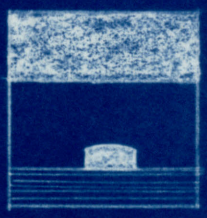

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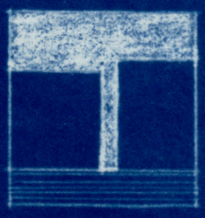
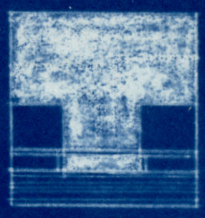


e.



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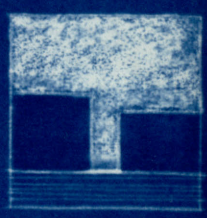

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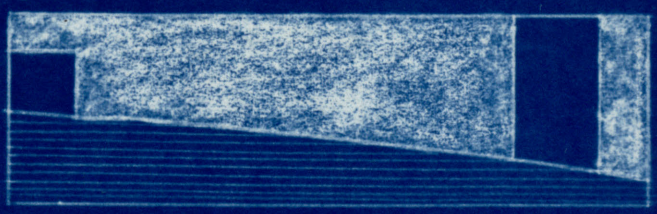
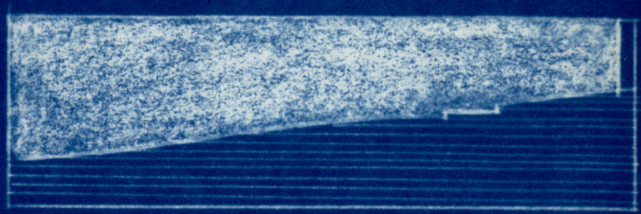


i.



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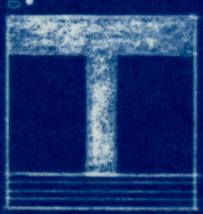

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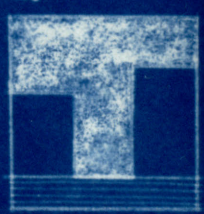


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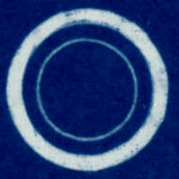
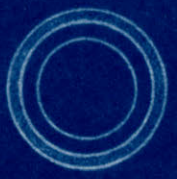
SOUND & VISIBLE FORM VIII.

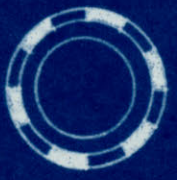
1. SOUND AND SPATIAL FORM



dominant sounds which are congruent with visible form

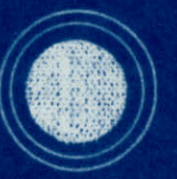


weak sounds which are congruent with visible form

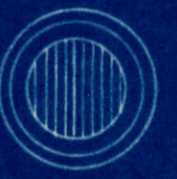


sounds which are uninformative or incongruent with visible form

2. SOUND AND VISIBLE ACTIVITY

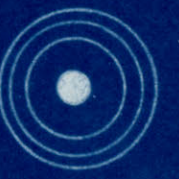


dominant sounds which are congruent with visible activity



weak sounds which are congruent with visible activity

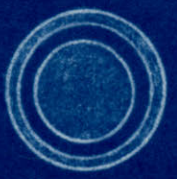
sounds which are uninformative or incongruent with visible form



little visible activity

EXAMPLES OF SYMBOL USAGE

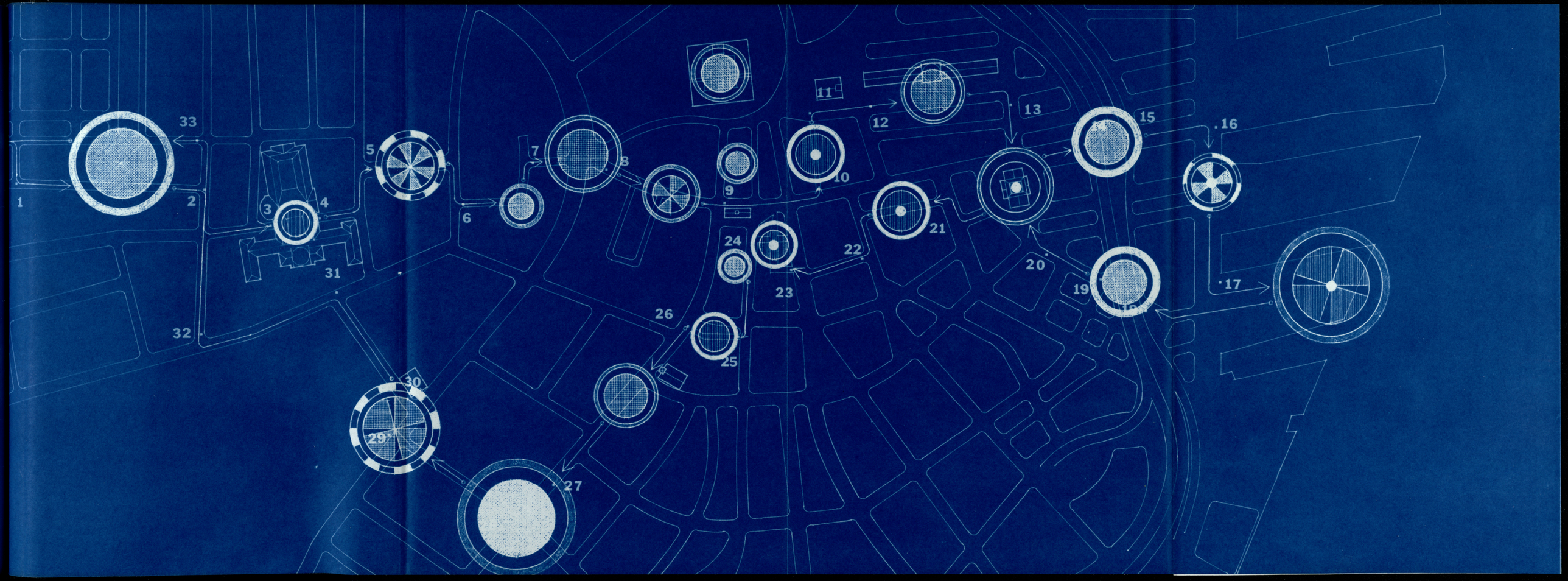
a setting with sounds that are informative of and congruent with visible activity and spatial form



a setting with sounds that are weak but which are congruent with visible activity and spatial form

a setting with sounds that are uninformative of and incongruent with visible activity and spatial form

1" = 200'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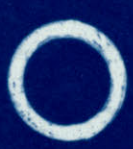
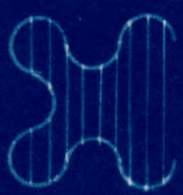
EVALUATION IX.

locality with strong visible and sonic form

district with strong visible and sonic form

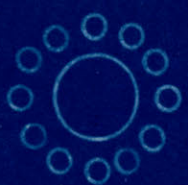


form which is strong visually, but weak sonically

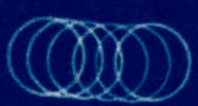


district which is strong visually but weak sonically

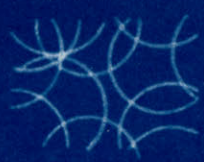
district which is strong sonically but weak visually



event which has high uniqueness or contrast with respect to the sequence



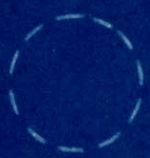
attention-demanding sounds which convey a low rate of information



district which allows high involvement with visible activity and form

setting which allows sonic interaction

setting with temporal continuity

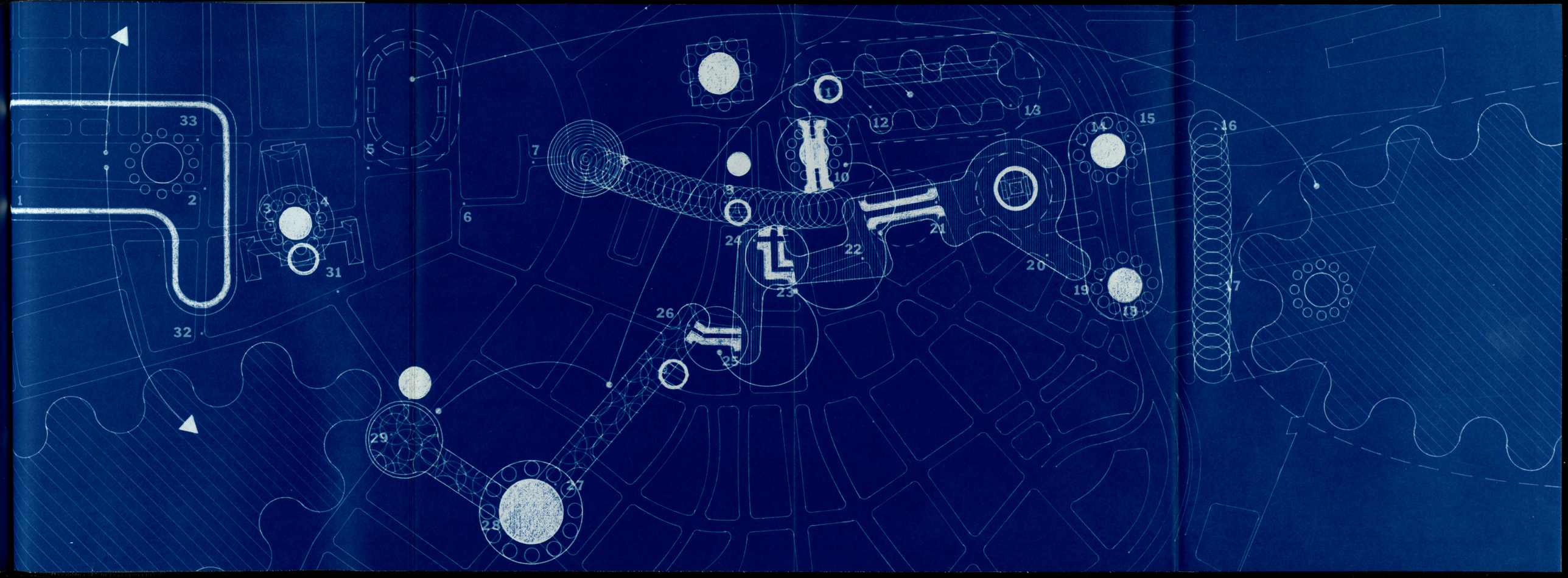


setting with little temporal continuity

setting with good sense of location with respect to the sounds of other districts

sequence which is visually redundant and sonically uninformative and eventless

settings with similar sound qualities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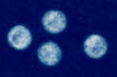
THE COMMON IMAGE X.

(auditory subjects)

1. LOCALIZED SOUNDS

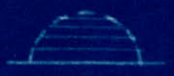

people standing and talking


doors opening and closing

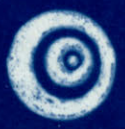

construction sounds


policeman with whistle


birds

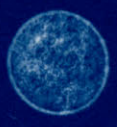

people above


fan


music


chimes


water

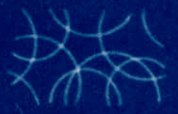

distant roar

2. FLOWING SOUNDS


vehicles

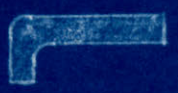

airplanes


MTA


people: footsteps and voices

3. SPATIAL SENSE

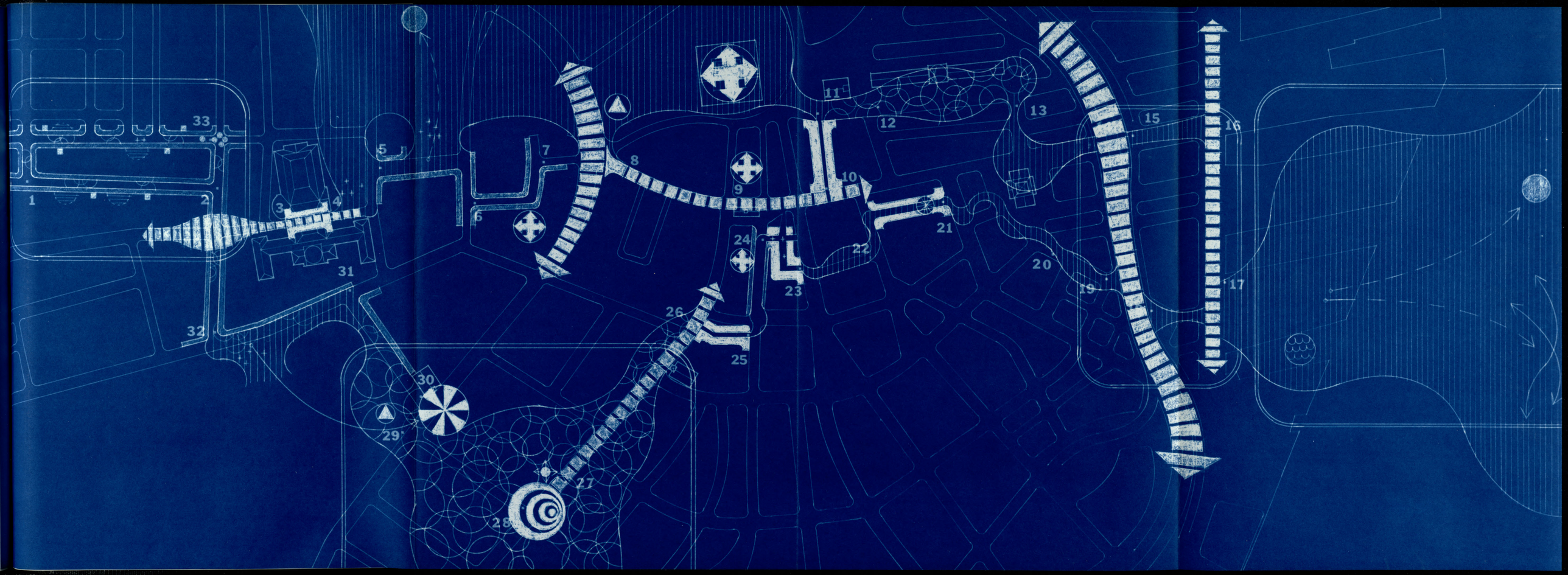

clearly defined with echoes


moderately defined


vaguely defined

4. MAJOR IMAGE DISTRICTS

1" = 200'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PART II: THE EXPERIMENTS

II. THE EXPERIMENTS

Two experiments have been performed to test perception of the soundscape in relation to the hypotheses and analysis presented in Part I. The purposes and methods of these experiments are discussed in Sections A and B; Section C presents the experimental results, and Sections D and E conclude Part II with a discussion of the limitations of the experimental results and some additional research hypotheses and experimental techniques. Experiment One is an investigation of auditory perception alone, and Experiment Two tests auditory perception in relation to vision.

A. EXPERIMENT ONE

The purpose of this experiment was to study perception of the sonic environment independent of vision with respect to the first two hypotheses presented in Part I. A primary concern was to determine how much one could tell about the city just by listening to it and also how perception of the soundscape changed over time and under varied weather conditions. A secondary purpose was to pretest experimental techniques for study of the non-visual environment in general.

Experimental Methods

Subjects were blindfolded and taken in a wheelchair on the same sequence analyzed in Section I, beginning with setting 1 and ending with setting 33. They were blindfolded in order to sensitize them to sound by eliminating visual stimuli. The wheelchair removed problems of anxiety which would have resulted from inexperienced blindfolded walking. The trip was given at different times of day and week and under different weather

conditions to study the temporal pattern of sounds.

Subjects were asked to tell what they could "see" as they took the trip, with the exception of subject #3, from whom feedback was not requested, in order to test his image with minimum reinforcement. All subjects were encouraged to use self-made sounds such as handclaps, whistles, or yells, in order to test the character of the spaces they were in. All comments during the trip were recorded in note form by an assistant. The note-taking technique slowed the usual one hour pedestrian trip time to between one and one half to two hours, with the exception of trip #3, during which the subject did not comment. After the trip all were asked to draw a map of the sequence as they remembered it. They were then questioned informally on their most memorable experiences and were asked to rank them according to their preferences; the same was done for sounds. They were also asked what kinds of clues told them the most about places, and how the trip could have been improved.

The Subjects

Five subjects were selected who were familiar with environmental design and who could be relied upon for reasonably articulate and meaningful expressions of their perceptions, since this is an area where vocabulary and experience are limited. All were familiar with Boston, but only one had fore-knowledge of the actual trip to be taken. The following is an outline of the subjects, their backgrounds, and the conditions under which the experiment was administered:

SUBJECT	SEX	DAY	TIME	TEMP.	HUMID.
1. Artist and designer	F	Sunday 4 Dec.	1:45-3:45 PM	38°	low
2. City Planning student (no feedback allowed)	M	Sunday 4 Dec.	4:45-5:45 PM	40°	low
3. Same as (2) to test	F	Tuesday 6 Dec.	1:50-3:50 PM	55°	low
4. Psychiatrist and researcher in perception of the blind	M	Tuesday 6 Dec.	9:40-11:05 PM	48°	low
5. Professor of Urban Design (fore-knowledge of sequence)	M	Sat. 10 Dec.	3:10-5:00 PM	58°	high (light rain)

The results of the experiment are reported in Section C, along with the results of Experiment Two.

B. EXPERIMENT TWO

In this experiment, the main purpose was to investigate the interactions between perception of the visual and sonic environments with respect to the third hypothesis stated in Part I. Also, it was desired to continue exploration of the first two hypotheses, to refine the techniques of Experiment One, and also to explore some new techniques.

In order to test the interactions between seeing and hearing, a trio of subjects who were sensorially differentiated were exposed to the settings simultaneously. These were:

a. Audition:	subjects who could hear but not see
b. Vision:	subjects who could see but not hear
c. Audition and Vision:	subjects with normal hearing and seeing

This subject specialization facilitated the analysis of sensory interactions because responses to settings could be analyzed separately, as well as together. Since the soundscape is so changing, it was imperative that each group be exposed to the settings simultaneously. Although it is extremely difficult to prevent the sensitization of subjects to either audition or vision, the hearing and seeing subjects acted as controls on other subjects, being unspecialized. Also, despite the visible apparatus, most subjects did not know what was being tested.

Auditory subjects were blindfolded and in a wheel-chair as before, since this had proven fairly successful in Experiment One. Some of the problems with this method will be discussed following a presentation of the

experimental results.

Visual subjects wore ear plugs and ear protectors or ear muffs. Research has shown that it is impossible to attenuate sound in the human ear without building a suspended anechoic chamber around the body. Even if the auditory canal were completely closed by an ideal ear plug, only one hundred decibels would be attenuated. In addition, fifty to sixty decibels enter through the skull bones, and also, fairly large amounts enter through the chest and abdomen. The most successful attenuation for this experiment proved to be a combination of ear plugs and ear protectors. FLENTS wax ear plugs were placed in the auditory canal, and a set of MSA NOISE-FOE EAR PROTECTORS with a grease-seal were placed over the ears; these are cup-shaped and are attached to a compression band. This arrangement effectively eliminated most sounds, except for very close ones or very loud ones. Voices could be heard faintly at two to three feet and a humming sound could be heard when cars were close. Also, sirens or other shrill sounds tended to penetrate. Subjects who are blind and deaf would have made the experiment more simple, but less successful, because they have become too specialized, and probably could not have given responses which are as valuable in designing for seeing and hearing people.

All subjects were given portable transistor tape recorders and were asked to respond spontaneously to the sequence. There were no questions during the trip. The detailed instructions for each subject varied somewhat, depending upon the sensory mode. (See Appendix A) All subjects were instructed to stay as close to one another as possible without being able to hear one another's comments. A monitor lead the

parade, followed by the visual-auditory subject, the visual subject, and the auditory subject, respectively. The wheel chair was last since it would often have been more interesting for the seeing subjects to watch this phenomenon than the settings.

Following the actual trip, subjects were asked to draw a rough map of the sequence as they remembered it, similar to Experiment One. Then they were asked to list the most dominant places, and those which they liked best, and those which they liked least. In addition, hearing subjects were questioned on their expectations, that is, which places they would have expected to have the most dominant, the most pleasant, and the least pleasant sights. The same was done for sound settings with the seeing subjects. Those who could see and hear were questioned on the dominance and their preferences for sound settings. Finally, they were all asked how the trip sequence could have been improved for them. (The detailed questions are contained in Appendix A.)

As in Experiment One, subjects were selected who could be counted upon for articulate and relevant responses. All were college-educated and most were familiar with environmental design. The fifteen subjects were divided into five groups of three each. An attempt was made to administer the experiment to each group under as similar conditions as possible. It was given on two successive Saturdays with very similar weather conditions between 10:00 AM and 4:00 PM, just as was the analysis of Part One. As mentioned earlier, this time was chosen because the soundscape seemed more informative and diverse than it would have on either a weekday or Sunday.

The following is a list of the subjects, and the times and conditions under which the trip was taken:

		SUBJECT	SEX	DAY	TIME	TEMP.	SKY	HUMID.
1.	A	Professor of Urban Design	M	Saturday 18 March	10:55-11:10 AM	42°	clear	39
	V	City Planning student	M					
	A+V	City Planning Student	M					
2.	A	Architect	F	Saturday 18 March	1:20-2:30 PM	39°	clear	57
	V	Artist	F					
	A+V	Artist	F					
3.	A	City Planning student	F	Saturday 18 March	3:00-4:05 PM	39°	partly cloudy	62
	V	Artist	F					
	A+V	City Planning student	M					
4.	A	Psychology student	F	Saturday 25 March	11:45-12:55 PM	40°	clear	65
	V	Communications analyst	F					
	A+V	Language Instructor	F					
5.	A	Musician	F	Saturday 25 March	2:30-3:45 PM	40°	clear	65
	V	Architect	F					
	A+V	Architecture student	M					

A = Audition; V = Vision; A+V = Audition and Vision

C. THE EXPERIMENTAL RESULTS

In general, the experimental results support the hypotheses presented in Part I. Briefly:

1. IDENTITY: Uniqueness and Informativeness

The most dominant settings were those which were most contrasted or most unique, relative to all other settings and the immediately preceding and following events in the sequence. They also tended to be more informative of the spatial and activity form, with the novel sounds being more informative than the redundant ones.

2. DELIGHT

The preferred settings, in addition to being high in uniqueness and informativeness, were most responsive and allowed greater receiver involvement, while settings which were least preferred were less informative, redundant, and generally very attention-demanding, having higher intensity and frequency sounds.

3. VISUAL-AUDITORY REINFORCEMENT

The dominant visual-auditory settings had visible activity and spatial characteristics that were supported by the sounds, with both the sonic form and the visual form being unique and informative. Settings with non-supportive visual form, that is, form that was weak or contradictory with the sounds, were less dominant.

The results will be presented in relation to the hypotheses and will be discussed for auditory, visual, and visual-auditory subjects both independently and as a group.

1. IDENTITY

The Interviews

For Experiment Two, the sound settings which had the greatest number of total choices in terms of dominance for auditory and visual-auditory subjects on the basis of the interview were:

1. Washington Street and Filene's corner
2. India Wharf
3. Central Artery
4. Beacon Hill
5. The Common

Of these, Washington Street received the highest average ranking for auditory subjects, while the Central Artery was ranked highest for visual-auditory subjects, with Washington Street close behind. Also, the Common was more dominant for visual-auditory subjects than for auditory subjects, whereas, Beacon Hill was far more dominant for auditory subjects, in terms of sound. This would be guessed to be true because the Common was more informative to the eye than to the ear, but the visual qualities helped seeing people to hear more or to remember it better. It is less clear why the sounds of Beacon Hill were less dominant for visual-auditory subjects, but perhaps the visual image is more powerful than the sound image, and is consequently remembered primarily visually. Also, the Central Artery received no choices for auditory subjects, but many for visual-auditory subjects. This may be because its sound tended to blend in with the many other car experiences for auditory subjects, but when its sound was coupled with its strong visual form, this helped the visual-auditory subjects to single it out.

The following table presents the total choices and average rank for the dominant settings as evaluated by auditory and visual-auditory subjects.

TABLE ONE: The Dominant Sound Settings: Auditory and Visual-Auditory Subjects

SETTING	TOTAL CHOICES	AVERAGE RANK
AUDITORY SUBJECTS		
Washington Street	5 (1)	1.2 (1)
India Wharf	5 (1)	2.8 (2)
Beacon Hill	4 (2)	3.8 (3)
VISUAL-AUDITORY SUBJECTS		
Central Artery	5 (1)	2.0 (1)
Washington Street	5 (1)	2.2 (2)
India Wharf	3 (2)	3.0 (3)
Common	3 (2)	3.0 (3)
AUDITORY AND VISUAL-AUDITORY SUBJECTS		
Washington Street	10 (1)	1.7 (1)
India Wharf	8 (2)	2.9 (3)
Central Artery	7 (3)	2.4 (2)
Beacon Hill	6 (4)	4.5 (5)
Common	5 (5)	3.0 (4)

These results are very similar to those of Experiment One with two exceptions. First, the alley and tunnel spaces were very dominant, both in experience and memory in Experiment One. In the second experiment, however, these were very remarkable during the trip, but tended to drop

out in the interview, with the exception of the maps. This may be due to variations in the experimental methods, since subjects of Experiment One were encouraged to interact vocally with spaces much more. Second, India Wharf was much less dominant for Experiment One subjects, probably because its sounds changed greatly from one exposure to another, and during at least two of the Experiment One trips, the Wharf was filled with parked cars. Consequently, the most dominant sounds were foreground sounds of cars and people, in contrast to the second series of trips, when most sounds were distant ones.

When the visual subjects were asked which settings they would expect to have the most outstanding sound qualities, they found it much more difficult to reach agreement than did the other subjects. Several settings received two choices, but none received more. These were India Wharf, Washington Street and the Market Area, and the Common, with average rankings in that order. Beacon Hill received no choices, nor did the Central Artery. This will be discussed further in relation to visual-auditory reinforcement.

The Maps

The map and the interview responses of Experiments One and Two generally agree. The most-indicated areas on the maps were Washington Street and Filene's corner, India Wharf, Beacon Hill, the Central Artery, and the State House tunnel. These were shown by all auditory subjects in Experiments One and Two. Several Experiment Two auditory subjects represented other reverberant spaces such as the alleys, in addition to the most-represented State House Tunnel and Central Artery. This is a dominance factor which did not appear in the Experiment Two interview. Also, the

Common was represented four times in Experiment Two maps of auditory subjects, but was not recognized as the Common in three of these cases, being described only in terms of its sounds. The map responses of visual-auditory subjects will be discussed in relation to visual-auditory interactions, but are less relevant in this section, since dominant sound settings were not separated out.

Sound Mentions per Setting

A commentary analysis of the number of mentions of sound types and qualities per setting also gives some indication of the informativeness of the soundscape during the trips. The following areas had the highest number of mentions and also had highest dominance in the interview, but in a different rank order.

TABLE TWO: Sound Mentions per Setting

AREAS	SETTINGS	TOTAL SOUND MENTIONS (A and A+V)
1. Beacon Hill	1, 2, 32, 33	126
2. Washington Street	26, 27, 28	87
3. India Wharf	17	50
4. Common	30, 31	41

If the density of comments per unit of trip length is calculated, the list is different and favors those settings which were small but unique.

TABLE THREE: Sound Mentions per Unit of Trip Length

SETTING	SOUND MENTIONS PER 100 FEET (approx. ½ minute of trip time)
1. Filene's corner (27)	17.5
2. State House tunnel (3)	10.0
3. Central Artery (14,18)	8.5
4. Change Avenue (10)	7.6
5. Doane Street (21)	6.7

The settings with the greatest diversity of sounds mentioned appear to have been the Beacon Hill and Washington Street areas. (See Appendix B)

The Most-Mentioned Sounds

An analysis of the number and distribution of sound mentions by type also gives some indication of the informativeness of the soundscape. Cars and people are by far the most-mentioned, whereas sounds which would usually be more informative are much less mentioned. Also, auditory subjects were more attentive to sound than were the visual-auditory subjects. (See Table Four, p. 44) The table on page 45 indicates the settings which had the most-mentioned sounds. It is interesting to observe that Beacon Hill has the highest mentions of both car and people sounds. Since this setting also has the greatest variety of sounds mentioned, one is lead to conclude that both diversity and quantity of sounds to which people pay attention is also a function of the transparency of the sound setting.

TABLE FOUR: Most-Mentioned Sounds

	MENTIONS 0 25 50 75 100 125 150 175
Traffic	55555 55555 55555 55555 55555 55555 55555 55
People	55555 55555 55555 55555 55555 55555
Birds	55555 555
Echo space	55555 55
Quiet	55555 5
Water	55555 5
Planes	55555
Distant Roar	5555
Bell	555
Doors slamming	55
MTA squeal	55
Radio	55
Police whistle	55
Whistling	5
Paper crinkle	5
Horns	5
Long whistle	5
Machines	4
Wind	3
Metal clank	3
People above	3
Overhead motor	3
Construction	2
Motorcycle	2
Sirens	2
Bicycle buzz	2
Dragging noise	2
Dogs	2
Small sounds	1
Street cleaning	1
Bouncing ball	1
Horse clopping sound	1
Screech of mailbox	1
Squeal of rags on window	1
Telephone bell	1
Hum	1
Something falling	1
Cart	1
Boat creaking	1
Flag flapping	1
Kitchen sounds	1
Cane on pavement	1
People kicking ash cans	1

5 = five mentions by auditory subjects
5 = five mentions by visual-auditory subjects

TABLE FIVE: Most Mentioned Sounds per Setting

Settings in order of total mentions	Sounds in order of total mentions →									
	TRAFFIC	PEOPLE	BIRDS	ECHOES	QUIET	WATER	PLANES	DISTANT ROAR	BELLS	DOORS
Beacon Hill (1,2,32,33)	36	39	6		6			6	4	8
Washington Street (26,27,28)	16	37								
India Wharf (17)			7			9	12			
Central Artery (14)	21			5						
Scollay Sq. & Court St. (8,9)	21									
Market (11,12)	14					6				
Common (30,31)			5		3				7	
Change Avenue (10)				8	3					
Quaker Lane (21)			4	5						
State House tunnel (3)				6						
Ashburton Place (5)								3		

Notes on Subject Commentary

Informativeness

Contrast appears to have been an important characteristic in determining what sounds people paid attention to. When sounds were prominent against their backgrounds, like the fan on quiet Doane Street, the pigeons at Quaker Lane, or the doors and people on Beacon Hill, they had more meaning for the subjects. Contrast with events immediately before or after was also important in determining an event's significance--the quietness of Doane Street and the noisy Central Artery seemed to reinforce one another, being in close sequence and of high contrast.

The irregular sounds tended to be more informative than the redundant sounds, and subjects also paid relatively more attention to them. The general sounds of cars, crowds, or many people walking usually fell into the background and didn't convey much information, other than about very general activity. But the music on Filene's corner, the blind man playing the guitar, the policeman's whistle on Washington Street, the boat creaking at India Wharf, the bells on the Common, and the old men talking in front of Beacon Chambers on Myrtle Street were all noticed and remembered and told much about the setting and helped to identify it.

Spatial Perception

Spaces seemed to be most meaningful and could be perceived most clearly when subjects could interact with the space using their own voice. The alleys, State House tunnel, and Central Artery were clearly recognized by all auditory subjects and were also quite well remembered, particularly in Experiment One. The widths of these spaces and the heights were fairly easy to judge. Most found them to be pleasant places, being in-

timate, quiet,and very responsive to sound, allowing one to "live in the echoes", as one subject stated.

Larger spaces were much more confusing and people judged them differently, but Boston was judged to be more spacious when listening than looking. Heights of buildings were hard to assess, and most subjects sensed the five-foot retaining wall in front of the State House as a three or four story building. The Common and India Wharf were not perceived as particularly large spaces by most subjects in Experiment One and by some in Two, but small Ashburton Place was seen as a huge open expanse, and was often mistaken for the waterfront.

Overhead sounds were confusing when at a distance of about a block and were often sensed as being sub-surface and it was sometimes difficult when under the artery for subjects to tell whether it was overhead, in front, or behind.

In addition to testing the character of spaces by using their own voices, whistling, or clapping, subjects found the masking effects of buildings to be informative. Moving cars also told of the direction of street spaces, and their speed was usually correlated with the openness of the street. The sound fill of spaces was informative if fairly transparent, like a few footsteps, doors closing, or a few voices, but an opaque background sound, like the hum of Washington Street, camouflaged most feelings for the space, other than what could be deduced from the congestion.

Temporal Pattern

The results of Experiment One indicate that the sounds heard varied much depending on the time of day and the day of the week. Weekend and evening trips were more imageable than weekday trips, which were homogenized by background sounds. For the subject who took the trip twice, once on a Sunday afternoon, and once on a Tuesday afternoon, there were few continuities and many contrasts between trips, in fact it was doubtful whether it was the same trip. The weekday afternoon trip was generally less informative and more dull because the generallevel of background sound (cars and people) was raised and tended to mask the more subtle irregular sounds. For this subject, the "water space" at Ashburton Place disappeared on Tuesday when the Government Center construction sounds were dominant. The interpretation of sounds also varied, depending upon the background against which they were heard. Doane Street, which on Sunday had been an empty warehouse district with the hum of a fan, on Tuesday became a residential area with people hanging their heads out of windows. The alleys, which had been high points on the Sunday trip because of their quietness and echo qualities, became less important when there were people in them. Also, the sound of pouring water at India Wharf was taken to be a car on the first trip, when the background sounds were cars, but was heard as water on the second trip, when gulls were flying over and the car sounds were absent.

Continuities between trips were the Washington Street activity and Filene's Musak, Park Station, with its hawkers and crowds of people, Beacon Hill and its residential sounds, the State House tunnel, and some major roads like the Central Artery, Cambridge Street, and Atlantic Avenue. (See diagram, p. 48)

CONTRASTS AND CONTINUITIES IN SOUNDS OVER TIME

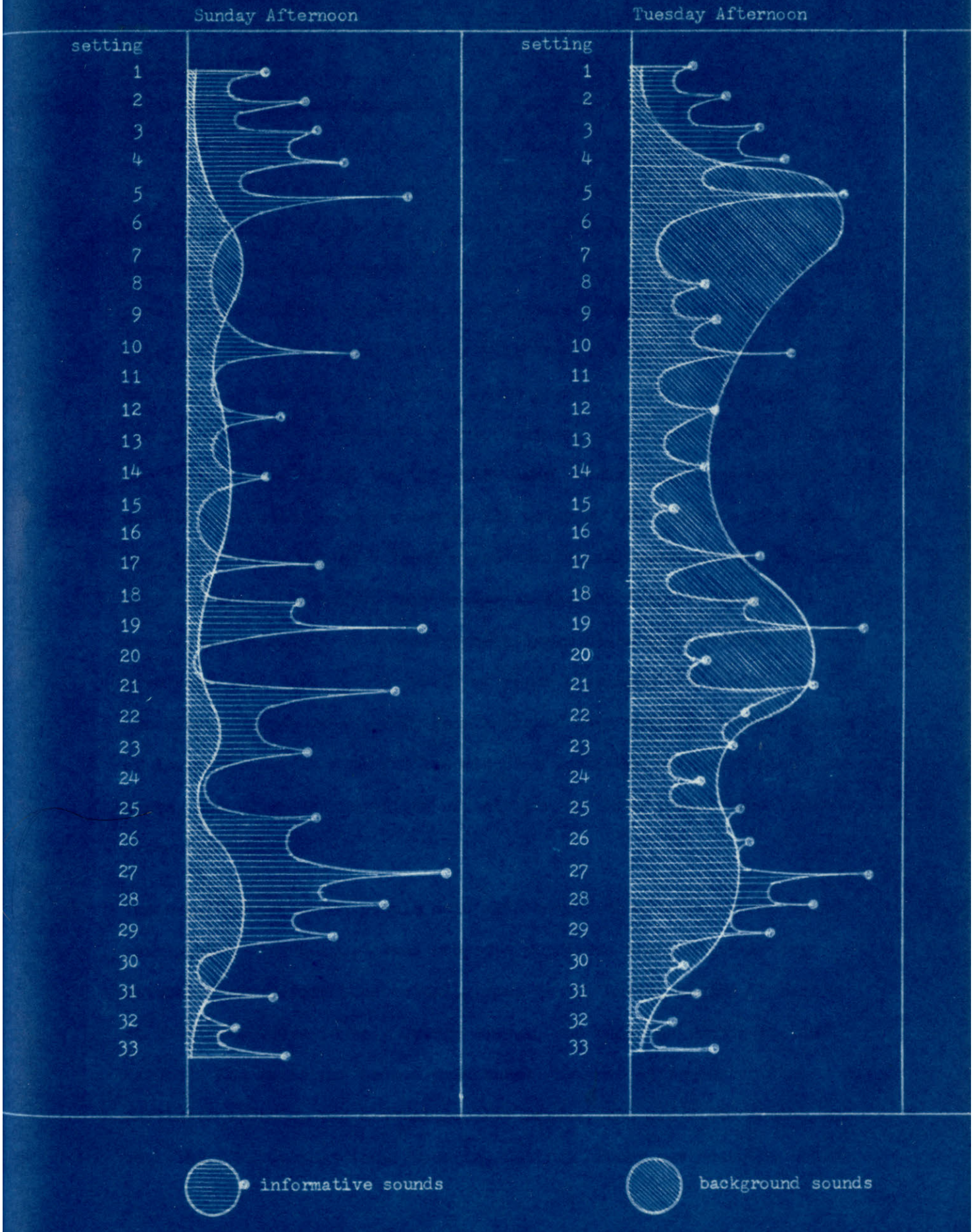

Image Quality

The images which subjects held were often caricatures of the real world and were invented on the basis of only small clues. For several, the State House parking lot became the Common, complete with trees, grass, rolling terrain, and people on benches, only because a few pigeons were heard and there was a general feeling of openness. Ashburton Place conjured up the waterfront for several subjects because it was generally quiet and the sounds heard were distant ones, it was windy, and there was a feeling of openness because one's voice was lost in the space. The place is distant from the water, however, and is not nearly as spacious as it was sensed to be. On the other hand, India Wharf on a weekday was not even perceived as being on the water by two subjects of Experiment One, but instead became a lower class residential community on the basis of a few voices on boats, cars moving on the wharf and at Atlantic Avenue, and a radio; it seemed to be a lower class area because of the careless, loud talking, the sound of paper blowingon the ground, and occasional broken glass which people kicked when walking. Other instances of invention were the Market becoming the North End when an Italian was heard, and often the footsteps of only two or three people were interpreted as a crowd.

The expectations which people held also helped them to interpret erroneously what they heard. Some subjects perceived the Central Artery several times before they actually came to it, having sensed it earlier at the State House tunnel, Change Avenue, and under an awning at the Market! The water was sensed prematurely by some at Ashburton Place, as mentioned earlier, and also at Scollay Square, the Old State House, and near the U.S. Customs tower,when the Central Artery was heard as water.

But when the water was actually approached, it was expected to be the North End by some and the sound of real water was heard as cars!

The structure of the sequence as represented in the maps of auditory subjects was very generalized and incomplete. Although the sequence of main events was clear and correct, it was generally imaged as a simple cycle with no irregular turns, and in several instances it was represented as being counter-clockwise rather than clockwise. Main events were usually packaged into clusters, with only vague connections between. Moving sounds like airplanes, cars, or the marching band which appeared one Sunday afternoon were very disorienting, especially when such events occurred in rapid succession. Kinetic hallucinations were also common, and it was difficult for many subjects to differentiate between uphill, downhill, and level movement.

Although all subjects were familiar with Boston, this knowledge was not particularly helpful in structuring the trip, even when there was foreknowledge of the exact trip, as was the case with one subject. Four subjects felt they had visited the North End and two others, Back Bay and the West End, but such was not the case.

2. DELIGHT

The Interviews

In Experiment Two, the most preferred sound settings are almost the same as the most dominant settings for auditory and visual-auditory subjects, the only difference being that the Central Artery drops out for the visual-auditory subjects. And again, Beacon Hill and the Common are not equally valued by both groups. The following table presents the total choices per setting and the average ranking of the settings by the subjects.

TABLE SIX: The Preferred Sound Settings: Auditory and Visual-Auditory Subjects

SETTING	TOTAL CHOICES	AVERAGE RANK
AUDITORY SUBJECTS		
Washington Street	4 (1)	1.3 (1)
Beacon Hill	3 (2)	2.0 (2)
India Wharf	3 (2)	2.3 (3)
VISUAL-AUDITORY SUBJECTS		
India Wharf	5 (1)	2.0 (1)
Common	4 (2)	2.3 (2)
Washington	3 (3)	2.0 (1)
AUDITORY AND VISUAL-AUDITORY SUBJECTS		
India Wharf	8 (1)	2.1 (2)
Washington Street	7 (2)	1.6 (1)
Beacon Hill	4 (3)	2.2 (3)
Common	4 (3)	2.2 (3)

The alleys were not mentioned by the subjects of Experiment Two as being among the preferred, but ranked high for the subjects of Experiment One, possibly for the reasons already discussed in Section One of this part. The expected sonic preferences of the visual subjects were again scattered, but interestingly contained two alleys, Quaker Lane and Spring Lane. Their other two choices were India Wharf and Scollay Square, which will be considered in more detail in relation to the visual-auditory interactions.

The least preferred sounds and sound settings in both experiments were cars. The Central Artery epitomized this dislike, and was number one for nine of the ten hearing subjects in Experiment Two, in fact, their conviction about this was so strong that no other settings were listed. Several auditory subjects did add, however, that car places in general, were unpleasant. The visual subjects, almost ignored the Central Artery, but expected Washington Street to be worst, in contradiction with the auditory subjects who ranked Washington Street as their number one preference.

Notes on Subject Commentary

Sounds seemed louder, and often more stressful when blindfolded, according to some subjects, particularly when the sounds moved fast and unpredictably toward the subject. However, two subjects grew to enjoy the sensation as it became more familiar, one subject remarking that the Central Artery was a rather grand "Piranesi experience" in sound. Another found a marching band which kept reappearing on a Sunday afternoon trip to be so disorienting as to be almost unbearable. High frequency sounds like whistles, bells, or the buzz of neon signs were

especially annoying to many subjects. Mechanical sounds in general seemed too repetitive and dull to many. Cars could be nice if they didn't move, but sat chugging like friendly animals. They also seemed pleasant to most when distant and fast-moving, such as the wave-like sound produced by the Central Artery when heard from the Market.

All subjects liked quiet, transparent, but informative places like Pemberton Square, Beacon Hill, or the alleys, and preferred the kinds of constantly varying soft personal sounds that people make, such as footsteps, fragments of conversation, whistling, or shuffling. The big, long, cool sounds of the waterfront were nice, as were "natural" sounds, such as wind, water, or birds, but several subjects found them too weak. The sounds of Filene's corner were delightful to all auditory subjects, one of whom remarked that it seemed as though he were being luxuriously bathed in humanity, a sensation which certainly would have evaporated had his blindfold been removed!

3. VISUAL-AUDITORY REINFORCEMENT

The Interviews

An attempt will now be made to determine some of the interactions between seeing and hearing, on the basis of Experiment Two. For all subjects, auditory, visual, and visual-auditory, Washington Street and India Wharf placed high in both dominance and average rank. Beacon Hill was high for people who could hear and the Common was high for people who could see. The following table lists the total choices for the most dominant settings and the average ranks for all subjects together, and separately.

TABLE SEVEN: The Dominant Settings: Auditory, Visual, and Visual-Auditory Subjects

SETTING	TOTAL CHOICES	AVERAGE RANK
AUDITORY SUBJECTS		
Washington Street	5 (1)	1.2 (1)
India Wharf	5 (1)	2.8 (2)
Beacon Hill	4 (2)	3.8 (3)
VISUAL SUBJECTS		
Quaker Lane	5 (1)	2.8 (2)
India Wharf	5 (1)	3.4 (3)
Washington Street	4 (2)	2.4 (1)
Common	4 (2)	4.3 (4)

(Table Seven Continued)

SETTING	TOTAL CHOICES	AVERAGE RANK
VISUAL-AUDITORY SUBJECTS		
Common	5 (1)	3.8 (3)
Washington Street	4 (2)	3.0 (1)
Beacon Hill	4 (2)	3.0 (1)
India Wharf	4 (2)	3.5 (2)
AUDITORY, VISUAL, AND VISUAL-AUDITORY SUBJECTS		
India Wharf	14 (1)	3.3 (2)
Washington Street	13 (2)	2.8 (1)
Common	11 (3)	3.8 (4)
Beacon Hill	10 (4)	3.5 (3)
Quaker Lane	6 (5)	3.3 (2)
Scollay Square	6 (5)	4.0 (5)

All of these settings are high in contrast with respect to their sequence position and activity and/or form type. For the auditory subjects, the selected settings had quite strong sonic, spatial, and activity identity. The selections of the visual subjects, on the other hand, tended to be stronger in visual than sound qualities, such as Quaker Lane and the Common. The responses of the visual-auditory subjects were a blend of both types.

Notes on the Subject Commentary

An examination of the trip commentary of both the auditory and visual subjects further substantiates the hypothesis that a correlation between sound and activity and spatial form matters. Washington Street and

India Wharf, respectively have the highest mentions of sounds that are related to the same activity and spatial form characteristics mentioned by the visual subjects. Four settings take third place. These are the alley and tunnel spaces: the State House tunnel, Change Avenue, the Central Artery, and Doane Street. These mentions also parallel the sound and form mentions of the visual-auditory subjects.

Interview Preferences

In stating preferences, the auditory and visual-auditory subjects are again in close agreement, with the visual subjects being more exceptional. The former picked the Washington Street, Beacon Hill, and India Wharf settings, which generally have both activity, spatial, and sonic dominance, while the visual subjects selected Quaker Lane, Spring Lane, and the Common, all of which are far stronger in spatial form than in activity form or sound. The following table presents these responses.

TABLE EIGHT: The Preferred Settings: Auditory, Visual, and Visual-Auditory Subjects

SETTINGS	TOTAL CHOICES	AVERAGE RANK
AUDITORY SUBJECTS		
Washington Street	4 (1)	1.3 (1)
Beacon Hill	3 (2)	2.0 (2)
India Wharf	3 (2)	2.3 (3)
VISUAL SUBJECTS		
Quaker Lane	3	1.7 (1)
Spring Lane	3	2.0 (2)
Common	3	2.0 (2)

(Table Eight Continued)

SETTINGS	TOTAL CHOICES	AVERAGE RANK
VISUAL-AUDITORY SUBJECTS		
Washington Street	4 (1)	2.5 (2)
Beacon Hill	3 (2)	2.3 (1)
India Wharf	3 (2)	2.3 (1)
AUDITORY, VISUAL, AND VISUAL-AUDITORY SUBJECTS		
Washington Street	8 (1)	1.9 (2)
Beacon Hill	8 (1)	2.1 (3)
India Wharf	7 (2)	2.1 (4)
Common	6 (3)	1.7 (1)

In terms of least preferred settings, the Central Artery ranked high for auditory and visual-auditory subjects, but the visual subjects slipped under, barely noticing it. It seems that the visual form had much less meaning without the sounds. When subjects were asked which settings had the least pleasing sounds, the auditory and visual-auditory subjects almost unanimously selected the Central Artery, as mentioned in Section Two of this part. But the visual subjects seemed almost oblivious of its presence, since it didn't roar in their ears and they couldn't see the traffic and didn't expect that its sound would be unpleasant. It seems again that the evaluative criteria of the visual subjects were quite exceptional; their least preferred setting was India Wharf and Atlantic Avenue, the Wharf being among the most preferred settings of the other subjects!

Notes on Subject Commentary

An examination of the trip commentary for the subjects who could not hear gives some clues as to why this may have been true. Just as the blindfolded subjects made far more mentions and closer observation of sounds than did the visual-auditory subjects, visual subjects were far more attentive to the visual character of settings and their eyes seemed to search continuously for new forms to play with, since there was little other novel sensory input. Sunlight was extremely important in attracting their attention, because it created a more contrasting setting and made the forms more differentiated and informative. Three-dimensional projections, such as bay windows, fire escapes, or awnings were mentioned far more by them, as were moving things, like blinking signs, or dripping water. Signs also received very high mentions, and in addition to providing momentary entertainment, informed them of activity which they couldn't get with their ears. They were also more conscious of textures and colors than the other subjects, and seemed to look for the hidden, and usually found it since they had few distractions. The cityscape was surrealistic in its peacefulness and in the way everything moving seemed to float quietly by.

But the city was also a very sad place for most of them, and was lacking in contrasts and was almost two-dimensional. For the first time, they were able to scrutinize it without the healing salve of sound. They found much more imperfection in its form than did the other subjects, particularly in settings which had little visible activity. The openness, the inactivity, the extent, and the redundancy of the waterfront along Atlantic Avenue and at India Wharf combined to make a supremely ugly experience because of its dullness and much more

apparent shoddiness. Washington Street, too, apparently sounded much better than it looked, and the cheap and garrish commercialism of this street was far more conspicuous to the visual subjects than to the others, who ranked it high in terms of preference. Elsewhere there were high mentions of garbage, dirt, cheap merchandise, and buildings and even people were criticized. Small intimate places were preferred, because they tended to change more quickly as one walked through them and were more unfolding. The form qualities of structures against the sky were also often admired and the absence of street-level sound seemed to free their eyes to the sky. As an example, the U.S. Customs Tower was noticed and remembered much more by the visual subjects than by the visual-auditory subjects. The following table illustrates the careful attention which the visual subjects paid to details of the cityscape in terms of mentions of visible form.

TABLE NINE: Mentions of Visible Form

ELEMENT	VISUAL SUBJECTS	VISUAL-AUDITORY SUBJECTS	TOTAL MENTIONS
Formal Details: facades, sculpture, doors, windows, proportions of masses and spaces, rooflines, etc.	121 (1)	30 (1)	151 (1)
Sunshine and Shadow	83 (2)	28 (2)	111 (2)
Animated Forms: water, blinking lights, flags, birds, ships, planes, etc.	66 (3)	15 (4)	81 (3)
Colors	64 (4)	14 (5)	78 (4)
Signs	36 (5)	25 (3)	61 (5)

(Table Nine Continued)

ELEMENT	VISUAL SUBJECTS	VISUAL-AUDITORY SUBJECTS	TOTAL MENTIONS
Projecting Forms: fire escapes, balconies, bay windows	35 (6)	11 (7)	46 (6)
Textures and Materials	36 (5)	9 (8)	45 (7)
Garbage and Dirt	31 (7)	12 (6)	43 (8)

In all cases, the visual subjects were far more attentive to the detailed form than were the visual-auditory subjects. Judging from the commentary, the latter group seemed to be much more involved in the activity of active settings, with the sounds being a strong bond, but they had less time for visual exploration. These subjects were also much more generalized in their commentary, synthesizing in broad outline fashion the general information drawn from several channels of communication but not attending carefully to any of the modes, except in the places where the messages of all modes were well-matched, as on Filene's corner, which thus demanded less overall attention than was necessary when there was no match.

Another illustration of the apparent search for novelty exhibited by sensorially deprived subjects is the perception of non-visual elements other than sound. The following table indicates that the subjects who received least information, the auditory subjects, were most attentive to these elements, in terms of mentions, and the visual-auditory subjects, who received most information, were least attentive.

TABLE TEN: Mentions of Non-Visual Elements

ELEMENT	AUDITORY SUBJECTS	VISUAL SUBJECTS	VISUAL-AUDITORY SUBJECTS	TOTAL MENTIONS
Smells	23 (2)	12 (1)	6 (1)	41 (1)
Temperature Sensations	24 (1)	8 (2)	3 (2)	35 (2)
Wind	19 (3)	6 (3)	1 (3)	26 (3)

In conclusion, it appears that sound settings which were dominant were more informative of spatial and activity form and were also rather unique or contrasted with respect to other settings in the sequence. Most settings were found to be sonically uninformative in terms of both spatial and activity form, and consequently lacked identity with respect to other settings, and also changed greatly over time. Also, the total range or diversity of sounds perceived was narrow. In addition to having the qualities of uniqueness and informativeness, the preferred sound settings were most responsive and increased the individual's sense of involvement. Least preferred settings were less informative, redundant, and usually very attention-demanding, having sounds of high frequency and intensity, which distracted from other interests.

When sonic and visual settings were coupled, attention to the visual form seemed to reduce the conscious perception of sound, and vice versa. But the added dimension of sound made city experience far more intense by building up contrasts and by increasing sense of involvement and the flow and rhythm of events, particularly if the sounds related to what was seen, and if what was seen was also animated. Settings tended to be more dominant when the sounds of a setting were correlated with

activity that was visible and form that was contrasting in type and sequence position. Visual-auditory settings that were judged as more pleasing were also more informative, and lower in attention-demandingness, thus allowing more choiceful interaction.

D. SOME LIMITATIONS OF THE EXPERIMENTAL RESULTS AND METHODS

The Results

1. The subjects were probably sensitized to what was being tested. Ideally, subjects would have no knowledge of the fact that they were being tested, but this is an almost impossible demand on an experimant such as this.

2. The subjects were few in number and nearly all were familiar with environmental design, for the reasons stated earlier.

3. Ideally, the sequence should have been designed with settings that would test the hypotheses in a clear-cut and orderly fashion by varying sound, visible activity, and spatial form one at a time. For example, the sequence used did not contain instances of high visible activity without sound, and only a few places with much sound and no visible activity.

4. All subjects were somewhat familiar with the area of Boston tested, and although they didn't know the exact sequence, they had good ideas where they might be and so may have listened for the sounds which they expected. Unfamiliar settings would probably have been better.

5. The trip was free of most real-world concerns, and it is more difficult to say how real city users with private plans would respond to the same experience and how attentive they would be to sound. The results presented here would probably most closely parallel the responses of persons whose plans are rather open, such as "to have

a good time", or "to go for a walk". But when these plans become more specific and goal-directed, this would no doubt narrow perceptions of the city, and those sights which helped or hindered most in the performance of the tasks would probably be most dominant. Tasks which required a sequence of intricate decisions, particularly under time pressure, would probably have the greatest interference effects with visual and auditory perception.

The Methods

1. The wheelchair method of navigation was better than walking, but was stressful to some, particularly at the beginning, and the vibration of the chair interfered with hearing and gave clues to the floor material. A better solution would be a highly-cushioned chair with huge pneumatic tires that would be resilient and silent.

2. The ear plugs were far from ideal, for the reasons mentioned earlier. But there is no way to improve markedly upon this without putting the subject in an anechoic box.

3. The tape-recording technique, although good was not ideal because of the machine used. The tapes lasted for only one-half hour, while the trip took one hour, and the subjects may not have felt as free to comment because of tape limitations. Also, subjects had to pay attention to the tape to check that it did not run out. Ideally the tapes should last for the duration of the trip so that subjects would not have to attend to the recorder.

4. Simultaneous feedback during the trip may have forced structure on the sequence which would not normally have existed, although the

responses of the subject who was tested without commenting during the trip were little different from the others.

E. SOME ADDITIONAL RESEARCH HYPOTHESES AND EXPERIMENTAL TECHNIQUES

Several more explicit hypotheses for additional experimentation develop from the results of Experiments One and Two. Most of these relate to visual-auditory interactions and are questions which must be answered before successful sonic design for seeing people can be done. Expressed in the form of questions, these are:

1. Do the events along a sequence in which the sounds are congruent with the visible activity have greater dominance or intensity than those of a silent visual sequence or one which is accompanied by interfering sounds?
2. Are settings which have much visible activity that is correlated with moving sounds more dominant than active settings with little or no sound, or inactive settings with correlated sound?
3. Are environmental experiences with supportive sounds learned and remembered better than those with non-supportive sounds or those with no sounds at all?
4. Do people become more attentive to sound as the input of visual information is reduced?
5. Does the location of sounds and their movement patterns affect significantly the elements attended to visually?

In order to test any of these it would be necessary to control the visual and auditory sequences independently. A workable method of doing this would be to make a film sequence and then to design several sound tracks to accompany it which are varied in relation to the visual material in accordance with the hypotheses being investigated. They could then be

tested on subjects in conditions similar to those of Experiment Two, in which one subject could see the film without the sound track, another could hear the sound track but not see the film, and a third could hear both together. A simplification of this would be to use slides which are paired with sounds, although this wouldn't be as relevant to the way in which cities are experienced.

A variation of this technique would be to follow the procedures of Experiment Two, but to add a subject who receives a specially designed sound track by means of a transistor recorder. Pace of movement would have to be correlated with the sound track, however, and the visual sequence could not be designed. The procedure could also be used in an automobile or subway sequence, and would be simpler in many ways because outside sounds would be cut off to a large extent and the rate of movement could be better controlled.

A second area in which further experimentation is needed is in the effects of individual purposes on perception. Information is necessary on the types of sounds and sights which help or hinder various types of tasks. This would be difficult to test, but a simple way of beginning would be to select a sequence as was done here and to then assign various tasks to several subjects which are to be executed on the specified route. It would not be possible to determine what was attended to during the actual performance of the task, but upon its completion, extensive interviewing could uncover much.

A third area for additional investigation is in the identity of sound settings. If a high fidelity recording of a city sound sequence could

be made, it would be valuable to test the ability of subjects who have taken the trip, or even randomly selected city users, to identify settings and to determine which characteristics of city sounds are most discriminable. Also, for subjects who have not taken the trip, expectation correlations could be tested by having them match the sounds with sights; and vice versa, slides could be shown and matched with sounds.

PART III: SONIC DESIGN

III. SONIC DESIGN

Some Criteria and Possibilities

If one were to journey around the world blindfolded and if he were only to listen to the cities visited, most would probably be indistinguishable from one another, except for spoken language. Exceptions might be Venice, because it has no cars (but it is getting motor boats); Istanbul, with its many bells and muezzins, calling people to prayer from minarets several times daily; or Cordoba, with its dramatic mid-day siestas that float a death-like silence over the scorching city, the trickling water in courtyard fountains being the only sign of life. American cities would most likely be among the most homogeneous. And if noise is a result of the progress of technology and has been increasing at the rate of one decibel anually for the last thirty years, as one author has stated, then the soundscape of the city of the future can be expected to be even less distinguished than the tiny sequence studied here, if there is no design intervention. To the author's knowledge, design of the sonic environment has never been done, or even contemplated at the city scale. Noise control attempts have been the closest, but are design in only the narrowest sense and are more concerned with silence than with sound.

If visual perception is as closely related to the accompanying sounds as the experimental results have indicated, this has real significance for city design--visible form conceived as an isolate can never perform as intended when the sonic form, or other non-visual factors, are not included. The design of the soundscape alone may be a way of making the city more visually delightful and acceptable to city users, and would

be economical, not requiring massive and costly face liftings or demolitions. Visually dull sections of the city might become vital if a new dimension of sound were to be overlaid. Or if it were desired to increase attention to visual material, novel sounds in the strategic places may do this, as they seemed to for the experiment subjects. Another but more difficult method of increasing visual attention would be to reduce sound to a very low level, as was well-illustrated by the visual subjects.

As stated in Part I, the existing soundscape does not satisfy the form qualities considered desirable in the research hypotheses. The general objectives for sonic design arise out of these failures and are:

1. To increase the diversity and informativeness of the soundscape.
2. To increase the number of opportunities for pure delight in sounds, particularly settings which allow individual involvement.
3. To increase the correlations of the sounds with visible form and activity.

The general blur of the daytime soundscape must be punctuated with contrasts and with more and new kinds of sounds. It appears that the types of contrasts most needed are contrasts of sound intensity and type, ranging from thin computer beeps to the thick chatter of a throng of people; or from the roar of a subway tube to quiet oases, such as the temple precincts of Tokyo, with damp lush foliage that mutes city sounds, and provides a serene setting for ritual bells and chanting. Such contrasts should also be correlated with visible form and activity, with accessible choices ranging from inactive, undemanding spaces to inter-

active, attention-demanding spaces with high novelty content. At the same time, greater identity and informativeness of sounds is needed for most settings, particularly those which have little visible activity, such as the sequence from the Customs Tower to Washington Street. Also, several settings like the waterfront are blotted out on weekdays and need more continuous identity to be visually effective.

Four types of form elements seem to have strategic design potential in terms of the objectives. These are:

1. Large open spaces
2. Signs
3. The sequence network
4. Small sonically responsive spaces

The large open spaces, such as the Common and the waterfront, are generally very quiet and the sounds are faint and not particularly supportive of the activity and visual form. Because of the high transparency in these settings, they are ideal testing grounds for the addition of sounds which are new and informative. The waterfront perhaps needs such sounds the most because of its visual redundancy, as illustrated by the comparison of the responses of visual and visual-auditory subjects. The existing airplane sounds, combined with the sight of the planes taking off, were among the most delightful events on the waterfront, but the weakness of the water sounds and the infrequency of moving ships and ship horns are disappointing. Water geysers and pleasure boats which call out destination-coded sounds would be attractive. Other possibilities would be bells or other big sounds which could sound at intervals from

opposite shores, or fireworks or luminous floating sculptures which would play over the harbor and which could be combined with sounds. Little can be done about the quietness of the gulls unless designers can swallow their pride and allow bird Musak. Large territory sounds in general are needed to dramatize the scale of the space.

The second area is in signs as sounds. Sonic signs have the advantage of being more attention-demanding than visual communication, and can also often conjure up images of the significant more successfully. The sound of steaks sizzling or of people drinking in a tavern would be more provocative advertisements than most verbal signs and would convey far more information, as did similar sounds in the experiment sequence. Sonic signs would be most effective when coupled with visual images and as an example, the sounds of people in Filene's basement could be played back at street level along with a TV image of the activity. This type of treatment would be particularly relevant in areas where much of the activity is hidden, such as on parts of Washington Street, the Market, or in the financial district and U.S. Customs Tower area, although signs as advertising would not be important in the latter.

The use of sound to communicate public information would also be appropriate. Just as chiming clocks tell the time of day, or sirens of an emergency, other symbolic sounds could be used to inform one of the weather, news, or of special events, such as baseball games, or concerts. The public sounds of certain districts, such as police whistles or bells, could even be given special character and could strengthen the identity of a locale.

The analysis and experiments also indicated the need for sound as signs to draw attention to certain parts of the visual scene, which often went unnoticed. The U.S. Customs Tower is the best example of this, being unmentioned by most visual-auditory subjects. If the clock at its top would tick continuously or chime every fifteen minutes people would have been attentive to its form. Other forms of symbolic significance which could be strengthened by special sounds are the Old and New State Houses, Old South Meeting Hall, and Faneuil Hall. Two examples of successes are the Park Street Church with its carillon, and the new City Hall, with its construction sounds and flying cranes.

The design of sounds along the sequence network is the third major area for sonic design. The sounds should be designed to be informative to the common purposes along the path, in addition to having variety and contrast. A delightful and sensible kind of public service would be to have routes programmed with several sound tracks so that one could pick them up on a radio as he passed through. Channels could be designed for different groups: children, shoppers, tourists, students, and many more. Some channels could be verbal, giving information on history, merchandise, or the like. Others could be non-verbal, and could broadcast the sounds inside structures as one walked by them, or the sounds could be completely unrelated to the visible form and could be abstract. This type of system would allow high receiver control and involvement, and could shut out unwanted sound. It would also be possible to apply such an idea to vehicular and public transit movement. These would have the advantage of blocking outside sounds more successfully. Success would also depend upon the design of vehicles which would allow better viewing.

To make the sequences more expressive of the activity and spatial form would necessitate a rather transparent or low intensity overall sound level, so that meaningful sounds could come through. To do this it would be important to hush vehicles in many districts. Areas of the sequence system which would be most difficult to deal with would be those with sounds that are high in attention-demandingness and low in information. Scollay Square, Court Street, and Atlantic Avenue are examples of this. Improvement would depend upon either lowering the sound level or adding informative sounds which rise above, but the sound levels here are already so high that it may merely increase the chaos.

In general, routes with slow and frequently stopping traffic seem particularly distracting, especially when many of the vehicles are trucks or buses. Also, areas with sounds that approach from many directions are far more attention-demanding than simple one-way routes. Fast-moving traffic, like the Central Artery, however, was actually considered quite pleasant by most subjects when they were about 300' away. They enjoyed the water-like sound and the constant flow of sparkling car tops and found it unpleasant only when underneath the structure.

The alley spaces, or other small hard-surfaced containers are a fourth potential because they are usually quiet, sonically responsive, and visually strong--characteristics which seemed important in subjects' preferences. Since these spaces are not usually containers for activity, there would be 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, in general, and might be among the first elements to consider in the execution of a sonic design. Such a

space could be peppered with hidden lights and speakers, activated by photo-electric cells hidden along paths of movement. A new sound-light sequence could be formed each time a person walked through, and groups of people could create an explosion of light and color, and sounds could be amplified, distorted, reflected, and repeated at the receiver's command. Change Avenue or Quaker Lane would probably be most suited to this type of experiment.

The responsiveness of other spaces could be increased by the addition of large sound and light reflectors that would focus sound and color at strategic points. This may be an appropriate device for clarifying sonically the blurred Washington Street space. In other areas, sequences of sonically differentiated floor materials, which squeak, rumble, or pop when walked upon would be fun and could be used to distract attention from dull or ugly visual settings. The biggest opportunities in sonic design would probably come in the creation of new public spaces, however, when there would be chances to shape the entire space to perform like a musical instrument.

The city at night would be particularly good for sonic events because it is quiet. Sounds and lights could be bounced from building tops, creating a symphony for sound and light at the city scale as spectacular as fireworks. The possibilities are unlimited.

Some Additional Research Needs

Before sonic design can be successfully done, much additional research is necessary. These needs are in addition to the experimental needs mentioned in Part II.

1. More information is needed on perception of sound in the city--how it is perceived by different social groups, what information people draw from it, how attentive they are to it, and how it affects typical personal plans.

2. In addition to the design experiments suggested, experiments are needed at the city scale to study more carefully the effects of space and material upon sounds of different types. Also, the possible masking effects of added sound need testing.

3. Additional research is needed on methods for quieting vehicle and airplane noise, and of designing and locating roads to reduce sound transmission to adjacent areas.

4. Analyses should be done of a larger portion of Boston using an area rather than a sequence, and also, several different cities should be analyzed.

These are specific research needs in the sonic environment, but if pleasing all of the senses is important, as this thesis suggests, then much more research on the non-visual environment in general is needed.

APPENDIX A

EXPERIMENT TWO: TRIP INSTRUCTIONS AND INTERVIEW QUESTIONS

AUDITORY SUBJECTS

TRIP INSTRUCTIONS

1. During the course of this trip, please describe spontaneously the total impression (form, space, materials, activity, light, social character) which you get from the sounds of the places through which you travel. Explain what you like or dislike about these places and identify what impresses you most.

2. Hold the microphone close to your mouth and speak clearly.

3. Identify your comments by the numbers which will be called out during the trip.

4. Please turn off the tape recorder when you are not commenting, in order to conserve on tape.

AUDITORY SUBJECTS

INTERVIEW QUESTIONS

PART A

Draw a map of your impressions of the trip, including the dominant experiences and their locations in space. Use notes for identification and additional explanations.

PART B

1. a. List the places which had the most memorable sound quality. Rank them in order of dominance.

   b. Name the places with the sounds that you liked best and explain why. Place them in rank order.

   c. Name the places with the sounds that you liked least and explain why. Place them in rank order.

   d. Describe the sounds which told you the most about places.

2. a. List the places that you think would have had the most memorable visual characteristics if you could have seen them. Rank them in order of expected dominance.

   b. Name the places that you think would have had the most pleasing sights and explain why. Place them in rank order.

   c. Name the places that you think would have had the least pleasing sights and explain why. Place them in rank order.

3. Explain how the perceptual form of the trip could have been improved for you.

VISUAL SUBJECTS

TRIP INSTRUCTIONS

1. During the course of this trip, please describe spontaneously your total impression (form, space, materials, activity, light, social character) of the places through which you travel. Explain what you like or dislike about these places and identify what impresses you most.

2. Hold the microphone close to your mouth and speak clearly.

3. Identify your comments by the place names or street names of the areas which you are in.

4. Space yourself far enough from the other subjects participating in the experiment so that they cannot hear you speaking.

5. Please turn off the tape recorder when you are not commenting, in order to conserve on tape. The tape on your machine will run for thirty minutes. Check to see that the machine is recording when you are speaking.

VISUAL SUBJECTS

INTERVIEW QUESTIONS

PART A

Draw a map of your impression of the trip, including the dominant experiences and their locations in space. Use notes for identification and additional explanations.

PART B

1. a. List the places which have visual characteristics that are most memorable to you. Rank them in order of dominance.

   b. Name the places with visual characteristics that you liked best and explain why. Place them in rank order.

   c. Name the places with visual characteristics that you liked least and explain why. Place them in rank order.

2. a. List the places you think would have had the most memorable sounds if you could have heard them. Rank them in order of expected dominance.

   b. Name the places you think would have had the most pleasing sounds and explain why. Place them in rank order.

   c. Name the places you think would have had the least pleasing sounds and explain why. Place them in rank order.

3. Explain how the perceptual form of the trip could have been improved for you.

VISUAL-AUDITORY SUBJECTS

TRIP INSTRUCTIONS

1. During the course of this trip, please describe spontaneously your total impression (form, space, materials, activity, light, sound, social character) of the places through which you travel. Explain what you like or dislike about these places and identify what impresses you most.

2. Hold the microphone close to your mouth and speak clearly.

3. Identify your comments by the place names or street names of the areas which you are in.

4. Space yourself far enough from the other subjects participating in the experiment so that you cannot hear one another speaking.

5. Please turn off the tape recorder when you are not commenting, in order to conserve on tape. The tape on your machine will run for thirty minutes. Check to see that the machine is recording when you are speaking.

VISUAL-AUDITORY SUBJECTS

INTERVIEW QUESTIONS

PART A

Draw a map of your impressions of the trip, including the dominant experiences and their locations in space. Use notes for identification and additional explanations.

PART B

1. a. List the places which are most memorable to you. Rank them in order of dominance.

   b. Name the places that you liked best and explain why. Place them in rank order.

   c. Name the places that you liked least and explain why. Place them in rank order.

2. a. List the places which had the most memorable sound quality. Rank them in order of dominance.

   b. Name the places with the sounds that you liked best and explain why. Place them in rank order.

   c. Name the places with the sounds that you liked least and explain why. Place them in rank order.

3. Explain how the perceptual form of the trip could have been improved for you.

APPENDIX B

VISUAL SETTINGS CORRELATED WITH SOUND MENTIONS OF AUDITORY AND VISUAL-AUDITORY SUBJECTS

SOUND MENTIONS PER SETTING RANKED IN DESCENDING ORDER OF FREQUENCY OF MENTION (A=AUDITION; A + V = AUDITION + VISION)

setting





	1	2	3	4	5
A	cars, trucks clopping of feet, footsteps echoing quiet house doors being unlocked and opened and closed birds, pigeons children playing very loud roar in distance wind radio people above dogs water dripping small sounds screech of MTA bell	cars slowly passing people striding past distant roar child running by	cars-slightly faster echoes all around, hard echoes a hollow clopping sound-a horse? children playing?	cars passing close, slowly people walking near quiet distant roar wind sirens heavy traffic, trucks workmen	sounds lost in space distant and middle-distant roar cars, moving slowly, ticking by footsteps quiet planes birds little trickle of water, snow melting maybe
A + V	quiet water dripping in gutter squeal of rags on windows		echoes		





	6	7	8	9	10
A	middle and foreground roar dull roar of traffic cars crossing water and mud echoes clank of metal wet sounds people noise heavy truck sounds footsteps work being done bouncing ball noise	cars street cleaning machine construction sounds traffic on wet mud	cars-faster traffic sound of motors trucks tinny horns high heels clicking voices beyond squeal of brakes--MTA a long bell--a telephone dripping water footsteps	cars-motor noises, trucks, stopping and starting people-girls talking, lots of people over-lapping sounds construction sounds radio someone whistling rumbling of the trains horns	echoes footsteps echoing muted quality of sounds distant roar ahead and behind quiet humming noises person talking
A + V		traffic	dripping water footsteps	MTA trucks	echoes footsteps echoing muted quality of sounds distant roar of traffic





	11	12	13	14	15
	cars people's voices children's voices car horns quietude sound of the wind bird wings sea gull	cars: car doors cars starting water dripping, pattering on tin rumbling traffic, heavy traffic, trucks, long truck sounds sound of boxes scraping on pavement airplanes humming away cars overhead footsteps voices, children	fast traffic dull roar big overhead sounds big long sounds water? voices	cars thundering overhead swooshing sounds traffic underneath echoing, rush and roar train rumble general rumbling all around undefined quality impressive sounding a Piranesi experience in sound	traffic overhead a hum wind-a grand kind of sound seagulls people's feet planes ship horn
A + V		water dripping seagulls calling airplanes cars amplified overhead	traffic dull roar	cars overhead amplified noise undefined quality	planes traffic overhead seagulls ship horn





	16	17	18	19	20
A	cars, trucks airplanes bang of metal distant roar train creaking boat dripping water closer sounds gull	cars: quieter water being poured, a steady fall airplanes gulls children, chatter chatter ship's horn voices flag flapping long, strong sounds distant church bells	cars above big horrible truck sounds overhead MTA train echoes	cars whistles rumble of a wheel-barrow or something being pushed echoes of footsteps people	cars, truck roar loud noises in the background water through a manhole
A + V	planes	water, the rustling of waves airplanes warming up gulls crying, calling, mewing	cars above echoes policeman's whistle	quiet and dead	cars





	21	22	23	24	25
A	echoes overhead motor, hiss, like a fan quieter wet mud sound footsteps water in sewer airplane child talking object being dragged	traffic people walking by popping sound water in sewers quiet	footsteps echoing pigeon, cooing birds flapping wings echoes whistling quiet	building noises, banging, objects falling voices; Italian, girls chattering, conversations footsteps cars, roar rattling bag quieter screech of MTA sound of pigeons	pigeon, bird wings quiet people, voices
A + V	machine sound, a fan quiet		echoes	building noises sound of pigeons	quiet





	26	27	28	29	30
A	cars: horrible noises of trucks, drone, whistle of traffic, moving slowly people walking pressing of feet voices, girls mainly bicycle buzz whistle motor sound on upper floor continuous din noisy trapped sounds plane	people noise voices: women, shouting, calling, chattering, screaming police whistles cars, horns paper bags crinkling shuffling enclosed sounds noisy whistling	people talking with accents Italian, French hum of talk traffic children doors opening and closing, car door slamming boy singing church bells plane policeman's whistle	people: running, talking cars church bells music	footsteps, occasional; women's shoes tapping birds; sparrows gulls quieter cars
A + V	horns music loose paper people police whistle	voices babies crying police whistles cars echoes in an alcove whistling boys	people talking traffic screech of mail box	subways stopping car radios, transistors	footsteps



	31	32	33
A	cars, fairly fast church bells chiming clock chimes footsteps people: girls walking quiet birds cracking noise echo children	traffic, occasional cars birds singing footsteps, individual children bell echoing people talking man shouting children noisier helicopter motorcycle planes	voices: articulate, Irish accent, coughing, old men talking cars: engine sounds, rattle, well-groomed engine doors opening and closing birds children screaming footsteps something being dropped kitchen sounds: clanking of dishes neighborhood and family sounds cash register bell music
A + V	cars church bells footsteps city noises	occasional traffic birds quiet	voices of old men cars idling cane on pavement kicking of ash cans

FOOTNOTES

1. Hall, p. 40.
2. Woodworth, P. 349.
3. Broadbent, Perception, p. 90.
4. Henneman.
5. Broadbent, Perception, p. 93.
6. Brodey, Pilot School.
7. Davis, p. 4-21.
   Hirsh.
8. Broadbent, Perception, p. 95-100.
9. Mudd.
10. Chapanis, p. 130-135.
11. Dewick.
    Elliot.
12. Broadbent, Perception, pp. 95-100.
13. Haber.
14. Hochberg.

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