ENVIRONMENTAL PERCEPTIONS OF THE BLIND & THEIR HAPTIC REPRESENTATION

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ABSTRACT

This thesis presents a perceptual investigation of the nonvisual characteristics of space by specificly studying how several adventitiously and congenitally blind students conceptualize the Massachusetts Institute of Technology campus, a complex and confusing urban university located within an area of Cambridge noted for its competing industrial, commercial, and educational land usages. In addition to providing the architect with a greater appreciation of the auditory and tactual signals of his physical surroundings, we explored the application of commonly used graphic techniques to design, produce, and test a meaningful tactual representation of the MIT campus in polyvinyl chloride for use by both the blind MIT community member and visitor to the campus.

to the blind students who made it all worth something

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PREFACE

The architect uses spatial properties to create interesting and useful physical relationships. He constantly seeks new ways to reassert the dimensionality, divisibility, directionality, and penetrability of space. Not having to touch or hear these properties in order to appreciate them, he strives to arrange their visual components into exciting juxtapositions by playing light against shadow, horizontal against vertical, and solid against void without worrying much about the other non-visual sensory side-effects. To a certain extent, his proficiency in handling the visual imagery which he uses to describe the spaces he designs masks incoming information from other sensory sources. If, however, he is fully to appreciate the subtleties of space, an architect needs to develop all of his perceptual abilities. We hope that our work will introduce him to the non-visual personalities that many spatial properties exhibit and will lead to the development of a set of non-visual sensory criteria to aid in the design process itself. Because much yet remains to be done before the full benefits of the tactual mapping techniques we describe here are reaped, and because the student of architecture is in a unique position to make a significant contribution in the field of tactual cartography, we urge those interested to continue this work and assure them that, in doing so, they stand to enhance their own understanding of physical spatial relationships.

INTRODUCTION

Many persons who have never seen or have lost their sight can still function surprisingly well within a complex environment. Spatial relationships have other signals besides the obvious visual ones. We have talked with congenitally blind individuals who have been able to conceptualize geometric relationships that we understand primarily through visual experiences. By using their tactual-kinesthetic sense to distinguish shapes and patterns, they have learned to differentiate between parallelism and perpendicularity, similarity and congruity, and a host of other geometric relationships. Even for those of us who can see, it is easy enough to feel the differences between a square and circular outline by moving our fingers along the edges. There are other, more subtle yet extremely informative spatial cues that can also be heard, touched, smelled, and even tasted that a sighted person usually ignores. With patient practice, however, a blind person learns to collect and assimilate these signals into a meaningful conceptual model of space. In this thesis we investigate how someone who cannot see perceives, experiences, and conceptualizes a complex environment and then endeavor to reconstruct in terms perceptually meaningful to him a haptic representation of that environment.

The environment we have selected for study and representation is the MIT campus, a large interconnected complex of buildings comprising a university of some eight thousand undergraduate and graduate students in the heart of the Cambridge-Boston metropolitan area. The five chapters of this thesis discuss the preliminary research, design, and testing of a tactual map to assist blind visitors and members of the MIT community in familiarizing themselves with the campus environs. Approaching the problem systematically, we have attempted to take the reader chapter by chapter through evolutions of a tactual map. Chapter One describes the range and characteristics of non-visual sensory abilities to perceive space that are potentially available to all of us and that the blind find particularly useful. We also develop the beginnings of a theory of haptic representation that is applied in Chapter Five. Chapter Two describes commonly and not-so-commonly used mobility techniques in an effort to discover which of the potentially representable environmental cues are most easily and directly experienced non-visually. Using portability, durability, tactuality, and economic feasibility for criteria, Chapter Three compares several currently available mapping techniques. We discuss the results of a test sample sheet produced in a process new to the field of tactual cartography, polyvinyl chloride. In Chapter Four we analyze the interviews, appended to the thesis, of blind MIT and Harvard students to find out what kinds of conceptualizations of the physical campus they possess and to evaluate their suggestions regarding the tactual map of MIT. In Chapter Five we describe the first mapping solutions in detail, list the results of informal tests, and make further recommendations for improvements.

HAPTIC AND AUDITORY EXTENSIONS OF SPACE

I

THE SENSORY ROLES IN SPATIAL PERCEPTION

From the moment we first open our eyes, we behold an array of spatial information that is only obtainable visually. Spatial imagery resides in no other sense more strongly than it does in sight. Walking around an object, we see that it has not one but many continuously changing shapes. We see shadows defining physical textures and accentuating the formal characteristics of masses in space. We see the inverse proportionality between the size of an object and the distance from which it is viewed. These and other important visually-stated relationships we frequently take for granted. More effectively than any of the other senses, sight permits the self to extend beyond its physical bounds into the space of objects, both near and far away. Sight alone can translate the physical laws of light and perspective into a non-mathematical display that is comprehensible for everyone.[1]

Although it would be foolish to try to deny vision's predominance in the perception of space, the remaining senses have the capability of presenting alternate representations of spatial relationships, albeit ones that are somewhat crude by visual standards. Because our informational requirements are more quickly and readily met visually, we do not usually develop the non-visual portion of our spatial perceptive mechanism. Instead, we use the other senses supportively, to reinforce the primary visual impression. In this section we turn to the impressions of the blind in order to examine those spatial qualities revealed to us non-visually.

CONGENITAL AND ADVENTITIOUS BLINDNESS

We begin this inquiry into the alternate appearances of space by describing two essentially different kinds of blindness. The first type, adventitious, retains a measure of visual imagery while the second, congenital, possesses no capabilities for visualization. Most authorities agree that many of the characteristics of congenital blindness, that is to say blindness at birth, will be incurred if sight is lost before the age of four or five.[2] If sight is lost after the sixth year, one usually retains a degree of visual imagery. For our purposes, we will consider a person to be congenitally blind, even if he had been able to see in infancy, provided he now possesses no visual memories.

A strange thing happens just after a person loses his sight or is adventitiously blinded. His overall sensory acuity declines. He loses his ability to monitor and analyze his other sensory inputs effectively.[3] In order to improve his sensory performance, he must regain confidence in his remaining senses minus the retinal image. This period of readjustment suggests that incoming non-visual data is closely coupled to the retinal image. If for example, I heard a strange noise, I would have to locate the source visually before I could be sure of what I was hearing. Similarly, reaching to my pocket for a dime, I naturally look at it as I take it out even though it has its own tactual identity. One trick a therapist employs to help the newly-blinded coordinate their sensory inputs is to teach them to videate the incoming sensory information. Videation or optification, as psychologists prefer to call it, is the ability to transfer non-visual sensory data - haptic, auditory, gustatory, olfactory - into a visual perceptual field. The resultant visual image, comprising no actual retinal impulses but only memories stored within the visual cortex, pulls together the diversity of incoming sensory signals into a meaningful conceptualization of the total experience.

Unlike the adventitiously-blinded individual a congenitally blind person is unable to videate because he has no reservoir of visual memories to draw upon. Accordingly, his imagery will comprise solely haptic, auditory, and gustatory-olfactory sensations. Both the sighted and the adventitiously blind can visualize simple objects such as a table. For the congenitally blind the table is hapticly representable by its texture, density, and tactual form. By calling together all the tactual-kinesthetic impressions associated with tables, a congenitally blind person can haptify the table in a way that is analogous to the sighted's visualization of the table. In 1945, Lowenfeld distinguished between visually-minded and hapticly-minded persons.[4] He speculated that the tactual scanning of a familiar object may not give rise to visual imagery in all people. This theory partially explains why some adventitiously blinded individuals adjust more quickly than others to the haptic world.

THE HAPTIC IMPRESSION OF SPACE

When we describe haptic perception, we cannot point to a specific or unique quality of sensations such as are derived from the ear or eye. We are referring, instead, to a group of purposive, tactual-kinesthetic encounters that result in a perception distinctly separable from vision, hearing, taste, and smell.[5] Of necessity, the blind must utilize their haptic abilities to a much greater extent than the sighted in order to accumulate a repertory of spatial experiences.

We are more conscious of the similarities than of the differences in sensory information overlapping the visual and haptic spheres. Most solid surfaces are both tangible and visible. A few visible quantities, however, such as smoke and fog are not tangible. A recent technological offshoot, holography, is tactually imperceptible although visually three-dimensional. Conversely, other surfaces such as plate glass may not be visible although tactually perceptible. The physical texture of a surface can be observed both visually and hapticly, but an accurate correlation between the various perceptual modalities is not always possible. That is to say what looks rough may not always feel the same way. Other physical properties are the exclusive domain of one or the other sensory spheres. We perceive color visually and temperature tactually, never the other way around.

Revesz suggests that there are significant phenomenological differences between visual and haptic perception.[6] He cites the confusion that formerly blind individuals initially experience in seeing things. One of the most interesting examples was discussed extensively in the writings of Locke and Berkeley in the eighteenth century.[7] About 1700 in England, a man who had been blind from birth with cataracts underwent a successful operation for their removal. For the first time in his adult life he experienced vision, but what he saw made no sense in the beginning. He reportedly could not even distinguish a cube from a sphere although both shapes were readily discernible tactually. He was so confused that he thought all seen objects touched his eyes. Revesz prematurely concludes from other similar experiences, documented by Von Senden, in which there was initial difficulty in interpreting the visual display, that the haptic world is indeed distinct and different from the visual one.[8] It is more correct to say that these people were cognitively blind at first and had to learn to perform visually the mental acts of recognition and interpretation regarded as a natural, spontaneous and intuitive part of seeing much as one has to practice balancing before he can ride a bicycle. The initial confusions probably resulted from a necessitated re-orientation rather than actually conflicting sensory data. Most of our tactual encounters occur simultaneously with vision. Revesz cites a striking example of the heterogeneity that occasionally arises when we perceive each modality separately from the other.[9] If we look at a piece of unpolished, pink marble, we note many small irregularities, convexities, and protuberances. By exposing the stone to the sun and then to the shade, or by first examining it with the naked eye and then through a microscope, we will experience a play of visual sensations with one and the same object. If we now examine the marble with our eyes closed, it appears unchanging both with respect to its structure and form whichever way we move it. Furthermore, a good synthetic imitation of the marble stone would be visually but not tactually indistinguishible from the real thing. Such is the deceptive nature of the heterogeneous visual and tactile impressions.

What, then, is the nature of the physical inputs that combine to form the haptic impression? The external world is hapticly perceptible only when the body comes into direct contact with the thing to be perceived. The sensations arising from the touching and handling of objects comprise the haptic experience, which goes beyond the classical modalities of touch and kinethesis. It is not enough to say that touching combines the data from feeling of movement and the feeling of contact, fusing the two sensations into one experience. Gibson points out that this model is lacking in two important respects.[10] First, it fails to account for the purposive character of tactual interaction, and secondly, it does not emphasize the multiple aspects of so-called kinesthesis.

The act of touching and feeling is a search for information. It implies a conscious effort to obtain sensory stimulation yielding, in turn, a perception of what is actively being touched. The motor organs of the body register stimulation through continual readjustment. The purposive character that makes this readjustment perceptually meaningful is missing in the traditional definition of kinethesis. Furthermore, kinesthesis is far more than the unitary 'muscle sense' to which it has been historically attributed. We are now aware of many other internal sensations besides the familiar muscular ones. Sensors indicate both the position and rotation of the joints while others describe the absolute and relative positions of the parts of the body. Muscle sensors cannot alone account for our awareness of the head's posture, its linear and angular accelerations, and a general understanding of the body's equilibrium. There is, in short an enormously complex flux of sensory information that the unitary tactual-kinesthetic model does not include.

The sense of touch as it is most often employed by actively using the hands involves an interplay of sensors coming from the whole skeletal-muscular system. Although active touch is not, in the strict sense, a single modality, it provides a definite channel of information about the external environment. We experience active touch in several ways. The object may be touched in one simultaneous act or may be explored more in a series of successive encounters. In both kinds of touching, the hand must move to achieve any recognition of even the most elementary tactual events. Revesz describes four kinds of motor activity that can provide useful information:

1) Touching with to and fro gliding movements reveals variations in surface textures.

2) The sweeping touch distinguishes planes, contours, geometrical relationships and individual details. The index finger or three middle fingers are usually employed.

3) Transitional touch in which gliding and sweeping motions are assisted by the thumb reveals more about the structure and appearance of an object.

4) Kinematic grasping is used to apprehend three-dimensional bodily structures.[11]

In any haptic encounter, the parts first appear in the order in which they are physically connected to one another. The whole object may occasionally reveal itself from the details obtained through a successive tactual analysis. More often, however, for recognition to occur there must be an interpolation of the haptic data to arrive at the object's material and form. Details do not define individualities in the haptic experience as they can and do in the visual process. That is to say, hapticly, a fork is readily distinguishable from a knife or spoon, but individual types of forks as represented by different patterns and services are not clearly apprehensible. This limitation explains why in the environment of the blind, we seldom meet objects whose individuality impresses us. Ornamentation serves no purpose other than to confuse.

THE HAPTIC RELATIONSHIP BETWEEN FORM AND STRUCTURE

Form is the unified impression of parts, a perceptual image of oneness. Structure implies a comprehension of each specific part. Form captures the immediate impression of physical sensations while structure assimilates consciously acquired spatial-temporal sensory data. Revesz distinguished between them in the following way:

> The form or shape is based on the empirical and homogeneous apprehension of a whole . . . the structure on the cognitive apprehension of the architectonic pattern and the knowledge of the functions of the relatively independent parts of the object. Form therefore belongs to the sphere of experience, structure to the intellectual sphere . . . Form is phenomenal, structure real.[12]

Our visual sense is directed to the perception of form, while our sense of touch is mainly directed to the recognition of structure. More readily expressed in structural terms, the qualities of haptic space will stress non-variability, sequential succession, and an analytic removal from the immediate impression. Fraser pointed out that visually we observe the whole, then consider the details of the parts; that the blind tactually observe the parts and construct the whole from them.[13] We note this perceptual shift in visually conceived and executed sculptures that have been hapticly transposed such as the one shown in Figure 1.[14] A congenitally blind boy who learned to model in clay copied the camel on the left. His figure on the right is structurally faithful to the original. Except for the missing knobs on the neck, all the parts and their relationships to one another have been correctly defined. From a visual standpoint, however, the model shows a lack of formal comprehension. The camel's hump and abdominal region are twice as small as the original. The three spherical shapes comprising the head have been overemphasized so that the mouth and eyes read as appendages to the cranial stem. A gap separates the cylindrical legs from the body. Because of these slips of form, the copy fails to transmit the uniqueness of the original. Forms, that fused into a distinct entity in the original, split into their component geometric shapes to produce a highly stylized representation in the copy.

PRINCIPLES OF HAPTIC RECOGNITION

Our discussion to this point, including the tendency to videate haptic inputs, the structural analysis of haptic forms, and the various kinds of kinesthetic sensations, suggests that there are certain spontaneous and natural acts of recognition and interpretation associated with each modality that may be expressed as basic principles of the particular sensory mechanism. Governing to a large extent the perceptual acuity of the blind, the principles of haptic recognition are so closely interspersed with the retrieval and organization of tactual and kinesthetic data, that they are frequently confused with the perception itself. We have tried in the following list to state as principles a number of the underlying concepts of haptic perception to which we have briefly alluded.[15] It is certain that these principles shape the character of haptic perceptions. We believe that a fuller understanding of what these principles imply can lead to the design of haptic encounters capable of expressing environmental relationships that are primarily apprehended visually today.

I The haptic perceptions of form and structure can only occur through the kinesthetic sensations derived from motor activity. Movements of the hands and fingers unite with the other tactual sensations to form an active touch, the principal vehicle for haptic representation.

II The most immediate and fundamental haptic impression, the sense of materiality, is most easily experienced by grasping an object simultaneously on all sides. The impression comprises sensations of resistance, volume, density, hardness, resiliency, and plasticity.

III The apprehension of form occurs through successive, sequential tactual encounters, revealing first the partial structures from which the whole is constructed. The forthcoming impressions of form will be structurally distorted similarly to the clay camel described previously.

IV Specific relationships of distance and proportion easily displayed in the visual first-impressions of form can only be apprehended structurally in the haptic sphere. They can be determined in one of two ways: either by using the hand or fingers as a measuring stick or by estimating the distances kinesthetically, that is to say, by noting the velocity of the hand.

V Kinds are much more readily distinguishable from other kinds than individuals within a kind are from each other. The reason is simply explained. Although forms may vary within a type or kind, the structure remains the same. In the haptic sphere structure, not form, provides the criteria by which things are most easily typed.

VI There is a need to supplement the vague haptic impressions of form by transposing or videating the contents of haptic perceptions into visual images.

THE AUDITORY IMPRESSION OF SPACE

In addition to the strong visual near-and-far space impressions of form and the vaguer haptic near-space impressions of structure, auditory sensations of both near and far space convey partial impressions of size, distance, texture, direction, and structure. The pioneering work of the Cornell Psychology Laboratory in the early forties first linked auditory sensations to what at that time was the unexplained ability possessed by many blind people to avoid collisions with objects.[16] Between

1949 and 1953 Worchel conducted a series of experiments to find out more about the mechanisms actually involved in obstacle detection.

Duplicating the conditions of the Cornell tests with the exception that the test course was outdoors rather than inside, Worchel succeeded in training seven blind subjects who had initially failed the obstacle test course to match the performances of those blind subjects who had originally passed the test course.[17] All the subjects showed striking improvement within the first thirty to sixty training trials. The few collisions that occurred resulted towards the end of the 210 training trials when the subjects became more confident and began to inch up to the obstacle, a masonite board.

A later, more extensive series of outdoor tests revealed that even under a complex set of conditions - ambient traffic noises, construction sounds, etc. - subjects possessing normal or near normal hearing, who were blindfolded only, learned obstacle detection rapidly.[18] Subjects who were deafened in addition to being blindfolded made more noise than the first group whose hearing remained unimpaired because they were trying to break through the ear blocks to hear their footsteps. The performance of this second group varied. Some continued to use auditory cues despite their ear blocks while others sought and utilized thermal and olfactory cues which, though less efficient than the auditory, served well enough to meet the criteria of the daytime tests. In nighttime tests when the thermal and the olfactory cues derived from the heat of the sun diminished, the subjects failed to detect the masonite board altogether. Worchel concluded that although obstacles could be perceived under certain conditions by many different means - sound, temperature, wind pressure, and odor - , auditory cues proved to be the most reliable, accurate, and universal.

Experiments conducted in the sixties by Rice and Juurmas shed more light on the principle auditory factor at work in obstacle detection. Using a form of echo-location, the sensory phenomenon most often associated with bats and porpoises, certain individuals were able not only to locate objects in space but under favorable conditions to judge accurately material and size. In a series of tests to measure the ability in various people to detect small targets using self-generated sounds such as clicks or whistles Rice found that the congenitally blind were as a group much better able to locate and sense the target than the adventitiously blinded who, in turn, were better than the sighted.[19] Rice also determined that the generated signals needed a wavelength considerably smaller than the target's diameter if they were to be reflected back to the subject. Earlier experiments verified that partially deaf subjects especially in the higher frequencies are not able to perceive obstacles as quickly as those individuals who have normal hearing.[20]

Rice and Juurmas also conducted experiments that revealed the astonishing ability of the blind to make size discriminations. In Juurmas's results, the best subjects were able to discriminate between two squares measuring 60 and 65 cm. from a distance of 200 cm.[21] When the distance and the size of the target were varied simultaneously, the number of correct responses decreased significantly, however. In the qualitative portion of his echo-location tests, Juurmas found that subjects could differentiate cloth surfaces from metal surfaces but confused pasteboard with cloth surfaces. Rice reports that the early and late blind subjects could locate objects more precisely than those sighted individuals who were blindfolded. As the azimuth increased from the zero- degree horizontal, the late-blind and sighted had increased difficulty in detecting and locating the target.[22]

Because of the non-aural characteristics of its impressions, the perception of objects in near space is frequently referred to as "facial vision". Although it is believed to be caused by the reflection of soundwaves, facial vision is not heard as sound. Most subjects in Worchel's obstacle-detection tests were not aware of hearing anything as they drew close to the object. Rather, they reported an impending blindness, feeling a cloud on their face, a sense of heavy blackness, or pressure on the cheekbones and forehead. The psychological reasons are not actually known why these impressions occur, but we may at least conjecture that the changes in ambient sound are probably so slight as to be at the threshold of auditory perceptibility triggering an instinctive rather than a conscious response. In fact most of us have experienced facial vision at one time or another groping around in the dark. Rearing back in alarm, we find that the wall is just inches away.

Amendola, working with newly-blinded individuals, teaches facial vision as part of a thirteen week rehabilitation program in spatial orientation at the Catholic Guild for All the Blind, Newton, Massachusetts. He believes the "closeness" many of his trainees reported feeling as they approached within inches of a wall, may be partially attributed to constrictions in the facial muscles and capillaries just below the skin. Amendola has successfully taught hundreds of newly-blinded individuals to increase their facial vision. His technique is simple. Approaching the blind subject who is walking towards him, Amendola holds a picture or piece of cardboard in front of his face. After several false stops, the blind subject learns to sense the object, stop a foot or two away from Amendola in time to prevent a collision, and step around him. The tendency at first is for the blind person to jump back, but in time most overcome their feelings of surprise and actually increase their perceptual threshold from six inches to one or two feet. Gradually through practice, the alarm reactions ameliorate enabling the subject to sense the impending object without shuddering or jumping back in surprise. The results according to Amendola are remarkable. It is like a gift of short-range sight for many people who thought they would never "see" again.[23]

Because the blind person relies on echo perception to provide environmental information that is usually obtained visually, sounds have implications for him beyond the acoustical ones most of us are familiar with. It is not towards the enhancement of music or speech but towards the uncovering of physical structure through an analysis of sound patterns that a blind person directs his echo perception. Metal heelplates and fingersnapping are two common techniques he uses to emit sounds when more information is needed. Alternatively, a slight shift of the head permits the detection of phase differences that can be helpful in pinpointing a sound source. The clarity of his environmental reception is heavily dependent on how he uses the reflections of everyday sounds - voices, machinery, traffic, running water, and air-turbulence - to locate and describe important physical definitions like corridors and corners, stairways and entrances, and intersections and crosswalks.

Audition can further strengthen a blind person's conception of the physical world by serving as a channel for indirect environmental information - whether relayed naturally by words or synthetically through a more elaborate auditory display. Verbal descriptions of far space relationships can do much to fill in the gap between a blind person's near and far space conceptualizations. In fact we need only think a minute to realize the importance of communication both in the formative years of the congenitally blind and in the rehabilitation period of the newly-blinded. In our work with blind college students, we have seen how much more effective a tactual display becomes accompanied by even the simplest verbal or written description. Because they are simple, verbal resources are often over-looked, but their value and economy have proven themselves time and time again.

Several radar-like devices, developed as sensory aids to help the blind detect obstacles at a greater distance, convert the reflections of transmitted pulses of energy into an auditory display.[24] The simplest of these devices was developed by Lindsay Russell in conjunction with the MIT Sensory

Aids and Evaluation Center to supplement the Hoover Cane by signalling obstacles that occur above the waist. Wearing the device around the neck, a user starts to hear ticks as he moves withing six feet of an obstacle that grow progressively louder the closer he comes until finally beeps sound when he is within thirty inches of contact. By assuming that only the existence of obstacles in the immediate path is of importance, the criteria for its design keep the amount of signal processing on the part of the user to minimum.

The Laser Cane introduces two additional channels of information. A product jointly developed by Haverford College and Bionic Instruments Inc., it packs three lasers and supporting electronics into what amounts to a slightly enlarged version of the Hoover Cane. One laser tracks objects that are ten to twelve feet in front; the second beams forward and downward to detect variations within the walking surface; and the third points upwards to check for above the waist hazards. All three lasers activate a single tactile stimulator in contact with the index finger. In addition, a small loud-speaker emits a high-pitched sound when overhead reflections are received and a low-pitched sound for downward reflections. Some users report feeling that the forward directed channel is useful but that the other two confuse more than clarify their impressions of what physically exists.

The most sophisticated display occurs in the binaural spectacles developed by Kay at the University of Canterbury, New Zealand. The system consists of two independent frequency-modulated channels utilizing a transmitter radiating into a fifty degree solid angle and two receivers mounted within a spectacle frame. In operation the ultrasonic spectacles transmit a beam of energy that sweeps from about 90 khz. to 45 khz. in one short pulse. The received echo is mixed with the transmitted signal and the resulting difference-frequency signal is conveyed to the user through eartubes. The complex array of objects typically present leads to the generation of similarly complex audio patterns. Students testing the spectacles say they are generally pleased with the environmental information they are getting. Occasionally the results are surprising. A yound lady said while experiencing a wooden-ribbed canopy covering the entrance of a post office, "That is a great sound (a musical chord). I wish you were plugged in so that you could share it with me". Another one said of rain, "The sound is more interesting than the trees. It even sounds like rain." A partially blind student who was having a difficult time with mobility was able to use the spectacles to walk up to a pole and grab it for the first time.[25] A blind student, with whom we worked, had used the spectacles continuously for almost a year. He said he had to wear them full time in order to give them a fair shake: that the only way the spectacles could be integrated with normal travel skills was by going out and hearing all kinds of things in order to acquire a vocabulary of sounds.[26] These cases all seem to indicate that an important transformation was at least beginning to occur. Instead of listening to the sounds, these people were hearing the objects.

We should add that before any of these sensory devices can be properly assessed, a realistic set of performance criteria must be developed to which, then, each of these devices could be measured. What kind of internal representation of environmental relationships does a blind person really need, to do what he wants to do? Spatial perception can exist independently of vision. It is not, therefore, a question of creating the same spatial schemata a sighted person has, but rather one of balancing performance against cost to find the optimum transformation based on cognitive needs.

SUMMARY

In this chapter we have explored the significant amount of spatial information contained within the haptic and auditory spheres that is blocked out because of the overwhelming strength of the visual impression. We suggest that the visual mechanism is closely allied with the correlation and synthesis of non-visual spatial information and that when trained to visualize his remaining sensory inputs, an adventitiously blinded person can sharpen his conceptualizations of physical relationships in space. Noting especially the de-emphasis of form, we have stated as principles several phenomenological acts of haptic recognition and interpretation. We have also discussed the primary components of obstacle perception and described several displays that modally transform spatial relationships into meaningful sounds and tactual sensations. Because of their limited involvement in the perception of form and structure, we have chosen not to discuss the gustatory-olfactory sensations. Suffice to say here, that acting as colors, gustatory-olfactory perceptions qualitatively reinforce the fundamental non-visual impressions of space that we have been dealing with in this chapter. We turn next to a discussion of orientation and navigation techniques commonly used by the blind traveler to reveal the non-visual cues most helpful in describing a complex and changing environment.

CHAPTER NOTES

1. Waterhouse, ca. 1949
2. Drever (1955), p. 611.
   Schlaegel (1953), pp. 265 - 277.
   Sylvester (1913), p. 211.
3. Amendola, interview #11, pp. 174 - 175.
4. Lowenfeld (1945), pp. 100 - 114.
5. Revesz (1950), pp. 52 - 69.
6. Ibid., p. 12
7. Wexler, "Shape Recog. - 1" (1965), p. 228.
8. Senden (1932)
9. Revesz (1950), pp. 28 - 29.
10. Gibson (1962), p. 478.
11. Revesz (1950), p. 63.
12. Ibid., p. 87.
13. Fraser (1917), p. 229.
14. Fig. originally appeared in Revesz (1950), on p. 220.
15. We have relied heavily on the work of Revesz (1950), esp. pp. 92 - 131.
16. Supa et. al. (1944), pp. 133 - 183.
17. Worchel et.al. (1951), pp. 170 - 176.
18. Worchel et. al. (1953), pp. 519 - 553.
19. Rice (1969), pp. 1 - 14.
20. Worchel et. al. (1953), pp. 519 - 553.
21. Juurmas et. al. (1969), p. 34.
22. Rice (1969), pp. 8 - 9.
23. Amendola, interview #11, p. 59.
24. Nye et.al. (1970), pp. 1890 - 1892.
25. National Academy of Engineering (1970), p. 122.
26. ML, interview #19, p. 284.

NON – VISUAL URBAN SIGNALS

2

EARLY CHILD DEVELOPMENT

To develop the skills required to understand his environment a blind person must first form an image of his body and learn to utilize his internal guidance system. Most child development experts suggest that basic impressions of the body including body surfaces and differences in the sides of the body are formed early and that by age six a child's laterality is well established as evidenced by his hand-use. It is apparent from the data of Cratty _et_. _al_. that laterality is not as well established in the congenitally blind child.[1] The congenitally blind child should therefore receive training early in life to heighten awareness of his body parts and their geometry in addition to exploring manually increasingly complex objects. Such training may also enhance speech development.

> As soon as possible the infant should be made aware of the front and back parts of his face and the location and names of his limbs. Furthermore, he should in every possible way be given tasks designed to enable him to understand various left-right concepts - that left and right directions change as he moves and that an individual facing him has a different left and right than he does. At the same time the child should be given tasks which enable him to locate himself relative to various objects. For example, using a box, various drills may be utilized which help him to understand how to stand with his back, front, left side, and right side nearest an object. If we are to believe the writing of Piaget regarding the importance of the sensory-motor period in the development of an infant and the sensory-tonic theory of perception advanced by Werner, it should seem that this kind of body image training is imperative for the child who has no opportunity to pair vision with movement.[2]

Without such early training, CL, a congenitally blind seventeen-year-old, was unable to understand her body geometry and therefore was unable to develop an understanding of the world around her, a factor contributing to her low mobility.[3]

In investigating the development of perceptual-motor abilities in blind children and adolescents, Cratty et. al. discovered several basic factors affecting mobility.[4] In the absence of auditory cues, a blind individual will predictably veer about 36 degrees per 100 feet of forward progress, or about 1.25 inches of deviation per stride. The highly anxious blind traveler will walk significantly slower and will veer about twice as much while walking 100 feet as will the more relaxed blind person. The blind person also tends to be more sensitive to the curvature of a path walked when it is opposite to his usual tendency to veer. Through training, veering can be significantly reduced as can the error of overturning 90 degree turns and underturning 180 and 360 degree turns. Further, postural abnormalities are not predictive of the direction nor amount of veer that the blind person will experience. The longer a person has been blind the less he will tend to veer and the more accurately he will detect gradients. The blind, in fact, are more sensitive to incline than to decline, congenitally blind adolescents being more aware of gradients walked than older adventitiously blinded adolescents. The former, however, have more difficulty differentiating between right and left in their spatial field than do the latter who had sight during the early formative period.

The blind infant should be encouraged to explore. Father Carroll believes that

> growing blind children must be allowed to crawl at the crawling age, to wander at the wandering age, and to climb at the climbing age, and their curiosity must never be deadened but rather stimulated by every means.[5]

When asked why he had such an excellent orientation sense, one congenitally blind adult replied that as a child he had broken all the rules in the book, including riding a bike with his friends and diving off forbidden docks all without the knowledge of his parents.[6] Such stimulation and pursuit of spatial experiences made him an adventurer and explorer in later life.

Father Carroll insists that "despite the qualms of parents, blind boys and blind girls must be given the opportunity for wholeness in their growing years if they are to be whole adults." [7] Sports like fencing and skiing can be an integral part of a blind person's training.[8] In fencing he practices coordinating footwork with arm work, as well as developing the proper light touch and feel. Much of what the blind fencer learns is applicable to long-cane travel since he learns to consider both the foil and the cane as extensions of his arm and hand. As well as stimulating the whole body and improving blood circulation and breathing, sports are a means of relaxation from heavy physical and mental pressure, particularly for the blind person who must concentrate continually on what he is doing and seldom has the opportunity to move about freely and relax completely.
IS revels in the speed of downhill skiing as his friend gives him instructions through a walkie-

talkie.[9] Through sports the blind person acquires self-assurance and self-confidence while developing a sense of direction and the courage to move about by himself.

Independent mobility, the capacity to travel in a safe and efficient manner, is based on three components according to Silver: (1) orientation, awareness of oneself in relation to the physical environment; (2) mobility, the ability to make easy movement; and (3) peripatology, the use of the remaining senses to achieve orientation and mobility.[10] Possessing these three abilities, a motivated blind person can adapt to and control his own environment. Dupress argues that four types of information are needed for successful independent travel: (1) knowledge of obstacles in the environment, (2) awareness of changes in the terrain, (3) knowledge of one's current location, and (4) a mental map of one's route from origin to destination.[11]

A critical variable in determining the degree of success a blind person will have in independent mobility, orientation to the physical environment is largely an intellective and cognitive process that has not yet been explored in depth. Yet it is apparent that one basis for orientation is a conscious mental map of clearly perceived starting and terminal points with the route between being experienced vicariously in non-visual terms. In some respects, this mental map resembles a detailed walking tour guide with visual directions such as "turn right at the candy factory" being replaced by tactile-kinesthetic, auditory and olfactory cues.

CUES UTILIZED TO UNDERSTAND THE URBAN ENVIRONMENT

Thus the blind person utilizes non-visual landmarks and environmental features to understand his environment and achieve mobility. Within the urban context, he understands the city primarily through the structure of the block, intersections and street corners. All cities have traffic noise and street blocks with curbs. Utilizing parallel traffic noise as a cue, the blind person judges his distance from the street as he walks down the sidewalk. Through his feet and through echo perception of the type of sounds produced by his heels or cane, the blind person can determine the texture of the ground surface such as asphalt which would feel softer and sound different from concrete. To orient himself and to determine his direction of travel, the blind person uses his cane to detect guidelines or shorelines - an existing border such as sidewalk and road (curb), pavement and grass, sidewalk and building. As he approaches a corner, the blind person begins to hear perpendicular as well as parallel traffic. He detects the curb either through his cane which falls off or through his dog guide which sits. The shoreline breaks - it is not there anymore. Through echo perception the blind person can also tell that the corner is coming up because he realizes, for instance, that he has passed the corner of the building next to him. If the blind person is able to master the techniques necessary to cross an intersection, then he can move beyond the block and a world of choices opens up.

There is a basic technique that a person in the blind uses to cross an intersection. At the curb he must square off and align himself so as to cross perpendicularly. Traffic will be moving parallel to the blind traveler. Then when the light is against him and perpenpendicular traffic is moving while parallel traffic is idling, the blind person will hopefully hear someone idling his engine. As soon as perpendicular traffic stops and the idling engine in the parallel lane is gunned, the blind person steps off the curb. Risk is reduced because the driver sees the blind person. The driver is stopped which eliminates high speed, and if he is about to make a turn, it is unlikely that he is daydreaming. The blind person is cautioned against listening to other pedestrians and relying on them since they may be jaywalking. As he crosses the street the blind person utilizes a sequence of cues: the step-down of the curb, the crown of the street, and the step-up at the other side. He keeps his head straight ahead for if he should turn his face toward the source of traffic noise he is apt to create the impression that he is sighted and is looking at traffic.

In the city there are also red-yellow traffic light cycles, requiring an alternate crossing technique. Not many blind people can use the red-yellow method since so few have the judgment to know when the red and yellow lights are on. The first clue of a red-yellow cycle is that both streets are busy. The control street is the busier of the two and in order to cycle red-yellow lights the blind person must push the button when the control street is stopped. After the control street starts and stops again, the red-yellow cycle begins. The blind person must hear both streets stopped in the beginning of the cycle. If he starts to cross at the end of the cycle, obviously he will be in the middle of the street when the next cycle commences. Several possible complications add to the complexity of this technique. If the cycle on the control street is long, all of the traffic on it may have dumped out. The blind person could not recognize that the red-yellow had come on because the sound cue would not be there. If a car came up with five seconds left in the cycle, the blind traveler would be misinterpreting it. He must then make time judgments based on the realization that the red-yellow cycle is usually 10 to 15 seconds. Another possible complication is the bus that idles while unloading passengers parallel to the traveler. The bus blocks out traffic noise and the blind person must wait until it moves.

As he walks down the sidewalk, the blind person derives information from auditory cues, olfactory cues, sun radiation, temperature, and air flow. Auditory cues of both near and far space indicate size, distance, texture, direction, and structure. Through echo perception the blind person can ascertain the size and location of a truck, for example, parked in his path, or the texture of the path or surrounding buildings. Traffic noise on a distant street provides orientation and the direction of traffic such as a one-way street may reinforce the traveler as he counts the number of intersections he has crossed en route to his destination. Other helpful auditory cues include the hum of machinery, water flowing in a sewer or water fountain, and the sound of people ascending and descending stairs. Olfactory cues such as a candy factory, cooking smells coming out of a restaurant exhaust fan, or formaldehyde odor from a biological laboratory reinforce the blind person's ability to orient. Sun radiation contributes to the blind traveler's sense of direction with respect to north, south, east, west, while the absence of sun radiation may indicate to the person that he is under a tree or overhang. A difference in temperature such as between a sunny street and a dark alley causes a front of cool air indicating the alley location.

Other cues become useful in entering or leaving a building and in navigating interior spaces. The sound of people going up and down steps may signal entrance steps. Utilizing air flow the blind person can locate, from the inside, an exterior door or determine whether an elevator is descending or ascending if the air current hits first the top of his head or his hands and chin. A change in air pressure in a familiar environment can indicate, for instance, whether the shower curtain in the bathroom is open or closed. Through echo perception the blind individual can ascertain the extent of a large interior space and distinguish it from an adjoining corridor. Sound cues such as a cash register can signal a place where the blind person can obtain information.

Certain areas and situations can prove confusing. Almost devoid of cues, large expanses of grass, plaza, steps, or parking are avoided. In lecture halls the arrangement of seats, podium, and exits are difficult to comprehend initially. Having been assisted to a seat in an unfamiliar hall, JK, a congenitally blind Harvard senior, spent the remainder of the period trying to figure how he was going to get out.[12] Intersections greater or lesser than 90 degrees necessitate an abnormal crossing technique while JK will go "miles out of his way" to avoid street crossings with islands. Unknown traffic underpasses can be more than a little disconcerting. Out in the middle of an intersection during a crossing, AD, an adventitiously blind MIT senior, unaware of a traffic underpass beneath him, heard a heavy truck rumbling toward him and thought it was all over until the truck passed under.[13] Unpredictable obstacles such as trucks parked at sidewalk loading docks, painters' ladders in corridors, or random sculptures with overhangs are harrassing. Cracked, pot-holed sidewalks are difficult to navigate due to the discontinuities which provide false cues and impede cane technique. Ice and snow obscure shorelines, create new ground forms, and make footing treacherous. Snow is truly the "blind man's fog".[14]

However well developed, a blind person's non-visual senses are not enough alone to enable him to perceive all of the environmental cues discussed above. He must extend the reach of his senses through the use of mobility aids. It must be emphasized that these aids are not substitutes for a blind person's senses, but an extension of them enabling him to detect and utilize other inaccessible cues to achieve a greater mobility.

MOBILITY AIDS

The three travel aids now in general use are: the human guide, dog guide, and long cane. Developed as practical answers to a critical problem rather than as outgrowths of scientific investigation, these aids have endured not so much because they constitute ideal replacements for vision, but because other proposed substitutes are less efficient. Although they promise an improved approach to the problem, electronic guidance devices are still in the development and field testing stage.

The Human Guide

The oldest and steadiest of resources, and usually completely untrained, the human guide was the main mobility aid available to the blind person up through the early part of the present century. Until that time few, if any, blind people traveled extensively alone for several reasons: they did not have sufficient self-confidence, they were infirm, they did not have the opportunity to develop mobility skills, or they always had a sighted guide available. The human guide should be an extension of the blind person's haptic sense, including kinesthesis. The guide walks half a step in front of the blind person, never behind, as the blind person grasps the guide's forearm at the elbow lightly but securely. Through this light touch the blind person can feel every movement of the guide and can even learn to anticipate in which direction the guide will next move or step. The human guide should know how to provide aid properly, without being over-protective. The guide's main responsibility is to orient the blind person, not take him on a guided tour. The blind person must know how to solicit aid and how to detach himself from it when it is no longer required. Frequently, aid is offered even though it is unnecessary and the blind person must learn to deal graciously with this problem. When an untrained person attempts to assist him from behind, the blind person must be able to effect the "Hines break" - the method for quickly breaking the hold of the sighted person.

In learning a new route, most blind people solicit aid from a sighted person since they find that verbal information is often sufficient to enable them to master the concept of a new route, even if it is as complex as the subway system. Once introduced to a new route, the blind person can then get around with another mobility aid, such as his cane or dog. Through the sighted guide, then, the blind person can ascertain his orientation, learn about the qualities of far space, and become aware of dangers such as overhangs. He can not, however, haptically discover all the textures surrounding him as he might with the cane and if he relies solely on the sighted guide, he forfeits his independence.

Dog Guide

The dog guide movement started in 1915 in Germany when a school was established to retrain military "search" dogs to guide war-blinded veterans. Dorothy Harrison Eustis, a wealthy Philadelphian who bred and developed ways to train German Shepherds in Switzerland, published an article after her visit to the Berlin school. Morris Frank, a blind American, heard about her article and in 1927 he obtained the first dog, Buddy, from her. He came back to the United States to demonstrate the abilities of the dog guide. With his foresight and her money, they founded The Seeing Eye in 1929, modeling it after the carefully organized German program.[15]

Granted that this is a very good system, only a few blind people can use the dog guide. The blind person must be generally physically fit, he must have a sense of balance and a sense of direction, his home and business environments must be conducive to a dog guide, and he must be able to enter into an intimate relationship with his dog. The Seeing Eye, Inc., estimates that less than 5% of the legally blind qualify to use a dog guide.[16] It is a working relationship and, almost inevitably, an emotional one. When his dog dies, the blind person must go through a long training period with a new dog. If his dog is sick, the blind person must be able to travel proficiently with a cane so that he does not lose his mobility. To be a good cane traveler one mustconcentrate a lot more than with a guide dog. But using a guide dog does not obviate the traveler from acquiring basic spatial concepts and motor skills. Like the human guide, the dog is an extension of the blind person's haptic sense. Through the rigid handle of the harness, the blind person can feel whether the dog is going up or down, right or left, slowing down or speeding up, and can thus learn a lot about the terrain. The greatest advantage of the guide dog is the speed and relaxation of travel. With the dog the blind person does not have to worry about every discontinuity. Initially it may be more difficult with a dog than with a cane to locate certain small objects, like a mailbox, since the dog is taught to think of these as obstacles, but a dog learns fast and after one or two times, he will know what the blind person is looking for. Both owner and dog operate within a framework of obedience where the owner relies completely on the dog, and where the dog relies on the owner to maintain complete control. The master does not simply say, "Home, James", but directs the dog by commands such as "right", "left", or "steady". Within this setting of obedience, the dog must be able to say no when the occasion arises. Like the human guide, the dog provides animate protection since his instinctual drive is directed to protect his master and himself not only from present but also from potential sources of danger such as a rapidly approaching car. Their relationship, then, is a working one based on mutual respect and responsibility.

Long Cane

Until World War II no definite technique or set of rules existed to enable a blind person to travel effectively by himself. In answer to the demand of returning war-blinded veterans for training to move independently in society, the Medical Division of the United States Army set up a program and training division in several of their hospitals to rehabilitate and train blinded veterans.[17] At that time the blind man's cane consisted of a short, heavy, stout walking stick painted white. To Dr. Richard Hoover these men, shuffling down the corridors of the Valley Forge General Hospital in Phoenixville, Pennsylvania, looked lame.[18] He realized that the veterans were using a crutch designed to substitute for strong legs, when they really needed an antenna to extend the reach of their touch senses. Dr. Hoover experimented with lighter, longer sticks finally arriving at the long cane or Hoover cane. Usually made of thin aluminum tubing or synthetic material not more than 1/2" in diameter, the long cane has a wooden or plastic tip at the ground end and is curved at the other end like a shepherd's staff. The shaft is usually covered with a material that reflects car headlights at night, while the crook is often wrapped with leather. Experimentation continues on non-collapsible canes to find a non-rigid cane that is structurally sound, has good transmission qualities, and is well-balanced. Since the purpose of the cane is to extend foot reach as well as arm reach, the length of the cane is determined by a person's height and the length of his stride, the cane usually reaching approximately up to the breastbone. This ability to sense his forward path haptically through the long cane enables the blind traveler to move with independence, assurance, grace and speed.

The crux of long cane training is the necessity for the blind person to incorporate the cane into his body schema, to make it as much a part of his body as the sighted person does a pen or bicycle. He must be able to use the cane efficiently without concentrating on his cane technique continuously. The proper use of the cane should be taught by a qualified instructor, a peripatologist. The ideal position of the cane is midline of the body, with one's arm tucked in. The cane is swung back and forth mainly by the wrist, with the tip of the cane not lifting higher than about 2" above the ground and hitting the ground with a short light tap at the end of each swing. The character of the tapping sound can indicate the surface he is traveling on, whether it be asphalt, brick, gravel, grass or whatever, and whether the path is sloping, ascending, bulging or hollow. The cane traveler taps the cane either with or against his natural body swing, the latter method allowing him more leeway to stop. To orient himself and determine his direction of travel, the blind person uses guidelines or shorelines. To detect obstacles, he makes contact within the arc of the cane or recognizes auditory signals initiated by or reflected off of the obstacle. Even under the most favorable circumstances, however, the cane in conjunction with hearing, touch, smell and kinesthesis is hardly foolproof. As the cane is swung through an arc in space, it describes a region of comparative safety, but objects that are shoulder- or head-height without supports on the ground (for instance, a low-hanging tree branch) usually will not be detected by the cane and non-visual senses.

Electronic Guidance Aids

Lay and professional interest in electronic guidance devices for the blind is quite high at the present time. Sophisticated aids such as those described in chapter one are being designed to provide sound, tactile or kinesthetic outputs that blind travelers can sense and interpret. Even the most advanced of these devices, however, are still in developmental and field testing stages and are not commercially available. Hopefully, one or more of these devices will prove to be a utilitarian aid enabling blind travelers to perceive obstacles and other physical features in the environment without blocking other sensory input channels.

CURRENT MOBILITY PRACTICES

The mobility techniques necessary to achieve competency in orientation and navigation are acquired through mobility training. In the past decade, mobility training achieved full acceptance. Teacher training, so greatly needed in this field, has been implemented with the establishment of a course in mobility therapy on the university level, including one at the Graduate School of Education of Boston College, and a similar course at Western Michigan University.[19] At present there is a shortage of qualified mobility instructors, but current training programs should meet these needs more fully in the next few years. Through formal teaching rather than through painful trial and error, an expanding group of blind people now has the opportunity to achieve varying degrees of independent travel. The current practice is to teach a sighted instructor to think like a blind person by blindfolding him so that he can experience a route in non-visual terms. He teaches the critical features of routes to the blind person by verbal descriptions and guided tours. The blind person becomes temporarily dependent on the sighted teacher in order to gain a greater degree of independence in the long run.

But, at present, to learn new routes and become familiar with a new area the blind person is forced to depend either on himself or on the sighted. It is here that tactual maps for the blind can serve their primary purpose. They are an important vehicle for enabling a blind person to become more independent. There is a second equally important role for maps for the blind, especially the blind youngster: to describe physical relationships that the blind person has no other way of knowing. This is particularly true for a congenitally blind individual who, without any usable visual memories, has no means of organizing the bombardment of unrelated information about his physical environment - the make-up and nature of such everyday things as streets, sidewalks, transportation systems and topography. Gilson emphasizes that

> many of these conceptual distortions are the result of the child's having been given too many repeated verbal descriptions without reinforcement and correction through physical contact.
>
> Since the child's "facts" remain on an intangible, abstract level, and have been cultivated by his imagination, his distorted concepts of space are more likely to mislead than help him find his way about. Furthermore, the child's actual contact with his physical environment has frequently not been integrated into accurate concepts of physical reality.[20]

From a tactual map a blind person can gain factual, conceptual information about a city's structure. He can judge where movement is possible and what direction to take to reach a destination. The map provides him with a framework for understanding the component parts of the city and their relationships to each other.

THE ROLE OF MAPS IN MOBILITY

The idea of providing blind persons with simple, portable maps is relatively new and only now beginning to gain a measure of acceptance. Some of the reasons for this are purely sociological, but others are related to the difficulties in handling as well as in the production of suitable maps. Here, interdisciplinary research plays a vital role. Cartographers, geographers, teachers of the blind, psychologists, peripatologists, and of course the blind users themselves need to be involved.

Architects too can make a significant contribution towards the development and representation of urban route maps and interior spaces. Trained in the design and description of physical form, they are in a particularly good position to understand how many urban relationships are perceived and used by blind as well as sighted individuals and to draw upon their professional expertise to transform these physical definitions into haptic representations.

Accordingly, we specifically addressed ourselves to the research and design of mobility maps for the blind. Was it possible to stretch the representational limits of hapticly-transposed environmental information to include a degree of freedom in travel that heretofore has been unobtainable through current mobility practice. What durable materials were either available or could be found to make for a portable, tactible map. In order to answer these questions, we searched for an urban locality to map, a locality of such complexity and density that a blind traveler would have to understand the relationships of its physical components to become truly mobile within it.

We found the perfect location at MIT, where as students we had been living and working for several years. In addition, we were encouraged by the MIT Planning Office to pursue these goals as a part of a larger program they had undertaken to implement changes within the MIT environs to aid and and assist the handicapped.[21] Only too aware of the confusing maze of corridors, lobbies and walkways and the larger conflicting industrial, commercial and educational land usages, they had just completed a guide designed to help people with ambulatory disabilities negotiate the campus more successfully. It was hoped that a tactual map could do much the same for the blind traveler, in this case a highly motivated and mobile group of blind students, most of whom would be using a route map for the first time.

CHAPTER NOTES

1. Cratty *et. al.* (1968), p. 116.
2. *Ibid.*, p. 117.
3. CL, interview # 2, pp. 122-123.
4. Cratty *et. al.* (1968), p. 116.
5. Carroll (1961), p. 255.
6. *Ibid.*, pp. 259 - 260.
7. *Ibid.*, p. 260.
8. Riley (1965), p. 109.
   H. van Dyck, p. 111.
9. IS, interview #8, p. 157.
10. Silver (1961), pp. 113 - 115.
11. Dupress (1963), pp. 7 - 11.
12. JK, interview #10, p. 172.
13. AD, interview #16, p. 249.
14. Proscia, interview #13, p. 203.
15. Maglione (1969), p. 3.
    ML (1972), telephone conversation.
16. Carroll (1961), p. 139.
17. Davey (1968), p. 19.
18. Amendola, interview #11, p. 173.
19. Carroll (1961), p. 135.
20. Gilson (1965), p.59.
21. Efforts to help foreign students and faculty overcome the language barrier have been continuing for many years at MIT. Programs such as evening language classes and language labs benefit not only foreigners but Americans planning to journey abroad. The Planning Office is presently developing a series of taped programs to describe the campus to the foreign visitor in his native language.

3

TRANSFORMING THE PHYSICAL - SPATIAL MAP INTO A NON - VISUAL DISPLAY

In designing a map of the MIT campus that is to be perceived non-visually, first considerations of representation supercede those of scale and symbology usually applied to the visual map. We need to choose the mode of apprehension that will most effectively communicate the information that we wish to present. Two different ways of presenting environmental relationships have been successfully used to map specific routes for the blind. Accordingly, we shall examine the merits of each and then proceed to the more detailed questions of material and process.

PHYSICAL-SPATIAL MAPS

Physical-spatial maps present a symbolic and much-reduced representation of the relationships between physical things, but at the same time preserve the literality of the relationship. A majority of maps for the sighted fall into the physical-spatial category. Using symbolic abstractions in a two-dimensional configuration, physical-spatial maps bear considerable visual resemblance, adjusting for differences in scale, to the perception of the reality mapped. Looking down from a hill or airplane, it is usually possible to match this kind of map with the immediate perception. The transformation is a self-explanatory visual correlation between symbol and that symbolized or between groups of symbols and the corresponding physical relationship. Using a variety of visually perceived landmarks, it is easy for the sighted to orient themselves in a strange environment by closing the information loop flowing from reality to map and back again. In adapting this kind of map for a blind population, the problem is finding a common set of mappable landmarks, capable of meaningfully describing physical relationships, that are readily identifiable by the unfamiliar as well as the familiar blind traveler. Whatever landmarks are chosen must be able to transform clearly into the corresponding haptic and auditory reality that comprises the blind person's direct perceptual link with the physical environment.

SEQUENTIAL MAPS

Differing generically from the physical spatial map, the sequential map is characterized by a successive list of actions or instructions leading to decision points that in turn branch into further instructions. Its familiar counterpart, the computer flow chart, is a map of sorts itself for the more detailed programming coding that actually feeds into the machine. The sequential map has a special appeal for many blind applications because of the successive, sequential nature of the haptic perception. Leonard compares the experiences of a climber scaling the slopes of a mountain to a blind traveler preparing to cross a busy intersection, neither of whom can see the route ahead.[1] Because each is limited to a number of specific choices of execution their next series of moves could most appropriately be represented in sequential format.

A particular advantage of the sequential map is that it can be verbally constructed in either tactual or auditory terms. Figure 2 shows a simple transposition from a physical spatial to a sequential representation. The mapped route presents two alternatives: going from A to B by indirectly passing C or by going straight to B. Leonard has experimented with several sequential portable maps for route travel. His braille-encoded spatial disc works by moving a pointer from instruction to instruction as one progresses along the route.[2] The outer ring of instructions, similar to the ones in the sequential sample of Figure 2 , provides the necessary information to get from destination to goal, while the inner rings supply supplementary data to clarify ambiguities that may occur along the way. He also tried taping the instructions so that they could be played back from a portable recorder as one walked the route. Both methods proved to be successful ways of portably presenting route information to blind travelers. Leonard reported that at least half of his test group finished a totally unfamiliar route without making any mistakes.

There are, however, some serious limitations in a sequential presentation. Route variation becomes difficult if not impossible because spatial connections and interrelationships cannot be simply defined. To show an alternate way to cross the intersection took five additional instructions in the elementary route map referred to in the preceding paragraph. The physical-spatial map, on the other hand, contains all the necessary information to formulate an alternate route.

Only a limited number of maps need be drawn of the campus to describe it adequately for the blind traveler. It is doubtful whether even fifty sequential maps could meet the needs of the blind community and visitors to the campus, even though many of the routes would be common for everyone.

It is one thing to use the Automobile Club Triptic map on a vacation but quite another to have to wade through five or six spatial discs or cassette recordings to go only a block or two. The real challenge lies in developing the tactual techniques to communicate the visually understood relationships of organization and physical structure in a way that will enable the blind traveler to enhance his route repertoire as he chooses. Although it may be that the physical spatial map initially places greater perceptual demands on the user than either the brailled or taped sequential, its potential benefits are far greater for the highly motivated and mobile blind traveler.

CURRENT MAPPING TECHNIQUES

Surveying the currently available physical-spatial maps for the blind, one is struck by the almost total lack of urban maps. Sherman, for instance, knows of only three other maps that would enable a blind person to find his way about a city.[3] One is the German map of Marburg-Lahn constructed on molded paper; one is an out-of-date portfolio of maps of the London Underground Railway and the third one is a newer map of central London shown here in Figure 3 . He has yet to find anything except a handmade, non-reproducible map of all or part of any American city. A great need exists for both inexpensive and portable urban maps that would enable blind individuals to travel freely about the city. Part of the reason for the scarcity of tactual maps is that no one has yet found a material both durable and inexpensive that can produce representations with a high degree or tactuality that are at the same time legible visibly.

Five basic types of tactual map processes are currently being used.[4] They include embossed paper maps, dissected relief or planimetric maps of wood or rubber, silk-screened maps, nonreproducible special maps, virkotyping, and molded paper or plastic maps.

Embossed paper maps

Figure 4 is an example of a typical embossed paper map. This one, produced by the Howe Press, Perkins School for the Blind, is a map of the state of Delaware. The legend and place names are in braille and textures are used for areal differentiation between land and water. Selling for only a few cents a-piece, the maps are ink registered to allow for sighted use. Unfortunately, they could hardly be called portable. Prone to creasing and tearing when dry, they completely disintegrete when they become wet.

Dissected relief or planimetric maps

Because they are cut out, dissect relief or planimetric maps resemble a jigsaw puzzle. Used to introduce the blind individual to shape and areal form, they are owned primarily by those agencies offering blind training programs. These balky and expensive map forms offer neither the portability nor economy to be of interest to us.

Silk-screened maps

A most unusual variety of tactual map is represented by the silk-screened atlas of Japan produced by the Osaka Lighthouse for the Blind. Figure 5 shows both a stencil and final map. Rating as one of the most ambitious and imaginative contemporary efforts in tactual carography to date, it is not without its drawbacks. According to Wiedel the tactual forms produced by the hand-cut stencils are particularly effective with respect to point and dotted line work but less so regarding solid line and areal symbols.[5] Wiedel also noted that most subjects, finding the map perceptually clear at first, experienced tactual fatigue using it for any length of time. For this reason and because of the incredible amount of craftsmanship that goes into a map of this kind, the process is not practicable for our needs.

Nonreproducible special maps

Hand-made, nonreproducible, special maps, while of no significant import for our purposes proven often to be ingenious attempts at fulfilling a special need. Several efforts done by individuals at MIT were so simple as to belie their real worth. One we saw was a symbolic physical layout of the main buildings on the campus. A blind student had made it on a Perkin's brailler as someone looking at a campus map described it to her.[6] The braille cell used to form each building was the particular number-name of the building.

Virkotyping

Called virkotyping or thermocraft, this is a relatively recent process that has been extensively used in reproducing braille text. A map plan in shown in Figure 6. Proving to be economical in large runs, the process unforunately employs a paper backing and its tactibility seems to less satisfactory for mapping applications than for brailling. A freshly printed page is dusted with a resinous powder which easily bonds to the sticky ink on the page. When the page is heated, the melted resins transform into a raised tactual image corresponding to the print on the page. The perceptual problem stems from the sharpness of the raised image and its tendency to powder, leaving dust on the fingers and making reading very difficult.

Molded paper and plastic maps

A significant step in tactual cartography was taken when Thermoform Company started to market small vacuum molding machines a few years ago making possible the reproduction of letter-sized molded plastic copies costing only a few cents apiece. Capable of elevations as high as half an inch, thermoforming intoduced a tactual dimension not found in the low-relief samples of virkotyping or paper embossing. As a result, the most meaningful work to date in physical-spatial route mapping has utilized the Thermoform process. A particularly impressive example is Bentzen's Map of the Grounds of Perkins School for the Blind shown in Figure 7.[7] Consisting of several different overlays constructed from collages of sandpaper and balsa wood glued to a heavy tin-foil master, it presents the campus in a series of progressively more-detailed representations. Although the process has a great potential for meeting the needs of agencies and small groups in highly specific applications, it is not suited for mass production. A hand process, labor costs run high for anything but small numbers. Minute variations from copy to copy have created further perceptual problems. In addition many blind people find this brittle material tactually fatiguing.

POLYVINYL CHLORIDE

Unfortunately, every one of these materials possesses one or more limitations with respect to perceptibility, durability, and/or production. In order to produce a truly portable map, we need to find a material possessing a high degree of tactuality but durable enough to withstand the ravages of wind, rain, snow, etc. It was with great excitement we approached the tactual investigation of a new material, polyvinyl chloride, introduced to us by Harry Friedman of Howe Press, that seemed to meet the durability and production requirements lacking in the rest. Originally used to make table mats, this floppy, weather resistant, fireproof material easily rolls and folds without creasing or tearing. Closely guarded by its manufacturers, Plastic Lace, Inc., the process involves heating resinous powders into a core varying two to three sixteenths of an inch in thickness. During the actual heating process, a master surface mold utilizing a photo-engraved plate selectively controls the actual thickness of the material while simultaneously inking the raised portions of the map. The high initial costs of the 4' x 5' master mold are recoverable if several maps are run from the same mold in quantities of fifty or more. We estimate that a two-sided map measuring 1' x 2' feet could be sold for less than five dollars a copy.[8] Although the costs of production are substantially greater than in thermoforming or embossing, urban and geographic map applications having a reasonably large marketability are economically viable within this process.

Convinced that the process could be adapted readily for tactual applications, Friedman in early 1972 produced the first polyvinyl chloride map prototype of Watertown, Square, Watertown, Massachusetts. (See Figure 8.) Consisting of various solid and dashed lines, 1/8" circular point symbols, and three large-screened patterns in the center, the map presented a discrete tactual level approximately 400 micrometers higher than the base surface. After examining some imperfections in one of the reproductions caused by dirt on the original negative and then looking more closely at some of the table mat samples, we thought it desirable to try for an intermediate tactual level. Accordingly, we prepared a test sheet sampling various areal, point, and line symbols, many of which were commercially available in transfer sheets. See Figure 9 and Table 1. In addition we drew a small map segment on the test sheet to see how some of what we judged, at the time, to be the most promising symbols would reproduce in a group context.

TEST SHEET

From the sample we learned although it was possible to produce an intermediate level that there were some constraints restricting the use of each level. Generally speaking, thinly drawn symbols, whether dots, lines or textures, comprised of thinly drawn lines or points, reproduced as intermediate levels. The thicker symbols formed a higher tactual level. The highest level areal symbols including textures and clusters of point symbols and lines were most easily discernible. At the intermediate level, some textures, maintaining a high degree of visual legibility were not tactually differentiable from one another. What we found in testing this sheet was that even though many blind subjects could differentiate between a number of textures, the differences in some cases were subtle enough that they could not always be remembered. With practice, however, a growing familiarily with the symbol was often sufficient to overcome the initial ambiguity.

Nolan's work, while of some help in formulating the group of point symbols, studied for the most part symbols at a much larger scale than would be practical for the kind of map we were proposing.[9] Therefore, we tested smaller symbols to see if we could find a minimum size that could be used effectively on the map. In our initial tests with the map segment on the test sample, we learned how much symbol perceptibility depended on the way point and line symbols were used in conjunction with the areal fields. For example, the intermediate areal symbol offers one distinct advantage over the high field areal symbol: namely, that line and point symbols superimposed into an areal field are buried in the higher areal level but are tactually discernible in the intermediate level.

Encouraged by the results of the sample sheet, we wanted to construct a map of sufficient detail to challenge the process, but it was necessary first to determine the scale and content of the map. In our next chapter, we examine the suggestions of the MIT and Harvard blind students whom we consulted regarding information to be included on a tactual map. We also turn to the experiences of several mapologists to learn about some of the problems of representation by familiarizing ourselves with their work.

TABLE 1 SAMPLE TEST SHEET SYMBOLS

See Sample Sheet (Fig. 9)

C = Chartpak L = Letraset P = Paratone H = Hand-drawn

Arch = Architectural Cart = Cartographic Geo = Geological Gen Des = General Design

Line B = Line Border Line G = Line, Grid Ran Dots = Random Dots Zip = Zip - a - Line

SYMBOL		EXECUTION		SYMBOL		EXECUTION	
High Areal Symbols:							
H 1	Coquile pattern	P	Geo 669	H16	Texture	L	Arch LT 137
H 2	Fiberous dense	L	Instantex 6	H17	Dot screen	L	Ran Dots LT 144
H 3	Fiberous light	L	Instantex 7	H18	Dot screen	L	Ran Dots LT 146
H 4	Solid	L	Instantex L 20	H19	Dot screen	L	Ran Dots LT 90
H 5	Textile pattern	P	Texture 319	H20	Open circle screen	L	Cart LT 129
H 6	Weave	L	Instantex 9	H21	Dot screen	L	Ran Dots LT 115
H 7	Weave	L	Instantex 3	H22	Dot screen	L	Ran Dots LT 114
H 8	Texture	L	Instantex 4	H23	Dot screen	L	Ran Dots LT 113
H 9	Mezzotint heavy	P	Texture 320	H24	Parallel lines	L	Line G LT 77
H10	Stone	L	Cart LT 181	H25	Parallel lines	L	Line G LT 950
H11	Stone	L	Cart LT 182	H26	Diagonal lines	L	Geo LT 923
H12	Light spots	L	Gen Des LT 98	H27	40% dot screen	L	Mech. Screen LT 11
H13	Bricks	L	Arch LT 163	H28	30% dot screen	L	Mech. Screen LT 10
H14	Line segments	L	Geo LT 132	H29	70% dot screen	L	Mech. Screen LT 7
H15	Line segments	L	Geo LT 131	H30	60% dot screen	L	Mech. Screen LT 6

SYMBOL		EXECUTION	
H31	50% dot screen	L	Mech. Screen LT 5
H32	Texture	P	Zip Tex 6012
Low Areal Symbols:			
L 1	Sandpaper	L	Gen Des LT 97
L 2	Fine herringbone	L	Gen Des LT 179
L 3	Medium herringbone	P	Texture 274
L 4	Sandpaper	L	Gen Des LT 934
L 5	Sandpaper	L	Cart LT 944
L 6	Line segments	P	Geo 284
L 7	Line segments	P	Geo 285
L 8	Sandpaper	L	Arch LT 935
L 9	Dot screen	L	Ran Dots LT 913
L10	Dot screen	L	Cart LT 143
L11	Dot screen	L	Geo LT 912
L12	Dot line row	L	Geo LT 164
L13	Diamond screen	P	Discontinued
L14	Medium gravel	P	Geo 271
L15	Dot screen	L	Mech. screen LT 9
L16	Dot screen	L	Mech. screen Lt 8
Lines:			
A	Dots 14/inch	C	21461T
B	Squiggle	C	22561T
C	Lind-square	C	42761T

SYMBOL		EXECUTION	
D	Alternating lines	H	
E	2 Parallel lines	H	
F	T's	H	
G	Sawtooth small	H	
H	2 parallel dot rows	H	
I	Dot-dash	H	
J	Dots 20/inch	H	
K	Dots 16/inch	H	
L	Saw tooth large	H	
M	Sawtooth medium	H	
N	Stars	P	Zip 240
O	Stars	L	Line B 83-103
P	Stars	C	TL 804A
Q	Stars	L	Line B 83-103
R	2 Squiggle lines	P	Zip 221
S	Loops	P	Zip 228
T	Off-set sine waves	L	Line B 83-103
U	Off-set sine curve	P	Zip 217
V	Wavy line large	P	Zip 224
W	Wavy line small	P	Zip 225
X	Wavy line smaller	P	Zip 226
Y	Dot field	P	Zip 278
Z	Parallel lines	P	Zip 301

SYMBOL		EXECUTION	
AA	Parallel lines	P	Zip 302
BB	Parallel lines	P	Zip 218
CC	Parallel lines	P	Zip 207
DD	Parallel lines	P	Zip 254
EE	Parallel lines	P	Zip 252
FF	Line, Medium	P	Zip 293
GG	Line, Small	P	Zip 249
HH	Line, hairline	P	Zip 250
II	Thick dashed	P	Zip 260
JJ	Thick dashed	P	Zip 261
KK	Medium dashed	P	Zip 258
LL	Small dashed	P	Zip 264
MM	Small dashed	P	Zip 257
Point Symbols:			
a	3 sided square	H	
b	T	H	
c	3 dots	H	
d	2 parallels	H	
e	Oval	H	
f	V	H	
g	Wiedel elevator	H	
h	Wiedel step	H	
i	4 dots (circles)	H	

SYMBOL		EXECUTION	
j	4 Dots (squares)	H	
k	Open circle	C	RDL 299
l	Open square (small)	C	TPDD 237
m	Open triangle	C	TPTT 233
n	Open triangle (small)	C	TPTT 936
o	Open Square (large)	C	RDS 20
p	Open Square (medium)	C	TPSS 1114
q	Open circle (small)	L	553
r	Solid circle (small)	L	553
s	Open triangle	P	522
t	Open star	C	RDSR 30
u	Solid triangle	L	PT 117
v	Asterisk	L	PT 117
w	Asterisk	L	PT 117
x	Solid triangle	P	55008
y	Thin-lined open sq.	P	55008
z	Thin-lined open cir.	P	55008
aa	Small open triangle	P	523
bb	Thick-lined open cir.	C	RDC 16

CHAPTER NOTES

1. Leonard (1966) "Aids to Navigation", p. 8.
2. Ibid., (1970), p. 171.
3. Sherman (1965), pp. 130 - 134.
4. A process which chemically etches tactual levels into plastic sheets has been used to produce credit cards and forms for printing work. The little research conducted to date into its tactuality indicates a potential for some kinds of tactual displays. There are problems to be overcome. Visually attractive, the two-color samples we saw were sharp and hard to the touch. There is a possibility that a softer plastic could be used to improve its tactuality, see fig. 16.
5. Wiedel (1969), pp. 2 - 3.
6. Alice Bailey, interview # 12, p. 168.
7. Reproduced with Mrs. Bentzen's permission from her unpublished Master's Thesis, Boston College, (1970)
8. This estimation is subject to the approval of Plastic Lace, Inc., Peabody, Mass.
9. Nolan (1971), 83 pp.

PROBLEMS OF CONTENT AND REPRESENTATION

4

PRELIMINARY CONSIDERATIONS

If the design of the campus map involved only the transformation of a visual map into a suitable tactual format, this chapter would not have to be written. We could, in fact, take the map supplied by the MIT Information Office, shown in Figure 10, ink-trace it onto a vellum sheet occasionally changing some of the solid lines into dotted ones, photograph the finished map, and send the negative off to make the photo-engraved plate for reproduction. If it were only that easy! Unfortunately, there are two major problems not to be overlooked: content, what to show; and representation, how to show it. Is the information that is important for a blind traveler the same that is presented on a visual map? What are some of the special representational problems of a tactual format and how can they be solved?

A QUESTION OF CONTENT

We had to keep reminding ourselves in the beginning of this project that the information presented on a printed map was intended for people who can see their environment, who think primarily in terms of visual landmarks, and who with one sweep of the head can grasp enough information to move about comfortably within a strange and unfamiliar environment. A blind person has to devote considerably more effort and energy towards closing the information loop from map to environment and back again because of his highly fragmented perceptual impressions. Many meaningful landmarks for a sighted person are not perceived by the visually handicapped or when they are, present a much less satisfactory auditory and haptic perceptual range. The city skyline, shapes and colors of buildings, signs, and other visual displays, all important reference points for a sighted traveler, are worthless as orientation and navigation aids for the blind individual.

It was for this reason that we went directly to some of the blind MIT and Harvard students to ask them how the campus revealed itself. We were interested in learning about the environmental cues they felt were the most meaningful and reliable, and we also hoped to gain some insight as to how they actually conceptualized the built relationships on the campus. We have included transcripts of these meetings in the Appendix and a comparative summary is presented in Table 2. While there were individual variations, the physical campus was most strongly characterized for the majority of them in terms of circulation. Every one of them organized the campus around the routes they were most familiar with. Those with a larger route repertory actually conceptualized simple physical-spatial patterns by superimposing their individual trips upon a simplified street network.

CAMPUS CONCEPTUALIZATIONS

The students' images of the campus most frequently were descriptions of an interconnected group of buildings, but there were some interesting variations. AD characterized his image as a maze with the central buildings connecting like dominoes.[1] BC's image expressed itself non-physically as a symmetric arrangement of building numbers.[2] JK, who had never visited the campus, surmised from various descriptions that he had heard during his four years at Harvard, that it was comprised of long, barn-like buildings.[3] The boundaries for each of the MIT students varied according to their individual mobility experiences. For everyone, Massachusetts Avenue was a predominant structural feature. In the case of AD, CN, and GL, it divided the campus in half. For BC and ML who spent most of their time on the eastern parts of the campus, Mass. Ave. constituted a prominent western feature, Vassar St. and Memorial Dr. being frequently mentioned routes and boundaries. The interior corridor leading brom the Bldg. 7 lobby through the main complex to Bldg. 8 was cited without exception among the MIT students and one staff member as being a principle route and the fundamental element upon which their overall understanding of the main building complex was based.

HAZARDS

We were surprised to learn from our interviews that negative environmental qualities took precedence over their positive counterparts. Almost all of the students favored choosing a route that would minimize potential hazards rather than enhance the variety of sensory stimulation of the trip. Occasionally preferences for an indoor or outdoor route would emerge according to the season. But by and large, pleasant travel was synonymous with maintaining as much composure as possible. The hazards they described fell into three categories. The passing-chance event was unanimously held to be the most difficult to cope with. Citing snow, potholes, cracked sidewalks, chained bikes, and trucks blocking sidewalks, they said they preferred to take a longer route any day to avoid these hazards. Fixed-obstacles such as outdoor sculptures and unexpected trees and posts comprised a second hazard, which once encountered, fortunately, could be subsequently avoided. Interestingly enough, the Great Sail, a large metal work by Calder sitting on the south side of the Green Building, served as both a landmark and obstacle. BC said she could easily detect it using echo perception, while AD, on the other hand, had collided with it more than once.[4] Confusing architectural definitions posed yet another set of problems. The Built Form platforms in the lobby of Bldg. 7 baffled all of the students. Similarly, the steps leading up to the second floor of the Student Center were difficult to understand because they led in the opposite direction in which one wanted to go.[5] Because of its lack of shorelines, the large plaza in front of the Student Center presented problems too.

STUDENT SUGGESTIONS

Although a third of the students had never used a tactual map before, we asked all of them what information they would find helpful on a campus map. Their suggestions included: a general outline of the buildings, streets*, sidewalks*, steps and the direction of steps*, various paving textures*, major interior corridors, entrances and specific entrance types*, mailboxes, hedges*, restaurants and cafeterias, and parking areas. In addition to the value of knowing the whereabouts of those features asterisked, they comprise meaningful local landmarks that the blind person readily perceives using prescribed mobility techniques. They can be used together to close the information loop from environment to map. For example, although he can not see the entrance to Bldg. 7 from the Student Center plaza, a blind person can verify his position with respect to where he thinks he is on the map by comparing the actual sequence of these feed-back cues to the predicted one. By noting discrepancies he will be alerted to errors in his course which he can try either to correct by himself or solicit aid. Fortunately these landmark cues occur frequently enough that he can confidently use them to find almost any place he wants to go. It is just a question of making sure they are clearly and accurately represented on a route map.

The students offered other helpful suggestions. Several felt that a braille or taped guide would be useful in introducing and supplementing the map. Bentzen reported similar responses from three of her test subjects.[6] Proscia urged that the map be made in a way that was compatible with sighted use. It would then be possible for a sighted person to help the blind reader if he had trouble interpreting something on the map.[7] Having seen Friedman's Watertown map, JK liked the pvc material and suggested that we use the back side for braille and keep the front for physical things like buildings and streets. Bentzen had used several overlays on her map of Perkins successfully. IS felt that the braille would be easier to read if it ran in only one direction. We agreed with him, remembering the difficulties several of these people had in deciphering the braille on Friedman's first map. Wiedel argued that if north was the top edge of the map, the braille could be placed at any angle as long as it could be read from west to east or south to north. Although it worked for him, we believe this kind of alignment makes for slower reading and may actually prove to be confusing if substantial amounts of information have to be brailled on the map.

THE REPRESENTATIONAL PROBLEM

We have reached a point where the questions of content must also embrace a representational analysis. In order to make the wisest selection of content, we need to determine the kinds and number of symbols that can be presented clearly on tactual maps. Wiedel has argued for the standardization of mapping symbols. It seems to us that until a reasonable process capable of producing a legible and portable map is universally accepted, this standardization cannot happen because each process has its unique representational characteristics. Symbols working well in thermoform cannot be counted on to be perceptually clear in polyvinyl chloride or embossed paper. Similarly each of these processes has differing characteristics with respect to resolution, tactual levels, and perceptibility. Because of significant problems with hand-drawn symbols, we would like to see the development of a sheet of transfer symbols compatible with photo engraved techniques common to several of these processes.

Despite representational variations between processes, the research conducted by Wiedel and Bentzen has spotted particular areas of concern that apply to all tactual maps. Wiedel found that the importance of linear scale decreases as the map scale is enlarged.[8] Both he and Bentzen took advantage of this fact by distorting for the sake of a greater perceptual clarity. In her Perkins map, Bentzen kept parallel line symbols and point symbols at least an 1/8" apart by stretching building outlines and relationships between symbols. Besides distortion, two other methods have been used to alleviate the problems of tactual clutter. It is possible in thermoform to obtain a variety of elevations and thereby relegate symbols to specific tactual levels. Wiedel felt that by keeping braille at the lowest level he was able to increase the legibility of the map. Overlay techniques such as the ones developed by Bentzen in which information is registered from sheet to sheet can significantly reduce the amount of symbology on any one sheet.

Both Wiedel and Bentzen feel that the optimum map size is a 12" square, the maximum area that can be surveyed in the space of two palm spans. Wiedel suggests that this size might be increased if orientation points are located within one hand span of each other. It should be noted that both Wiedel and Bentzen were limited to this map size because of the size of the thermoform machine they were using. Larger mobility maps need further testing before they can be adequately evaluated, but they at least offer the possibility of presenting more information simply.

There are several other points worth mentioning here. Wiedel found that it was preferable to mark the entire north edge of the map than to use a single point indicator. He also developed a directional stair symbol which clearly indicated whether the steps were ascending or descending. Leonard and Angwin discovered that dotted lines are tactually clearer than solid ones. Wiedel's tests confirmed that a line of 20 dots/inch was easiest to follow and he therefore used these for sidewalks and recommended pathways. To date, a variety of point, line and areal symbols have been tested, a usable number of which have been found discriminable in the media of virkotype, thermoform, and embossed paper. Some of the symbols were designed and produced in hand processes while others were considered for high-volume mechanical production. Unfortunately, there has been little research in trying to cross-correlate the various symbols to see how they reproduce in those processes other than the ones for which they were specifically intended.

TABLE 2
SUMMARY OF INTERVIEWS

	AD	CN	ML	BC	GL	VITO PROSCIA	IS	JK
	MIT undergrad student Aero-Astro	MIT undergrad student Major undeclared	MIT grad student Economics	MIT grad student Economics	Harvard grad student MIT undergrad. Physics	Director, Sensory Aids MIT, MS Columbia, Elec. Engr.	Harvard undergrad student, Social Relations	Harvard undergrad student, History
1. TYPE OF BLINDNESS:	Adventitiously blind at age 5.	Adventitiously blind at age 11. A little residual vision.	Congenitally blind. Monocular vision until age 4. A few visual memories.	Congenitally blind. Some residual vision in one eye.	Legally blind. Has some vision in both eyes. Wears glasses.	Adventitiously blind at age 12.	Congenitally blind.	Congenitally blind.
2. MOBILITY AID EMPLOYED:	Collapsible MIT cane.	Non-collapsible cane.	Used cane until Feb. '72 when he got a Seeing Eye dog. Used Kay's binaural spectacles for 1 year, with the cane. Prefers non-collapsible cane.	Non-collapsible cane. In familiar places like her apartment & Sloan Bldg., travels without a cane. Used collapsible cane until elastic broke.	Travels around MIT without a cane. He would carry a non-collapsible cane in an unfamiliar place.	Collapsible cane. He has used the Path-sounder & Tac-Com. Has metal heel plates on his shoes. Carries compass in unfamiliar places.	Non-collapsible cane. Has tested & broken MIT collapsible canes.	Collapsible cane. Travels without a cane in familiar environments.
3. MOBILITY TECHNIQUES:	Had mobility instruction in cane.	Had mobility instruction in cane.	Had mobility instruction in cane, dog, spectacles.	Had mobility instruction in cane.	No mobility training. Self-taught.	Had mobility training in cane.	Had mobility training in cane.	Had mobility training in cane.
	He memorizes routes. Initially someone shows him routes. Thinks in terms of N,S,E,W. Uses echo perception. "Once you're familiar with MIT interior routes, they're easier than exterior routes."	Usually has someone show her new routes.	Uses echo perception.	Asks for directions. Her technique is automatic except when it's icy. Thinks in terms of right & left. Uses echo perception.	Tries to memorize a pattern by picturing a logical circuit in his mind. Uses echoes of different spaces.	Solicits aid. Uses echo perception.	Memorizes routes. Someone usually shows him new routes. Thinks in terms of N,S,E,W. Uses echo perception.	Usually his wife shows him new routes. Uses echo perception. He would study a map before taking a trip.

	AD	CN	ML	BC	GL	VP	IS	JK
4. HOW INTRODUCED TO CAMPUS INITIALLY (MIT OR HARVARD):	Learned MIT himself. Asked people, then went on his own. Learned Main Bldg. and connected buildings in a week.	Freshman guides showed her the MIT campus. Used a map of MIT (for the sighted) with building numbers in braille.	Had peripatologist show him Sloan Bldg. and MIT campus.	Gave map of MIT to her husband & he showed her the campus.	Relied on visual cues initially to learn his way around MIT. Other freshmen helped him. There was formalized assistance the first few days & then he struck out on his own. He would have liked to have had a map. He was very lost at first.	His secretary & to some extent his wife showed him the MIT campus.	His mobility instructor showed him the Harvard campus.	He tried to get a mobility instructor but could not since he was an out-of-stater. His wife showed him the Harvard campus.
5. YEARS AT MIT:	$2\frac{1}{2}$	3/4	4	4	4	$4\frac{1}{2}$	0	0
6. PLACES ON MIT CAMPUS WHERE SPEND THE MOST TIME:	Senior House, Project MAC Bldg. 39, Sensory Aids Center Bldg. 31.	McCormick Hall, main complex of buildings.	Sloan Bldg. (E52), Comp. Center Bldg. 39.	Eastgate (E 55), Sloan Bldg. (E 52).	Baker House, Bldg. 20.	Sensory Aids Center (Bldg. 31).	None.	None.
7. PREVIOUS MAP EXPERIENCE:	None.	Used maps when had vision. Used a map of MIT for the sighted with bldg. numbers in braille prepared during her first week at MIT. Used a map of MIT made by a friend out of braille cells. It indicated bldgs. and routes of the central part of the campus but no names.	Used a lot of maps. Used map of London & British Isles geographical maps. Bentzen's maps. A lot of other tactual material like diagrams & circuits.	Used Sherman's model of Univ. of Washington campus.	Had not seen a map of MIT. Had used tactual geographic maps & orientation maps describing bldgs. They were not very helpful. They were complicated & difficult or so simple that they did not convey enough information.	Used maps when he had vision. Had felt Howe Press paper maps. Had used Bentzen's thermoform maps. Had read Gilligan's raised blueprint map of the MIT campus.	None.	Had map courses for history. Had used embossed paper maps with braille. Geography around the world (countries, cities, rivers, mtns) Can't put it all together. Map work on U.S. last year was helpful.

	AD	CN	ML	BC	GL	VP	IS	JK
8. IMAGE OF THE MIT CAMPUS:	A maze. Conglomeration of bldgs. Bunch of perpendicular streets. Horseshoe of bldgs. around Great Ct. Central bldgs. connected like dominoes. Bunch of things sticking off in all crazy directions.	A bunch of buildings sprawled together.	Main Bldg. - Bunch of bldgs. interconnected. Behind that & northwards is a large open area that has a lot of bldgs. & cross sidewalks in it.	Symmetry of building numbers.	A complex of buildings arranged in a schematic structure. Main Bldg. is a long hallway that branches off into various bldgs. Thinks mainly of streets & sidewalks.	A large number of buildings that runs along a strip along Memorial Drive.	None (Been to MIT once).	Long buildings that look like barns. (Never been to MIT).
9. BOUNDARIES OF THE MIT CAMPUS:	Memorial Drive & the Charles River on the south, Kresge on the west, Vassar St. and Project MAC on the north, Kendall Sq. on the east.	Charles River on the south, McCormick on the west, Sensory Aids on the north, 26-100 on the east.	Vassar St. on the north, Memorial Drive on the south, Kresge on the west, and Sloan Bldg. on the east.	Wadsworth St. & Main St. on the east, Memorial Drive and Charles R. on south, Chapel on west, northern boundary unknown.	Vassar St. on the north, Ames St. on the east, Memorial Drive & Charles River on the south, McGregor on the west.	Mass. Ave. on the west, Memorial Drive on the south, Vassar St. on the north, Ames St. on the east.		
10. LANDMARKS: STRUCTURAL FEATURES:	Charles River. Mass. Ave. defines middle of campus. Thinks of things being east or west of Mass. Ave. Also: Vassar St., Main St., corridors, smaller streets, walkway to Kresge.	Main corridor in Main Bldg., Mass. Ave.	Memorial Drive, Vassar St., Main St. Memorial Dr. & Vassar St. are principle periphery routes to most buildings on the campus.	Mass. Ave., Charles River, Main St.	Streets like Mass. Ave., & sidewalks.	Perimeter routes and streets.	Street blocks.	

	AD	CN	ML	BC	GL	VP	IS	JK
LANDMARKS: REFERENCE POINTS:	Great Court, Bldg. 7 lobby.	Bldg. 7 lobby, McCormick, Student Center	Steps in front of Bldg. 7, Main Bldg., Computation Center, Med. Dept. 26-100.	Bursar's Office, Med. Dept., Grad. Dean's Off., Bldg. 10 lobby, Bldg. 7 info center, Gt. Sail, Walker (garbage smell; pin-ball machine at night) Comp. Center (strange smell).	Interior stairwells, intersections, Baker House, Kresge, Bldg. 20.	Sensory Aids Center in Bldg. 31, Bldg. 7 lobby.		
11. CUES:	Floor surfaces, office sounds such as typing, Sun radiation, Rubber runner in Bldg. 7 lobby.	Traffic sounds on Mass. Ave., Student traffic in the main corridor, Interior & exterior staircases.	Traffic noise. Smell of F & T Diner on Main St., Driveways to fire station on Main St., Rug in Sloan Bldg. lobby, Echoes.	Traffic noises. Steps Echoes. Air conditioning in Comp. Center. Echo from Great Sail. Water flow.	Traffic noise. Rubber runner Bldg. 7 lobby. Brick area around Kresge. Visual cue of moat around Chapel. Can see large openings in walls. Can see traffic light at night. Can see path textures. Colors. Intersections of major corridors.	Traffic noise. Rubber runners. Large interior space is an auditory cue. Can tell large space from corridor by echo environment & air flow difference. From air flow, can distinguish if elevator is going up or down even if doors closed. Temperature differences. Formaldehyde in Bldg. 56 - nutrition bldg.- cooking smell. Brigham's on Ames St. is a smell cue. Stairs - people walk differently on them. Blacktop different auditory cue from concrete.	Traffic noise. Heavy traffic vs. light traffic. Direction of traffic (one-way). Smell is an aid. Exhaust fans from food places. Curbs. Shorelines. Wind (It's more windy on a corner).	Surface textures. Echoes from walls, doors, cubby holes, openings, lobbies.

	AD	CN	ML	BC	GL	VP	IS	JK
						Sun radiation. Curb lines. Grass lines. Slopes. Echoes off trees & poles. Street crown. Water flow (sewer, water fountain).		
12. HAZARDS AND CONFUSING SITUATIONS:	Grass disorients you. Intersection of Main St. & Vassar St. and parking garage. Rotten sidewalks. Great Sail. Other randomly placed artworks.	Built form in lobby Bldg. 7.	Stairs to second level of Student Center. Great pine tree by Vassar St.	Street potholes and cracked sidewalks. Unlevel streets. Ice. Bikes chained to stair railings. Loading docks. Beasts that drive around. Local hoods.	Parking lots because no cues. Columns in Bldg. 7 lobby. Patterns of sun & shadows confuse him. (He gets around better when it's cloudy). Ladders in corridors. Gets disoriented in lecture halls.	Loading docks. Intersection of Main St. & Vassar St. & parking garage (W70). Jogs in corridors. Out of the way locations of steps & elevators are a problem. Snow.	Street crossings around Harvard Square.	Snow. Street crossings with islands. Orientation in lecture halls.
13. DESCRIPTION OF BLDG. 7 LOBBY:	Spatial. Impression that ceiling is way up there. Big open area with bleachers. Hallways to the right and left. Pillars around the edges. Knows where telephones, elevator & information center are.	Big open space with garbage on the sides.	If come in near electric door & go straight on you will get into a wide corridor which will lead you to Bldg. 10. Other hallways happen off Bldg. 7 lobby. Echoey. Feels wind directions from doors to get out main doors	Information Center. Echoes. Watches her head so that she will not hit it on built form in Bldg. 7 lobby.	Very big. Dimensionally very high. Pictures balconies around it. Knows where entrance door is & hallways to Bldgs. 5 & 9. Knows location of information center & telephones. Knows where columns are because he has to avoid them.	A large expanse in both directions. Hallway to Bldg. 5 on rt. Hallway to main corridor straight ahead. To the left are rooms, corridors, & stairways. Randomly placed obstacles are in the expanse. Catwalks at the second level. Visualizes lobby as a large		

	AD	CN	ML	BC	GL	VP	IS	JK
						space rather than a corridor. It's large in the x - y direction, rather than z direction. He thinks that there are balconies all over the place but does not imagine it that way.		
14. SUGGESTIONS FOR THE MAP:	Elevators. Exits. Stairways. Major offices. Telephones. Mailboxes. Entrance types - specifically, revolving, electric, and swinging.	General outline of buildings.	Map should be clear sighted as well as for the blind. Food shops.	Building relationships. Whether the building numbers are odd or even. Restrooms. Room numbers. Interior routes. Where you can cut through buildings.	Bathrooms.	Bldg. locations. Walkways. Hazards. Streets. Hedges. Driveways. Pkg. lots. Corridors. Stairways. Restrooms. Elevators. Stair direction. Entrance type: electric, revolving, swinging. Rubber runners in large expanses. Different surfaces if not clutter map. Mailboxes. Water flow (sewers, water fount). Drinking fount. Embossed arabic numerals better than braille.		
15. OTHER:	Raised arabic room nos. on doors/ beside doors. Braille menus. Braille St. names on sign posts Raised indication for men's & women's rooms.		Verbal supplement to the map. Brailled index.	Raised arabic numerals on elevator buttons.	Verbal supplement to the map.	Verbal supplement to the map.		Braille on vending machines comes off.

CHAPTER NOTES

1. AD, interview #16, p. 241.
2. BC, interview # 14, pp. 207 - 208.
3. We asked JK to describe the campus before presenting the first tactual map to him. In this way, we could evaluate the contribution of the map to his conceptualization of the campus.
4. AD, interview #16, p. 254.
   BC, interview #14, p. 213.
5. Vito Proscia, interview # 13, p. 197.
6. Bentzen (1970), p. 55.
7. Vito Proscia, interview # 9, p. 163.
8. Wiedel (1969), p. 49.
9. Bentzen (1970), p. 29.
   Wiedel (1969), p. 16.
10. Angwin (1968), p. 118 - 119.
    Leonard (1966) "Aids to Navigation", p. 10.

DESIGNING THE HAPTIC MAP

5

CAMPUS SURVEY

Before we could draw a map, we had to spend considerable time and effort surveying the campus on bicycle. We noted parking lots, obstacles, steps and entries and tried to locate any discrepancies or errors on our copy of the base plan of MIT. Much of the information we gathered was not provided on any of the available campus maps. Mailboxes and bus stops had to be located, routes updated, pavements and curbs examined in order to decide what should be shown as parking area and what as plaza. At the same time, we had to determine how the entrances around the campus were used. From this analysis we divided the entrances into three groups: primary, secondary, and those not suitable for blind use. Primary were the most heavily traveled on the campus. Secondary were less frequently used, but nontheless provided useful cues with respect to shorelines and sounds. The last group comprised out of the way entries which were either off the safe path or so concealed that even the sighted person unfamiliar with the area would not use them. (Refer to Fig. 11)

CRITERIA FOR THE MAP DESIGN

The plan of the map on the front side included all the basic physical information and a few appropriate symbols such as traffic lights and bus stops. Refer to Table 3 for a complete listing of what symbols were used on the map and how they were made. The back side contained the more specific, brailled and symbol information that could be approached selectively such as building and street names, door types, and overhead links. In actuality, the sample that was produced comprised two pieces of polyvinyl chloride which were stapled together. It would be possible to heat seal the sheets together in a commercial version. Problems of registration had to be worked out carefully before the braille and symbols were drawn on the back side. Showing the middle third of the campus, the map prototype was 17" x 21" in size. Rather than introduce a specific set of reference points, we opted for a grid similar to the one Bentzen used on her Perkins map. Occurring at one inch intervals, the lines ran down both sides of the map and across the bottom and were labeled by brailled letters or numbers on the back side.

We wanted to find a way that would naturally encourage the blind reader to hold the map face-up so that a sighted person could see the front side. One of the problems with opaque overlays like braillon is that a sighted person cannot see through the overlay pages in the same way a tactual reader can. After some consideration, we devised a method of reversing the braille on the back side so that if thought of as appearing on the front side it would read correctly. We tested this method with some of the proof readers at Howe Press, and they said it presented no problems. It remained to be seen, however, how the building, street, and legend brailled information would be perceived on the back of the map using this inverted brailling running from right to left.

One of our first tasks was to find a way of clearly labeling the map for the sighted that would not confuse the tactual reader. The easiest method would have been to take the finished tactual map to the printer. Friedman felt that we should look for an alternate method to be implemented during the initial run where the heated resin powders melted into the tactual impressions. It would reduce the overall cost of the map by making it a one-step process. We therefore went back and studied the Watertown map and some of the table mat samples to see if it was possible to camouflage words and arabic numbers in the textures themselves. We tried two techniques on the sample sheet. First, it seemed to us that a small impression in the raised solid texture would be much less tactually perceptible than its reciprocal image reaised on the base of the map.We reasoned that if we could find a white letter small and thin enough to use in the solid building texture, it would barely be tactually perceptible. The letter we used in the test sample was a little big, but we believed a smaller letter size would still work. The second way was to hide the letter in the grass. In the sample we confirmed that words were tactually imperceptible in a grass field. The problem was that they tended at times to bleed visually into the grass field, but since they were legible we used this method on the first map.

We tried whenever possible to provide symbol groups with the logic of the physical relationships they represented. In doing so, we could reduce the total number of symbols contained on the map. For example, there was no need to use a special symbol for crosswalk which could be represented just as clearly by superpositioning the path over the street. Similarly, the intersection of building and path signalled entrance. We chose, however, to notch all primary entries to facilitate finding the door-type symbol registered on the back. Roads could be defined by two parallel sidewalks, because of the instances where two sidewalks ran parallel with no roads in between.

With one exception we used all of the definitions that were recommended to us by the Harvard and MIT students. Omitting the hedge because it crowded sidewalks, we added several symbols that would alert the blind traveler to certain conditions that normal mobility practice could not always be relied on to pick up. An obstacle symbol located fixed hazards such as sculptures, problem trees, and the particularly confusing architectural definitions that were pointed out by the blind students themselves. On the back of the map we represented a very valuable sound cue mentioned in the interviews. Called the overhead link, it defined second story building connections and outdoor underpasses such as the lower entrance leading into the Student Center.

AREAL SYMBOLS

Six areal symbols appeared on the front side of the map. We chose the highest and clearest symbol on the sample sheet for the buildings, a solid field. We used a low dot screen to indicate grass and all the things that were not covered by the other areal textures. Likewise a low field marked the plazas. It was necessary to use the low field in both instances to enable the superpositioning of other symbols like steps and obstacles onto these surfaces. There were only subtle tactual differences between grass and plaza which could be distinguished on the test sample. It remained to be seen how easily they could be discerned on an actual map. We used high field textures to show water, parking and service roads, and the ice rink since no superpositioning had to occur in these areas.

LINE SYMBOLS

Line symbols indicated major and minor paths, walls, railroad tracks, and principle interior corridors. The unfamiliar blind traveler was encouraged to stick to the major paths because they were the safest and easiest to traverse. The minor paths, alternative routes, were represented with a smaller line symbol. Running through the center of the main complex was an artery of corridors that were important enough to be included on the general campus map. We used thick dashed white lines through the center of the buildings to show these principle interior routes.

POINT SYMBOLS

Point symbols appeared on both sides of the map - all of which had been taken from the test sample sheet. Modifying the 'T' stem of the Wiedel step symbol, we converted the dots into two small squares in order to sharpen the distinction between the stem and dotted paths.

The challenge was to design the map in a way that would clearly present all the information we wished to show. When in doubt in a test prototype it was better to allow too much rather than too little room between symbols. The scale we chose not only had to work on the front but also had to leave enough room between the braille and symbols registered on the back. After trying several different scales to find the smallest one, we decided on approximately 1" = 125' for the building and grounds. In actuality, the buildings were drawn proportionally smaller than their surroundings to allow more room in between for symbols. Jogs were eliminated from many buildings, and certain areas distorted to provide more room between symbols. We had to be careful that in distorting an area like the Student Center plaza we did not irreconcilably throw off larger relationships. It could only be worked out through a trial and error process.

We realized soon after we began to draw the map that it was going to be difficult to predict what some of the tactual transformations would be like. Would symbol X feel as different from symbol Y as it looked. Would they reproduce as well in grass as they did on the base field of the sample sheet. At the very least it would be necessary to evaluate the tactuality of the symbols within the context of the map. In the two weeks following the production of this first map, we spent several hours testing it with each of the students whom we had initially interviewed.

THE FIRST COPY

The hand produced map shown in Figure 12 is much more variable quality-wise from copy to copy than if it had been run on the standard production mold. In our copy the visual resolution was poor because the dye used in coloring the raised areas smeared as the sheets were pulled from the matrix. Tactually, there was little difference between the hand-run and mass-produced techniques except for a few places where the areal symbols were less sharply defined. It should be emphasized that this hand run is only used to test prototype designs and that the final map would be run on the bigger mold.

We were disappointed with the quality of our hand-drawn symbols because of their poor resolution. (See Figure 13&14) Drawing them on the base vellum sheet, we did not realize that the acetate overlay containing the transfer texture would partially obscure them in the photographic process. Similarly the major path symbol shown in Table 3 visually and tactually bled into the grass field. An even greater drawback of the hand-drawn point symbols was the variability in their line width and overall size. It would be necessary in future maps to devise templates or adapt transfer-sheet symbols to correct the problem. For these reasons, we were not at all certain that the map would be comprehended by the tactual reader. In the series of eight tests we conducted, despite its problems the map demonstrated a measure of success that we had not expected. We were surprised by the enthusiasm with which all of our subjects responded to the map, the most detailed they had ever read.

Our tests involved reading sessions rather than actual trips made, map in hand. The preference of the students was for a map that they could study at home. Most were accustomed to memorizing a route before they traveled it alone. However these were MIT students who already had achieved a high level of familiarity with portions of the campus. The blind traveler visiting the campus for the first time might actually want a simpler map to carry with him. We were curious to see if the MIT students would be able to recognize familiar locations and routes on the map and perhaps in doing so discover other physical relationships that would be helpful to them. It would also be interesting to see how much of the campus the blind Harvard students could perceive from the map.

RESULTS OF TESTS

We hoped in these tests to answer some of the questions about the representational quality of the symbols and determine how the map was generally perceived. The results of these informal sessions are presented in Table 4. Except for Proscia whom we needed to test in order to ascertain its content, we read a brief introductory statement suggesting that the map be placed with the topside facing up and briefly describing the legend. We also explained that the material on the back was registered with the front.

Almost everyone turned the map over to read the legend. When they finished, they turned the map over again and surveyed it with both of their hands. (Fig.15) Buildings were immediately perceptible. Streets were not so obvious. In particular, the MIT students relied heavily on their campus experience to help them relate the physical structural landmarks and reference points to the map. They readily located

Mass. Ave., the Main Building, and Vassar Street to use as a framework for grasping the more detailed particulars. The Harvard students, neither of whom were familiar with the campus, were much slower in locating and relating these structural features on the map to one another, and having found them, they tended to lose them again. It therefore required a much more concerted effort on their part to scan the map for roads, which were denoted by the base surface of the map. It would be desirable in a subsequent map to define the roads in such a way that they are more readily distinguishable from the rest of the map.

Far and away the most interesting and variable of responses, the braille on the backside of the map initially provoked strong negative reactions from most of the students. Finding it difficult to read at first, some adjusted quite rapidly to the inverted braille format (CN, ML, GL, AD) while others had considerably more difficulty (VP, JK, IS). Because she was not a proficient braille reader, BC could not perform this part of the test. Everyone felt that it would be better to write the legend in normal (writer) braille since they found it easier despite our directions to read the legend when the map was placed with the braille side facing up. Those adjusting quickly were able to read the registered brailled information when the mapside was facing up. After working with the braille for at least an hour, they were asked to evaluate this method. Two responses were negative (AD, VP), three were mildly negative (ML, GL, IS) and two were positive (JK, CN). JK's response was particularly interesting. Initially the most negative of all, he could barely read the braille on the first morning we tested the map with him. He took the map home for a day. Two mornings later we met again. By now, he had become quite adept with the braille and said that he did not think we should change to writer because the map worked well for him this way - he could read the braille with the braille side facing down. From all of this we have been able to determine two things for sure: that for most it takes an hour or so to get used to the inverted braille and that it is then possible to read the map with the braille side facing down. It is necessary now to consider whether registered normally-brailled information can be read when the backside is facing down. If it is possible, then writer braille should be used on the back of the map.

There were other signs besides their words of encouragement that led us to believe that the students were really beginning to use the map as a map. BC said that she had not realized that the Student Center was north of the Mass. Ave. cross walk and sidewalk leading to Kresge. She had not known where Vassar Street was located or that it was a northern boundary of the campus. After only a few minutes on the map GL exclaimed that we had omitted the sailing pavilion. AD called us on an entrance to Bldg. 24 that we had overlooked. Although ML was extremely familiar with the eastern portion of the campus, he was surprised to discover a mailbox on the map that he had never realized was so close to 77 Mass. Ave. CN discovered from the map that the ice rink was not a building but an outdoor area. She located steps that we included between Bldgs. 5 and 7 that were not there and suggested that we include the overhead link symbol between the two halves of Bldg. 54. Later CN told us that the day she kept the map she used it to find a new route to Sensory Aids, Bldg. 31, by way of Bldg. 13.

The obvious need for this map, the encouraging responses of the students, and the committment on the part of the MIT Planning Office to produce a tactual map of the campus has prompted the design and testing of a second tactual map on our part which we hope will represent a significant improvement over the first map. Through the analysis of our test results we have made several conclusions which shall be considered in the design of the second map.

Concerning representation:

1) The design of a map must allow for a wide range of tactual acuity in any user sample. Having little to do with intelligence, these perceptual variations reflect the kinds of experience a person has had with tactual displays as well as possible physiological variations in his make-up.

2) The number of symbols can be reduced on a map if the ones chosen are selectively combined to express additional relationships.

3) Low field areal symbols should not be used together. The low field plaza and grass textures were totally indistinguishable from each other on the map.

4) Three-point symbols including the loading dock, traffic light, bus stop, obstacle, and food were frequently confused.

5) Clear symbols included the mailbox, revolving door, swinging door, building, minor path, north indicator, and water.

6) A tactual system of complex registration, as demonstrated by the front/back correlation on the map tested, presents no problems perceptually.

7) It is important to indicate roads so that they immediately stand out from the other features shown on the map.

8) Acetate overlays should be avoided in the drawing stage because of the resolution problems they create.

9) Symbols in a legend should be grouped according to kind. (i.e., building texture, inside corridor, entrance,all employ the solid field and should be shown together. Streets, service roads, tracks should be grouped together.)

10) Everyone tested preferred writer braille for the legend.

11) Small hand-drawn symbols reproduce poorly in polyvinyl chloride.

Concerning Content:

1) The major/minor pathways proved to be a needlessly confusing distinction. Students tested felt that route evaluation at this scale was a matter of preference which the traveler himself could express by evaluating the hazards represented on the map.

2) If a corridor network is shown, it should be completely stated. Students tested were puzzled as to why when the building turned the corridors stopped.

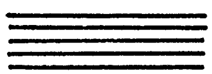
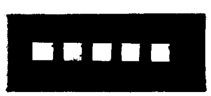
3) In choosing an appropriate symbol for representing physical things, one should consider use first, appearance second. A particularly good example is the Student Center steps. Benches located under a low overhang block access to the lower steps from that direction. We were not sure what to show. CN recommended that we use a wall.

4) The overwhelming preference was for a map that showed too much information rather than too little. Students said they did not mind spending the time it took to read this tactual map.

5) A supplement, brailled and/or tape, introducing the user to the map, referencing buildings to grid numbers, and containing other pertinent information, should be included.

TABLE 3 SYMBOLS USED ON MAP

* See Sample Sheet (Fig. 9) and Table 1: Sample Sheet Symbols

SYMBOL	USE	KIND	EXECUTION
<u>Areal</u> <u>Textures</u>, <u>Front</u> <u>Side</u>:			
H 4 *	Buildings		
Base of Map	Streets		
L 4	Grass		
L 2	Plaza		
H 7	Parking & Service		
H 23	River		
H 15	Ice Rink		
	North	Hand-drawn	Ink, Parallel lines 1/ 16" apart
<u>Line</u> <u>Symbols</u>, <u>Front</u> <u>Side</u>:			
N	Major Path		
A	Minor Path		
	Corridor	Tape	ACS 3/ 32" x 360", ink

SYMBOL	USE	KIND	EXECUTION
V	Railroad Track		
● ● ● ● ●	Field Track	Tape	Chartpak 19661T
▬ ▬ ▬ ▬ ▬	Wall	Hand-drawn	Ink
<u>Point Symbols, Front Side:</u>			
	Building Entrance	Hand-drawn	Ink
|▪▪	Steps	Hand-drawn	Ink
b	Bus Stop		
aa	Traffic Light		
f	Obstacle		
u	Loading Dock		
<u>Letters & Arabic Numerals, Front Side:</u>			
	On Buildings	Transfer Type	Letraset 48•10•CLN White
	In Grass	Transfer Type	Letraset 47•14•CLN White

SYMBOL	USE	KIND	EXECUTION
<u>Point</u> <u>Symbols</u>, <u>Back</u> <u>Side</u>:			
d	Swinging Door		
○	Revolving Door	Hand-drawn	Ink, #2 pen, template 1/4" diameter
a	Electric Door		
□	Mailbox	Hand-drawn	Ink, #2 pen, template 1/4" diameter
e	Overhead Link		
c	Food		
	Grid	Hand-drawn	Ink, #2 pen, 1/2" lines, 1" on center
⠿	Braille	Transfer Type	Friedman's sheet 19700, Howe Press

TABLE 4
MAP TEST RESULTS

	AD	CN	ML	BC	GL	VITO PROSCIA	IS	JK
	MIT undergrad student Aero-Astro	MIT undergrad student Field of concentration undeclared	MIT grad student Economics	MIT grad student Economics	Harvard grad student MIT undergrad. Physics	Director, Sensory Aids MIT, MS Columbia, Elec. Engr.	Harvard undergraduate student, Social Relations	Harvard undergraduate student, History
1. TACTUAL ACUITY:	Good.	Good.	Good.	Poor.	Good.	Fair.	Good-Fair.	Good.
2. ABILITY TO READ REGULAR BRAILLE:	Good.	Good.	Good.	Poor.	Good.	Good.	Good.	Good.
3. AMOUNT OF TIME TO ADJUST TO READING BRAILLE ON BACK OF MAP:	Approx. 1 - 2 hours. Adjusted but did not like it. By end of testing read braille from front of map.	Adjusted immediately. Read braille from front immediately.	Adjusted immediately. After reading legend from the back, read braille from front.	Did not really attempt to read it. We read it to her.	Approx. 15 minutes. After reading legend from back, read braille from front.	In an hour he began to adjust. Read braille from back.	Approx. 1 - 2 hours. At end of testing read braille from front.	Approx. 2 hours. At end of testing read braille from front.
4. EVALUATION OF NEW BRAILLE ARRANGEMENT:	Initial reaction: "Hard to get used to. It's like slate." Confused braille "5" with "9" Reaction at end of testing: "I can read it, but my fingers pass over braille with little finger first instead of index finger." Reads map with right hand & braille	"It's OK. No problem."	"Reading braille from the front (the new way) is not great, but it works."		OK. Does not confuse braille with symbols on back.	Braille on back confusing only at beginning. Front & back system is inconvenient but may be best of available systems. He would rather see overlay. Because of substance of map would have to read it on flat surface. Slit overlay in half. Easier to read flat surface. Maybe front and back not inconvenient,	Initial reaction: "It would be good if the braille could be changed, but it could work." Reaction at end of testing: "Braille is fine but it might be nicer reading right to left."	Initial reaction: "I don't know. That's bad. Too hard. I don't think it's convenient. It's distracting. The braille itself is good (way it feels in pvc) but I can't read reversal fast enough." We noted that once he finished the legend & got into the map that he had no problems reading the braille.

	AD	CN	ML	BC	GL	VP	IS	JK
	with left hand. He would prefer the braille to read as usual.					but new. I would use no braille. Use ink print with Optacon. Optacon available in 5 years at $5,000. Low vision people would use magnifying glass.		He could read bldg. nos. & names & "info ctr." etc. Reaction at end of testing: "The braille was objectionable at first but as I looked at it the more it seemed like a possible method."
5. EVALUATION OF SYMBOLS:								
Areal Textures, Front Side:								
Buildings:	Distinguishable.	Distinguishable. Good.	Distinguishable.	Distinguishable. Good.	Distinguishable.	Distinguishable.	Distinguishable. Good.	Distinguishable.
Streets:	Distinguishable. Good.	Distinguishable.	Distinguishable.	Distinguishable.	Distinguishable.	Distinguishable.	Distinguishable. Good.	Distinguishable.
Grass:	Indistinguishable from plaza.	Indistinguishable from plaza.	Indistinguishable from plaza.	Indistinguishable from plaza.	Indistinguishable from plaza. Good symbol for grass. That's what I perceive grass to be like.	Indistinguishable from plaza. Clearly differentiable from road. Confused grass with parking.	Indistinguishable from plaza. Distinguishable from parking. Good symbol.	Indistinguishable from plaza but good symbol. Distinguishable from parking.
Plaza:	Indistinguishable from grass.	Indistinguishable from grass.	Indistinguishable from grass.	Indistinguishable from grass.	Indistinguishable from grass.	Indistinguishable from grass.	Indistinguishable from grass.	Indistinguishable from grass.
Parking & Service:	Distinguishable. Easier to distinguish	Distinguishable. Somewhat similar to plaza	Distinguishable. Easy differentiation from	Distinguishable. Good.	Distinguishable. Can follow service roads.	Distinguishable.	Distinguishable from grass and plaza.	Distinguishable from grass.

	AD	CN	ML	BC	GL	VP	IS	JK
	parking from grass than plaza from grass.	initially. Distinguishable from grass. When familiar with map could find service roads off path. At end of testing, pkg. was clear. Keep it.	grass.					
River:	Distinguishable.	Distinguishable. Good.	Distinguishable.	Distinguishable. Good.	Distinguishable. Good.	Distinguishable. Good.	Distinguishable.	Distinguishable.
Ice Rink:		Not good. Use another texture.						
North:	Distinguishable.	Distinguishable.	Distinguishable.	Thinks in terms of rt. & lt. so N not helpful	Distinguishable.	Distinguishable but could be more distinct.	Distinguishable. Nice.	Distinguishable.
<u>Line Symbols, Front Side:</u>								
Major and Minor Paths:	Distinguishable. Making distinction between major & minor is unnecessary. Marking path is adequate. Minor path symbol preferable to major path.	Distinguishable. Both symbols are good. Do not need distinction between major & minor so use minor path symbol of dots rather than stars.	Minor path symbol easier to pick out than major path symbol. Could omit distinction between major & minor paths.	Clear. Prefers minor path symbol to major path symbol.	Distinguishable, but close. Route symbol could be clearer if have one symbol for route instead of primary & secondary.	Not bad. Major symbol better than minor but minor does tingle the fingers. Keep primary & secondary path distinction.	Close but can tell difference between major & minor path symbols.	Distinguishable.
Corridor:	Distinguishable. Not matter if other corridors shown since he assumes bldg. has corridor.	Distinguishable.	Distinguishable.	Distinguishable. Could follow it.	Distinguishable.	Not well defined because should show all the corridors or none of the corridors.	Distinguishable.	Distinguishable. Good.

	AD	CN	ML	BC	GL	VP	IS	JK
Crosswalk Convention:	Understandable.	Understandable.	Understandable.	Understandable.	Understandable.	Understandable.	Understandable.	Understandable.
Railroad Track:	Distinguishable.	Distinguishable.			Similar to wall.		Distinguishable.	Distinguishable.
Field Track:		Had problems knowing what it was. Should be in legend.						Distinguishable. Did not know what it was. Should be in legend.
Wall:	Distinguishable	Distinguishable.			Similar to railroad.		Distinguishable.	Distinguishable.
<u>Point Symbols, Front Side</u>:								
Building Entrance:	Distinguishable.	Distinguishable.	Good. Door type on back reinforces it. Easy to locate.	Distinguishable.	Distinguishable but could be better.		Distinguishable.	Distinguishable.
Steps:	Distinguishable in legend. Difficult on the map.	Distinguishable. Difficult in certain places like before Stud. Ctr.		Distinguishable.	Distinguishable on legend. Indistinguishable on map.	Distinguishable in the legend.	Distinguishable in the legend.	Difficult at first. Got used to them.
Bus Stop:	Distinguishable.	Similar to traffic light & obstacle.	Similar to loading dock.	Similar to traffic light.	Distinguishable.	Too small.	Similar to traffic light, obstacle, loading dock. Looks like braille F.	Distinguishable. All right.
Traffic Light:	Distinguishable.	Similar to obstacle & bus stop.	Distinguishable.	Similar to bus stop.	Distinguishable.	Too small.	Similar to bus stop, obstacle, loading dock	Distinguishable but small.

	AD	CN	ML	BC	GL	VP	IS	JK
Obstacle:	Distinguishable.	Simialr to traffic light & bus stop.	Distinguishable.	Distinguishable.	Distinguishable.	Too small. Not open enough.	Similar to bus stop, traffic light, loading dock.	Distinguishable. Small.
Loading Dock:	Distinguishable on legend. Harder on map.		Similar to bus stop.		Distinguishable.	Tip fades so not get arrow head. Fair but not recommended.	Similar to bus stop, traffic light, obstacle.	Distinguishable but should be more pointed.
<u>Letters</u> <u>&</u> <u>Arabic</u> <u>Numerals</u>, <u>Front</u> <u>Side</u>								
On Buildings:	Distinguishable but does not present prob.							Distinguishable but not confusing. All rt. Keep for sighted.
In grass:	Indistinguishable.	Indistinguishable.	Indistinguishable.	Indistinguishable.	Indistinguishable.	Indistinguishable.	Indistinguishable.	Indistinguishable.
<u>Point</u> <u>Symbols</u>, <u>Back</u> <u>Side</u>:								
Swinging Door:	Distinguishable.	Distinguishable.	Distinguishable.		Distinguishable.	Distinguishable. Good.	Have to use fingernail to distinguish it from swinging door. Need to differentiate them more.	Initial reaction: Similar to elec. door. Need to use fingernail to distinguish from elec. door. Later: symbol good. Different from electric door.
Revolving Door:	Similar to overhead link but later could distinguish between them better. Emphasize oval quality of link.	Distinguishable. Not confused with overhead link.	Distinguishable.	Similar to overhead link.	Distinguishable.	Distinguishable. Good.	Distinguishable. Good. Circular like revolving door. Different from overhead link.	Distinguishable. Different enough from overhead link.

	AD	CN	ML	BC	GL	VP	IS	JK
Electric Doors:	Distinguishable.	Distinguishable.	Distinguishable.		Distinguishable.	Tight.	Have to use fingernail to distinguish it from swinging door. Need to differentiate them more.	Similar to swinging door. Have to use fingernail to distinguish from swinging door. Later: Symbol good. Different from swinging door.
Mailbox:	Distinguishable.	Distinguishable.	Good. Useful to know.		Distinguishable. Good to know about.	Fair. Rather see textured lines. Box could be good if bigger with thin lines.	Distinguishable. Like it very much.	Distinguishable. Good symbol.
Overhead Link:	Similar to revolving door but distinction easier later in testing. Emphasize oval.	Distinguishable. Not confused with revolving door.	Distinguishable.	Similar to revolving door.	Distinguishable.	Distinguishable.	Distinguishable. Different from revolving door.	Distinguishable. Different enough from revolving door.
Food:			Distinguishable. Like it. It's different.		Confused with other upward symbol.	Not clear symbol. Not distinct enough.	Distinguishable.	Distinguishable. Small.
6. GRID:	Could use it.	Could use it.	Could use it. Grid is good to have. Can follow grid with hands or use ruler.		Clear. Grid could be helpful.	Clear.	Had never used a grid before. Wanted grid to go through map. Took a while to learn how to use it & not veer but could use it well after 3 - 4 times.	Had never seen one before. Thought it was great. Was able to use it to find entrance Bldg. 7.

	AD	CN	ML	BC	GL	VP	IS	JK
7. LEGEND:	He read legend from the back side. Legend could be front or back. Would prefer to read legend in normal way.	She read legend from front as it had been intended. Legend should be regular braille. Group symbols in legend. Group front side & back side symbols. Easier to have legend in 4 columns than straight across.	Legend should be in regular braille. Legend can work on back. Group symbols by texture & by what is shown on back & front.		Symbols should be grouped in legend. Legend could be on front. It would be easier to reference symbols. It's easier to flop map over.	Consider running legend across map & not in vertical columns.		Group bldg. symbols together in legend.
8. SCALE OF MAP:					Scale good. It should not be bigger.	Scale not bad.		Good. If smaller, there would be too much info on the map.
9. ROUTES TAKEN ON MAP:	Made trip from Bldg. 7 lobby to Hayden Lib. Found interior & exterior route.	Found Mass. Ave. quickly. Trip from 77 Mass. Ave. to McCormick, & from McCormick to Bldg 26. Traced service rd. from Bldg. 37 out to Mass. Ave. by Bldg. 9. Found Gt. Sail. Trip from McCormick to Hayden - int. & ext. ways. Found & actually physically traveled a new route from McCormick to Sensory Aids the day after first testing.	Found Mass. Ave. first.	Hopped from bldg. to bldg. & asked if she was touching the bldgs. she thought she was.	Found Mass. Ave. first.	Found Mass. Ave., Vassar St. & Bldg. 31 first.	Made trip on map from parking garage (W45) to Bexley.	

	AD	CN	ML	BC	GL	VP	IS	JK
10. AMOUNT OF TIME SPENT WITH MAP:	1 - 2 hours initially. Second testing 2 days later. Total hours approx. 5.	1 - 2 hours initially. Second testing 3 days later. Total hours approx. 6.	1 - 2 hours.	Less than 1 hour.	2 hours.	1 hour.	1 hour initially. Second testing 1 week later. Total hours approx. $6\frac{1}{2}$.	1 hour initially. Second testing 2 days later. Total hours approx. 5.
11. COMMENTS & SUGGESTIONS:								
REPRESENTATION:	Make sure registration is accurate. Lower door swing of Kresge is not registered accurately. Difficulty reading abbreviations: "pkg.", "bldg."	Steps confusingly described in legend. Registration around Stud. Ctr. not good. Steps in front of Stud. Ctr. too tight & confusing. Too crowded: steps & service road between Kresge & Amherst St.	Missed "up" in reading step symbol in legend. Fingers stick on smooth bldg. texture.		Missed "up" in stair symbol in legend. Steps near Kresge not good. Traffic underpass representation unclear. Difficult to understand symbols superimposed on other symbols, but paths on grass clear.	Don't like smooth bldgs. Heights are not distinct enough. Not enough break between bldg. & adjoining texture. Tip fades on loading dock.	Make sure registration is accurate.	North symbol is in the wrong place in the legend. Registration for the most part is good. Food symbol under Stud. Ctr. does not register. Want immediate recognition of symbols. Some are distinguishable only with effort. Some symbols are small or similar to others. Didn't realize Mem. Dr. was divided because braille name was under upper $\frac{1}{2}$ of road, not middle.
CONTENT:	Indicate moat around Chapel. You forgot Bldg. 24 entrance, "Bridge" in braille, write "track" after "railroad". Change entry" to "entrance".	Show reference point to get started on map-probably Bldg. 7. Show all main corridors. Should not be steps at entry between Bldgs. 5 & 7. Bldg. 54 needs	Street symbol should have line around it so know it's a symbol. Maybe put names of streets in better places. Grid lines might be at $1\frac{1}{2}$" inter-	Indicate moat around Chapel. Indicate pedestrian tunnels. Differentiate between taxi & bus.	Indicate moat around Chapel. "Bldg. entry" should be "Bldg. with entry". "Interior path" should be "corridor". Forgot sailing pavilions. Say "route" in-	Frame street symbol in legend. Should indicate more corridors. Remove grass. Keep plazas, ice rink, service & pkg., paths. Insert symbol for mall	Put box around street symbol in legend. Write railroad "track" in legend. Could have braille R instead of food symbol. Allow more bldg. around cor-	St. symbol should have line around it in legend. Trans. should be spelled out. Make loading dock more pointed. Write "track" after RR Use another line on

	AD	CN	ML	BC	GL	VP	IS	JK
	Emphasize oval quality of overhead link.	overhead link. Spell out"transportation." Write "Hayden" & "Gt. Court". Use different texture for ice rink & show fence around it. Wall in front of Stud. Ctr. could define which way steps go. Likes idea of using electric door symbol for step symbol.	vals. Grass could be base level instead of texture. Parallel lines easier to locate for roads than blank base. Interesting to know width of road. Mass. Ave, could be 4 parallel lines & Vassar 2. Separate dots of food symbol more. Likes idea of electric door symbol used for steps and linking them together to show expanse of steps. This symbol would be clearer if wider. Suggests fine sandpaper texture for bldgs.		stead of "path". Omit routes in plaza. Entrance could be protuberance instead of indentation. Forgot "Danforth St." Show main corridor in each bldg. or no corridors.	on Mem. Dr. Could use dot - dash line for service road. Could use parallel lines for roads, & interrupt for crosswalk, traffic light, or control st.	ridor in legend. For RR track use crosswalk symbol from Watertown map. Dashed line good for fence & solid line for wall.	back under RR instead of RR symbol. Forgot field track in legend. Separate lines of electric & swing. door symbols more. Write "Corridor" instead of "Int. path". Symbols couldn't be bigger because couldn't place them close together. So use combination of symbols & braille like braille E = elec. door Letter can't be an invert of another. Use names as much as possible like "field track" Put bus & subway symbol on the front. Describe food more - restaurant or campus. Show all main corridor Write "taxi". When several doors close together, show main one.
OTHER:	"Takes time to memorize all the symbols. I like the map. A good beginning."	"In general the map is pretty clear. I think the map has about the right amount of information. My experience	"This map is pretty workable. It has a lot of information. Takes time to become familiar with all the sym-	"Very interesting map. PVC is delightful material. It can be rolled up. It bends easily so one can read	"Things need to be improved, but it's a good start. On supplemental recording give more information about	Initial reaction: "Too much on here. Tactile display not distinct enough. Too much clutter. Too much informa-	Image of the campus at end of testing: Vassar St. & RR track are northern boundary, Charles R. & Mem. Dr.	"I'm really impressed with the map. Ecstatic Need supplement to explain north convention overhead link, traffic

	AD	CN	ML	BC	GL	VP	IS	JK
		on the map & on the campus correlate. Need supplemental tape & bldg. index brailled on paper. In supplement explain Student Center steps, traffic underpass & bldg. entrance convention.	bols, & to be truly oriented to the map. Grid would be more useful with braille supplement- list of bldgs. with grid location. Need supplemental tape to go with map. Like an instruction manual. Tells you how to use the map. Explains hazards. Give you practice in locating something. London map supplement told you where places where.	the back. It could be used for recipe books. In supplement indicate bldgs. under construction; & height of bldgs. (for echo perception). A map would have been handy when I first came to MIT. I didn't realize that the Stud. Ctr. was so offset from Bldg. 7.	symbols. Should say plaza is vast paved area.	tion to give me orientation. Everything is hidden in clutter. Things are buried in clutter. My first impression is that the map is cluttered. Not to say there's too much information. Therefore remove grass.	are southern boundary. Mass. Ave. goes north-south through the middle of the campus.	underpass, that when path goes to bldg. it goes to a door. Prepare braille booklet. Use grid system as ID. Student wants more information than visitor. Might want briefer map for visitor. How high are the bldgs. & how big? Include scale. Image of the campus after testing: Not many streets. Bldgs. are large & interconnected. MIT bldgs. are like Bio Labs off Divinity Ave rather than like Harvard Yard bldgs.

CHAPTER NOTES

1. This is a map of the central part of the MIT campus. We are orienting the map so that north is on the top. The map is on the front and the legend and braille are on the back. You do not have to flop the map over to read the back. We suggest that after you familiarize yourself with the top side, i.e., the map side that you, keeping the map side facing you, put you hand under the map to read the legend on the back side of the map. The legend is in four columns starting in the upper left hand corner. You may find the grid lines on the side of the map helpful. The names of buildings and streets are on the back.

APPENDIX

INTRODUCTION

The participants of the following interviews have kindly permitted us to include transcripts of their interviews here. Our original intention had been to tape these interviews so that we would not have to take notes. The tapes, however, proved to be extremely enlightening, telling a story far beyond the scope of the thesis body. Accordingly we have included them in this appendix. Paralleling the interviews, evaluations on the right summarize the main points of the interviews and inject relevant supplementary information and opinion.

1 LR / LESSARD

INTENT: To observe a mobility lesson on red-yellow crossings with a highly mobile student.

INTERVIEWED: Kevin Lessard - a mobility instructor at Perkins School for the Blind.
LR - age 17, adventitiously blind at 13, student at Perkins.

DATE: 10 February 1972

Lessard: Since the student at Perkins is not in his home environment, he learns the concept of the residential area, and does not memorize Watertown where Perkins is located. The student learns an approach.

In mobility training, students learn an approach, the concept of a residential area, rather than memorizing a specific area.

LR is a good traveler. He has gone through all the sequences of mobility except Boston. He's gone through traffic light intersections and knows the structure of traffic patterns.

Evaluation of LR's mobility.

There's a method a blind person uses in crossing an intersection. Traffic will be moving on Market Street, the street parallel to you. Then it will stop and traffic will start on Washington Street, the street perpendicular to you. It has right of way. As soon as Washington stops and Market starts, you step off the curb. Risk is reduced because the driver on Market sees you. He's starting from a stopped position. This eliminates high speed. Also, if the guy is stopped at the street and is going to make a turn, it's unlikely that he's daydreaming. He sees the blind person with the cane and also he's a pedestrian.

Description of the usual method a blind person uses in crossing an intersection. See February 16th interview with IS.

Red-yellow crossing is an abnormal technique since you can't see it. Not many blind people have the judgment required to know when the red-yellow light is on. Therefore we do not give this course to every student. He has the other technique to cross without red-yellow, but it is not as safe as red-yellow. Here is the four-cornered intersection of Market and North Beacon. Both streets are busy. This is the first clue to use red-yellow lights. At most red-yellow intersections, you must push the button. In Boston it's built into the cycle. At every traffic light intersection there is a control street - the busier of the two. Here it's Market. Control street means this: One street goes through on its green cycle while the other had a red cycle. Then they'll switch. If you push the red-yellow button, the red-yellow light will only come on after the control street stops. Clue you must use: You must hear both streets stopped. Also you must hear them stopped in the beginning of the red-yellow cycle. If you start crossing at the end of the red-yellow cycle, you'll be in the middle of the street when the next cycle begins. You can't take that risk. How do you control that? You hear Market stopped and North Beacon idling, then you know that's your clue to cross. Ideally, you push the button when the street that's not the control street starts up. If you push the button when the control street is moving, you won't get the red-yellow cycle.

Description of how a blind person makes a red-yellow crossing. Cues he uses and complications he encounters.

(We left this intersection because the telephone company was making too much noise and went to the intersection of Washington and Market Streets).

Lessard: Washington is the control street. This intersection has an added feature: Street cars, LR, you'll have to tell me when to push the red-yellow button since the button is off to one side on the island. Then you tell me when you think you should cross. There's a complication. Market could be stopped. You could hear Washington stopped, but since the cycle is long on Washington, the traffic could have jumped out of Washington. You could hear cars idling on Market, but not get the sound clue on Washington. Red-yellow might come on, but you couldn't recognize it because the sound clue was not there. If a car came up with five seconds left in the red-yellow cycle, you'd be misinterpreting it. How do you control that? Washington cycle is long. Make time judgments on the control street so if you don't hear a car and then you hear a car, but the cycle's been long, then you won't cross since the red-yellow cycle is almost over. The red-yellow cycle is usually 10-15 seconds. You have to take that into consideration. You also have the problem of the bus that just came up alongside on Market Street. It blocks out traffic noise or gives misrepresentation of a clue. But LR should be able to tell that it's a bus. But it throws the whole plan off. You have to wait until it moves. Cars sometimes go through red-yellow (One did during the lesson), but LR will hear the traffic stopped. If a car does not stop at the intersection, the driver could be dropping his wife off. Have to be careful of making instantaneous reactions. A bus on Washington blew this red-yellow cycle. It stopped in the middle of the intersection and drowned out clues when it started up. Don't listen to other pedestrians. They may be crossing wrong. It's important to tell me when to cross. It's just as important to tell me when not to cross. LR's judgment will pick up as he gets more familiar. Just now a truck idled on Washington going the other way (near lane) so it threw the clue off. So LR you were five seconds early on calling the red-yellow.

LR: (Saying what we with vision miss) It's not what we miss, it's what we take for granted as sighted people.

	In mobility you learn how to analyze. I'm familiar with parallel and perpendicular. It's drilled into you. The more you handle all this information, the more it's natural.	Learn how to analyze in mobility.
Authors:	Have you been exposed to geometry?	
LR:	I had sight until I was 13. It makes a big difference. I know what a square or circle is.	LR had sight until he was age 13 so he has visual memories. He remembers geometry and color.
Authors:	Does this fade or will it never go away?	
LR:	At times it has. But every night I think for 5 or 10 minutes. I practice the alphabet everyday. Some kids have asked me what the sun is. I talked about it in terms of color. I realized how lucky I was because I had memories. I never regretted blindness because I had more opportunity this way than I would when I'm sighted because when you're sighted you're like 80 million other people, but when you're a blind person you're someone a little bit different. You're not like people in traffic intersections who are always in a hurry and are really risking their lives half the time.	
Authors:	If you dream, do you see things?	
LR:	I do because I have a memory. I've always wondered myself what the dreams of a person who has never seen are like.	LR has visual dreams because he had sight until age 13.
Authors:	Did you ever ask any of your schoolmates?	

LR: Yes. There are kids at Perkins who can't visualize even what a wall is. Some of them don't realize it goes up to the ceiling. They dream in their own way whatever is in their mind that they see fit to think of an object as.

Some students at Perkins dream non-visually.

Authors: Do they actually see things in their mind?

LR: They see things to them what represent the objects visually tactually. I've always been interested myself how a totally blind person dreams or what they visualize. I guess it boils down to what they know or what they think.

Authors: How would you help someone who doesn't know what a wall is, has never seen a wall? Would there be any way that would be easier than actually approaching the wall or the door directly to give him a better sense?

LR builds a model or piles chairs up to the ceiling to show fellow blind students what a wall is.

LR: I've always tried to build a small replica and describe it or pile up the chairs and get up to the ceiling.

After 3 or 4 years it's an automatic instinct to always listen. I used to be in a rock'n'roll group. If it wasn't loud it wasn't good. I stopped since my ears were ringing.

If I walk into a bathroom and the shower curtains are closed, automatically I know they're closed because the pressure and the atmosphere are different.

If LR walks into a familiar bathroom, he knows if shower curtain is open or shut because the pressure and the atmosphere differ.

Authors: But that's a room with which you'd be familiar.

LR:	Hardest thing in the world is to walk into a strange building. You go in the door and move to the side of the door so that you don't bother anyone and stand there and listen. If you want to go over by the cash register, you listen for the sound. You listen in what directions the people are walking and you can tell by the way they are walking if there are aisles. For example, if all the people are not going straight down, but are walking over this way and you hear people walking across the back, you know there is probably something in front of you. In a store the best thing to do is to find your way to a cash register and there you can ask information.	LR also observes by echo perception. Description of what a blind person does when he walks into a strange building.
Authors:	Let's say you've gotten familiar with some buildings you know. Do you find that there are some that are easier to move around in than others or is it a question of getting to know them well enough to understand them?	
LR:	It's a question of getting to know them. Some buildings may have more obstacles or displays, but if you're there long enough you know what's there. Plus if they are there, the cane will pick them up.	
Lessard:	It depends on the purpose of the visit too. If you just go to City Hall to pay a bill once a year, you're not going to worry about getting complete orientation to the building.	
LR:	There's more to mobility training than just being able to mobilize yourself because the cane can give you a lot of confidence in yourself and probably more than you'd get by using a seeing eye dog. I've never been afraid to ask people for information. The cane isn't like a security blanket because it doesn't run for you. It's a metal stick with a	Mobility training and the cane give the blind person confidence. It makes him mobile which helps him socially and psychologically.

tip on the end of it that makes noise, you run it. You can feel different textures. You can tell the difference between a bush and an iron railing.

Lessard: There's a lot involved in the socialization process from the point of view of being more mobile, not sitting at home. Psychologically too, being able to walk by yourself.

LR: My mother sees me a few times a week since I'm always out doing something. The cane gives me great satisfaction because I feel confident in things that I do and what I've learned through it and I'm sure enough of what I've learned to go and use it. I'm part of Radio Emergency Associated Communications Team, a rescue squad, like a dispatcher. It's harder for people who have always been blind to go out and make friends. They don't always want to. I write guitar music. Every blind person has to get over being ashamed of his blindness. My one greatest fear in life is living alone.

2 CL

INTENT: To observe a mobility lesson on sidewalk travel and intersection crossing with a student of low mobility.

INTERVIEWED: Kevin Lessard - a mobility instructor at Perkins School for the Blind.
CL - age approximately 17, congenitally blind, student at Perkins.

DATE: 10 February 1972

(CL was supposed to walk down sidewalk to intersection and cross. At a driveway she walked off the sidewalk and into the street. Being told she was in the street she walked back, missed the sidewalk and went up the driveway.)

Lessard: She can verbalize it when I structure the lesson just for that. It's a step by step process. She has a lack of ability to synthesize things. She's walking off the sidewalk, across the driveway and into the street. She has trouble getting back. She has poor orientation. She doesn't know which way to turn to get back to the sidewalk. She doesn't have distance judgment. If I had explained driveway, she could have gotten into and out of it. She didn't use traffic cue of how far away traffic was from her to find she had gone into a driveway and was still walking away from the sidewalk. She can't remember previous lessons. Her low mobility doesn't help her self-image.

CL was supposed to walk down a sidewalk with front lawns, low hedges and entrance walks to houses on one side, and a small width of grass bordering the street on the other. Driveways crossed the sidewalk. At a driveway CL walked out into the street. She did not check width of pavement with her cane to see if it was drive or sidewalk. She shuffled her feet without thinking and lost her orientation. She had poor locomotion and gait. She could not move in a straight line, but would angle off.

(CL gets to curb of intersection)

Lessard: Her cane falls off. She should interpret it but, can't very well. She can't orient herself to the rounded curb. She angles out into the intersection. I have her side step 4-5 steps to get away from the rounded curb since she can't line her feet up right. She gets emotional and panics easily.

She didn't use traffic cues and didn't use distance judgment. She forgot previous lessons. She memorized rather than than analyzed. She got emotional and panicked easily.

3 IS

INTENT:	To find out what information would be useful on a map for the blind and what orientation and mobility cues a blind person uses.
INTERVIEWED:	IS - age approximately 21, Harvard senior, Social Relations major, congenitally blind.
DATE:	16 February 1972

IS: I have little conception of any kind of urban or suburban environment. I have no conception of Boston, but I know in some places the streets are north-south or east-west and the reason they're not. I'm often disturbed when I think of the little conception I have of campuses. I'm congenitally blind.

IS is surprisingly independent in negotiating city streets and subways.

Authors: Do you have a conception of a block?

IS: No, I think of it as one big piece of macadam between two streets. I don't have much more of a conception than that of a city block. I had problems conceptualizing when I was working with my mobility instructor in high school. He found it was easier to make me learn things by rote memory than to get me to conceptualize things because it was so impossible for me to conceptualize almost anything. I seem to have the kind of mind that tends to memorize as opposed to thinking of larger patterns or relationships.

He has worked with a mobility instructor.

Rote memory helped IS, but he was certainly conceptualizing to some extent, or his performance would have been similar to CL's.

Authors: It may also be because no one has lucked into a good way of describing these things.

IS: Maybe.

Authors: Where do you generally go when you're around Harvard? Do you stay here most of the time?

IS: No, I go into Boston quite a bit. Usually it's appointments. Yesterday I went in for a haircut.

Authors: What are the cues that you look for?

IS: I memorize everywhere I go. One important thing is landmarks. For example, when I went to get a haircut, I walked out of the subway at Washington Street. As I got off the escalator I knew I had to make a left turn to go out of the subway. Then I walked straight, I knew to cross the street because of echo perception. Everyone has echo perception. When you're outside tapping a cane, the sound from the wall nearest you (say there's a wall in front of you) will bounce back to you. So if I were about to walk into the wall chances are that I would know (you would too, if you closed your eyes. I've done experiments with this. I know it can be done) that I was going to hit the wall even before I hit it. Mobility instructors are requiring now more and more that students have their senses stimulated like that. When I went out the door I knew when to cross because the wall which is on my left discontinued and then I just turned right and crossed the street and went down one block and crossed there and went down to the next corner (a rounded corner) and turned right. I knew where the door was because

IS memorizes a successive list of actions which he then uses to get to a particular location.

IS cites specific auditory cues based on echo perception.

	Fanny Farmer which is right before the door has an exhaust fan. Smell is an aid. What's important is, is the cue going to be there all the time? The exhaust fan is there year round so it's a reliable factor. If smell is seasonal, then it's risky.	Smell is an aid if it is not seasonal.
Authors:	When you first went to the haircut place did you go by yourself or did someone show you?	
IS:	When I first went to the haircut place someone showed me. Once in a while I teach myself how to get places, but that's not as often as people show me. It's easier that way.	IS learns most of his new routes by having someone show them to him. It is easier that way for him.
Authors:	If you had a map then you could use it to get there and not have to depend on someone. It might also be a way of refreshing your own mind as to routes you're familiar with.	
IS:	Sure.	
Authors:	What method do you use to cross streets? What do you do at an intersection?	
IS:	Intersections around here are often all messed up. I'm used to red and then green as opposed to yellow. When the light is against you and therefore perpendicular traffic is moving and parallel traffic is idling and hopefully you can hear someone idling his engine. The minute he guns his engine to go down that street, you step out into the street to prevent him from turning down your street (the assumption is that perpendicular	IS describes how he crosses an intersection. He sometimes bluffs cars, but this is not a recommended mobility technique. See interview with Kevin Lessard at Perkins.

traffic is stopped). That was the method I was taught to cross streets. Other methods are less desirable - like bluffing cars. I do that too.

Authors: Does the recommended method work?

IS: Not around Cambridge. In practice, I'm very unhappy about all the crossings around here. I think they're dangerous. There is one I use all the time which I'm convinced is dangerous. It's right by Krackerjacks. There are crosswalks there, but I think cars come whipping around the corner so fast that they really can't see the person who's crossing. Either I wait for a break in traffic or I'm beginning to learn to estimate distances. How fast is a car coming at me so I can get across. I've just started learning how to do this. If a car is coming rapidly, can I still get across or do I have to wait for him? I'm not too good at it yet, but I'm better than I was two years ago. I'm still very cautious about those kind of things, but I'm getting better. I've learned if there's a whole line of cars coming through, just to inch my way out into the traffic, which is condemned from a mobility point of view. My instructor told me never to do that, that it was very dangerous. It was only my fault if I got hit. Sometimes it seems it's the only thing to do. You're forced to do it. There's no one around.

Over the last two years IS has improvised other techniques for crossing busy intersections.

Authors: You must be able to distinguish corners. I mean when you're on a sidewalk, you know when you've come to a corner and you know when you're at a corner that you've got several different choices. When I said, "Can you conceptualize a city block?" I didn't mean the physical block of buildings, but simply the sidewalk experience - and you must be able to do it since you can get around the city - as a means of orienting yourself within the scheme of things. You get cues when you're walking around the city, by corners, for one thing.

	You can count your corners and you know how far along you are. Are there any other organizational things that give you clues as to where you are in relationship to where you're going?	
IS:	There are street names. I'd keep the names in my mind. I'm working at a place five blocks from the subway. I have to keep those numbers in my mind. I know the last street is Columbus Avenue. It's before the Mass. Turnpike bridge. I know there's a bridge over an underpass.	Street names provide a way for IS to remember street sequences.
Authors:	What happens if you forget which corner you're at?	
IS:	Going to this place it doesn't matter because the bridge will be on my left and I'll hear cars going underneath. Coming back it would make a difference. I would have to ask how many more blocks to the subway entrance.	If IS forgets the block he is walking down he usually asks someone.
Authors:	Are there any qualities either tactual, smell, auditory that allow you to determine which corner you're at? You'll have to think of corners you're familiar with.	
IS:	Here is an example, but exceptional. If I were walking back to Quincy House from Emerson and I came to a corner of a street, there's one of two possibilities. It could either be Mt. Auburn or Bow and Arrow Street. Mt. Auburn is a busy street. The street directly behind me, there is no traffic. So a street with heavy traffic as opposed to a street without heavy traffic is a cue. Of course, in Boston where all streets are heavy like Washington, Winter, etc., that would not apply. Out in the suburbs sometimes you can tell a corner because there's a stone wall in with grass on it as opposed to a stone wall with bushes on it.	Suburban corners sometimes can be identified by a stone wall with grass on it.

Authors:	Does it help to identify corners by the direction of traffic?	
IS:	Sure. If the street were one way, this would do it. If the map had directions of traffic, it would help. It's easy to perceive traffic direction. It's good to know entrances of stores out of which people come quickly like a department store. You need to use a shorter cane technique there so you won't trip people. It's helpful to know that there is a revolving door since there is a technique for getting through it. You might map the reference point, i.e., where can I put my hand on the part of the door that doesn't revolve, so that I can take my other hand and feel the door go swish, swish.	Traffic direction and traffic volume provide cues characteristic for streets.
Authors:	Is it necessary to pinpoint entrances or tell what kind it is?	
IS:	It's nice to know if you're walking down the street that it's the fifth door on the right or third recessed entrance on the right as opposed to a non-recessed entrance. It's frustrating because when you ask people directions they don't know this. To me it would be better to put too much on a map than too little because I can rule extraneous things out. It might make the map more interesting.	IS would like to know where the non-recessed vs recessed entrances are, and if there is a revolving door. IS does not realize the problems of tactual clutter.
Authors:	What kind of visual dreams do you have, if you have such things?	

IS: Yes, I have dreams, but they're not visual dreams at all. They're sound or texture or smell or taste. No visual imagery.

IS' dreams are not visual.

Authors: But you've mastered visual concepts because they have meanings in other senses as well. You've mentioned several like parallel, perpendicular, right, left.

IS: "Visualizing" has an overlap of meaning. I'm visualizing it, but I'm not visualizing.

Authors: A visual map is usually made to scale that may not be so important tactilely. If you can distort distances you may be able to clarify the map perceptually.

IS: The subway network is interesting. If you enter, where will you end up?

I'd be willing to try reading smaller braille (sharper).

How you're aware of a corner: You begin to hear perpendicular as well as parallel traffic; curb; the shoreline breaks - it's not there anymore; maybe it's more windy on the corner; going downhill; you can just tell the corner is coming up because of echo perception. These are all clues of a corner. Some of these you could have on a map more successfully than others.

IS describes how he can tell he is coming to a street corner.

4 BENTZEN

INTENT: To discuss Mrs. Bentzen's thesis and her ideas about maps for the blind.

INTERVIEWED: Billie Louise Bentzen - mapologist and teacher at Protestant Guild for the Blind.

DATE: 17 February 1972

Bentzen: I have a copy of my thesis here. It's promised to Knut Lienemann of the MIT Planning Office. He's been commissioned to make a tactual map of MIT. I'll give it to you to read and then you can give it to him.

I visited Wiedel.

Authors: How can he be helpful to us?

Bentzen: I question the value of what Nolan has done because he hasn't applied it to very much. His last work was on textures and he found a number which were distinguishable from each other. As far as I know, he hasn't used any of them on maps. That wasn't a part of his map research report.

I think that the smaller the scale that you can use to communicate anything in, the better off you are and if you're working with things this size (her thesis map) you can't have a very gross tactual symbol for that or you can't read it.

Nolan and Morris' work is presented in a final report, Project No. 5-0421, published by the Department of HEW. They haven't applied their textures to maps. As a teacher, Mrs. Bentzen can test her ideas.

Here is my map of Perkins. These represent buildings. They are both raised and textured. The texture immediately communicates what it is without deciding this is something made up of lines or something made up of triangles. You don't have to decide what it's made up of, what it's components are, to read it. It can be very small and still be legible. I don't know of any of Nolan's textures, maybe one or two, that you could use an 1/8 of an inch line and know what it was, very few that you could use a 1/4" and know what it was for sure. So, as far as I'm concerned, they're very nice, much more sophisticated experimentally than anything I've done, but I don't think you can use them. There may be someone down there with him who has put things to work and has tried them out and knows more about it.

Bentzen's maps are thermoform. Thermoform gets brittle and tears easily.

Authors: Harry Friedman's (manager, Howe Press) map can be mass produced. Can thermoform?

In 1971 Howe Press did a test map of Watertown Square, Newton, Mass., in the polyvinyl chloride process.

Bentzen: Thermoform can be mass produced too. If you're really talking about mass production, in many thousands, Friedman's process is cheaper. If you're talking in terms of hundreds, which is perhaps more realistic for any local blind population, then thermoform is cheaper. Thermoform is a crude looking process, but it has advantages none of the other processes have yet. I'm anxious to see maps go beyond this stage (thermoform), but I'm not convinced Friedman's is the direction to go in yet. So far, Friedman hasn't shown me that his process can do two things which I'm convinced are of paramount importance in producing tactual maps. Now not everyone would agree with me, but certainly Wiedel would and Schiff and Levi in New York would. I've found in working with blind people that you need to produce a variety of elevations. Friedman's doesn't have that. Part of the reason that this texture on my map is good is because it's not just two levels, it's multi-level. Here I can get a base level, a texture which is multi-level plus an additional level on top of that. For that bit of information, I'm maximally using that space.

Thermoform can produce multi-level surfaces.

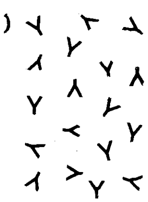
Authors: How long does it take to produce this (thermoform)?

Bentzen: I did these at Perkins on their machine and Friedman could presumably get someone to do that.

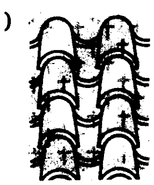
We have found that the polyvinyl chloride process is capable of producing subtle, but perceptible changes of level in proportion to the density of black on the original inked drawing.

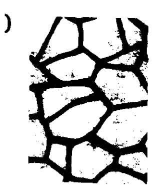
Authors: On Friedman's map, whether it's intentional or not, there seems to be slight differences in elevation. It might be reasonable to pursue the possibility of different elevations. I don't think Friedman tried.

Bentzen: There was a patch on Friedman's that was dirt on the negative which, to me, is the most satisfying texture. Lessard (mobility instructor at Perkins) and I were together when we discovered that. Whether Friedman can deliberately produce things like that, I don't know, but that's more valuable than anything he's done here (pointing to the traffic island with trees on the Watertown map). This texture is so coarse as to be distracting. (1) These are not very distinctive (trees in island on Watertown map). (2) Anyone would do as well as the other, but I don't think you should use them all. This texture is distinctive, but it's harsh. (3) This texture is just quietly there telling you what it is (right next to roofing texture). (4)

(1)


(2)


(3)


(4)


To use the overlay technique, put one hand or finger on the top sheet with the braille and the other hand on the sheet below to relate. The braille name of a building is right over the building. On the top sheet there is a grid reference, i.e., A-4, that has keyed system. So E-2 is Magnus. Of the six test subjects that I had, none of them - that's not true - a few of them had used a grid for some purpose or other. None of them had ever used an overlay, but they all, within two minutes or so, were very enthusiastic about it. The nice thing about the overlay is that you can remove clutter. In an earlier process I tried to get braille on the buildings. There's a so-called micro dot braille that's in common use in England, but not in this country, that takes a little less space than this (braille), but not much less space. Braille is just big. It's not like print that you can really reduce. I haven't tried micro dot. I went from my first process to overlay and was enough satisfied with overlay. Once I removed clutter, I found it was such an advantage that I didn't want to put it back on. It's hard to read braille on something like this (right on her map) since the corner of the building can appear as a dot.

Mrs. Bentzen uses overlays to remove clutter.

Micro dot is a smaller, but not much smaller, braille cell.

Authors: It would be conceivable to use overlays in Friedman's process.

Bentzen: Overlays really do work and you don't have to have sophisticated people to work with. I've done it with seventh graders, not on this particular map (her thesis map), but on simple things using an overlay.

I worked with Perkins students somewhat. None of my test subjects were familiar with Perkins campus. I wanted to establish that a sophisticated blind traveler, having no information about an area whatsoever other than a tactile map to travel from point A to point B using a map, which they did, not without problems and not perfectly, but parts of it were perfect.

Authors: Have you experimented with distortion in order to clarify?

Bentzen: What I've done is more intuitive than experimental with different kinds of things. I've found, for instance, and other people have found, that you can't get two symbols closer than 1/8" and have them readily distinguishable. So the path on this map shows about 40' away from the building when it's actually adjacent. It is distorted. As people traveled, they did judge relative distance of things. They used distance as a cue and were somewhat thrown by this business of it having to be this far away or you couldn't see it. Someone would initially interpret it as a walk of 40 feet. There was a tremendous amount of learning that took place as they used the map. They had three objectives. The third was the most complex route, yet everyone was much more successful at that. That was because learning occurred. They came to anticipate relative distance and also characteristics of the campus, like you wouldn't know from this map that there's no way by texture or slope to tell the difference between sidewalk and driveway, and this throws off the blind traveler, so you don't know you've crossed it unless you happen to be trailing a shore line. Once you've discovered that that happens, then you keep track of the shore line and you know when you're crossing the driveway.

Bentzen's approach is more intuitive than experimental. She has made much progress.

Bentzen used distortion to clarify.

Bentzen found that learning took place as the blind used her map.

First I gave them a chance to learn how to use the map. That's described in experimental procedures in my thesis.

If you're using a map to teach a concept, you may very well want to include much more information than a map which is going to be used by a lot of travelers. Here are some concept maps. This is an intersection. It's made of heavy art foil that would be a thermoform master. I got one texture by putting the foil over sandpaper and rubbing my finger nail across it.

I'm not convinced that it's very important to produce this kind of thing. I think it's important for a teacher to have a means to make something and there are lots of means. There is not nearly the need in this field as there is for more complex things.

Here are some minute maps. This one consists of different layers of sandpaper of different grades.

I use a tracing wheel to get these textures (dotted line). Some of the British researchers, Leonard and Angwin especially, have decided that 20 dots/inch is the best kind of line to follow. A rough line is easier to follow than a smooth line, so they decided they would use rough lines for ways to be followed, and smooth lines for barriers or something like that. This sounded good to me so I've used it. Everything else I've used is original.

We have found that, to a certain extent, the perceptibility of a line or texture is dependent on the process. 20 dots/inch is legible in thermoform and PVC, but the tactual experience differs significantly. That is to say, the symbol changes physically from one process to the next.

Thermoform gets brittle after a while and tears relatively easily. It's not as durable as Friedman's. Friedman hasn't gotten around to finding out if one can use different elevations in his process. He hasn't tried out other textures. Friedman said his process wouldn't normally produce more than one elevation.

I think what I've contributed is pretty sound and relevant because I've always been teaching at the same time, so everything I did I could immediately try out and find out whether it should be scrapped or not.

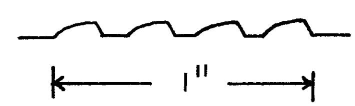
Orientation points. Most of my subjects used the main building or driveway for a reference point. That was not something I suggested to them. It just happened. Most users will find their own reference points in relation to where they live or specific destination. That will probably become their reference point.

I like Wiedel's recommendation for the north side of the map being indicated. I didn't end up using it. I just used a north arrow here. This works best as an arrow.

Ideally the top sheet of the overlay should be in print and transparent too so that it can be used by the low vision reader, as well as by the totally blind.

I would suggest that you stick to mapping Watertown Square and not do simpler intersections.

This would be a good symbol for something.



5 PROSCIA

INTENT: To find out about sensory aids and discuss Mr. Proscia's ideas about maps for the blind.

INTERVIEWED: Vito Proscia - Director, Sensory Aids Evaluation and Development Center at MIT, adventitiously blind at age 12.

DATE: 18 February 1972

Authors: Could you tell us about the different kinds of sensory aids?

Proscia: The cane is the major mobility aid. It can be supplemented with other aids. The cane is not preferable to a seeing eye dog because the dog is a companion who alerts you before you come in contact with an obstacle. To use the cane you go through periodic and long training. Mobility requires training prior to the use of the cane - spatial representation, how to project oneself out across areas, how to go up and down stairways, how to avoid or solicit aid. Orientation involves having to know where you're going before you get there. The age of blind persons determines how you teach them.

Mr. Proscia comments that sensory aids are supplements to the cane and the seeing eye dog.

There are three devices:
1) Pathsounder. It has a neck loop and is worn on the chest. It generates a multi-sonic signal. The shape of the beam is such that it detects obstacles at a range of 6 feet maximum (a step beyond the tip of the cane). It detects obstacles

He describes in detail the pathsounder, the laser cane, and Kay's binaural spectacles. None of these is available commercially.

within a field of waist to forehead, and the width of the shoulders. Any obstacle that appears above your wrist is detected. The cane detects from the waist down. It's a head and chest protector. It detects tailgates, post boxes, etc. It's an above the waist line detector. It will detect a pedestrian before you find him with the cane. It costs about $1000.

Using the cane you get different tactile responses: gravel, grass, etc. Also slopes, even 1" step-up or step-down.

2) <u>Laser Cane</u>. It's very expensive. There are only 7 in existence. It weighs 16 oz. It's a multi-purpose device. It's a cane and also gets 3 directions of information with 3 beams. One beam points ahead of the cane to detect step-up and step-downs before the cane does, by auditory display. Another beam detects 10 to 12 feet in front of you, obstacles 2 feet off the ground. The third beam picks up overlays. It's skewed vertically. All 3 beams are very narrow beams. This cane is huskier than the usual cane. There is a speaker in the crook of the handle. On the shaft there is a vibrating knob that indicates obstacles 10'-12' straight ahead. The speaker has 2 tones: a low tone indicates step-ups and step-downs; a high tone indicates obstacles at forehead level. The problem is: Are you feeding the human too much information? Will he miss his usual cues? The cane is heavy - 1 1/3 lb. It's made of an exotic material - epoxy boron fiber which costs about $600/lb. Also, it fractures in certain cases.

None of these devices are available for sale except the cane (Hoover cane). The pathsounder and lasar cane have been around 5,6,7 years. The glasses have been around 3-4 years.

3) Ultra-sonic Binaural Spectacles. This is an environmental mobility device. Information is in a complex auditory language. The Spectacles tell you there is an obstacle out there and may tell you the texture and azimuth location. It takes a long time to learn it - 4 hours a day for a month. It gives you information outside of the mobility path like a bush at the side of a walk. It can tell you that an approaching pedestrian on your left will cross in front of you to pass on your right. It gives you location by sound. You carry an electronic package on your belt. Transducers are carried on the front plane. Little tubes plug into your ear, and supposedly don't mask the usual auditory cues, squirt sound into your ears.

ML uses the Spectacles regularly and describes them in his interview, 12 April 1972.

Authors: What do you think of Mrs. Bentzen's thermoform maps and Friedman's polyvinyl chloride process?

Proscia: I don't like thermoform as a material. It's too flexible. When I examine it, it folds up. That doesn't happen with polyvinyl chloride.

Mr. Proscia does not like thermoform as a material because it is too flexible. and folds up when one trys to read it. That does not happen with polyvinyl chloride.

I introduced Mr. Gilligan to Mr. Friedman. Mr. Gilligan is concerned with and technically knowledgable in how to produce tactile displays. Things came to a standstill. Technology is not that firm for producing tactual materials (etching on metals or what have you). He has developed tactile displays on the formula. He does it for commercial reasons, not for the blind. He's worked on the process for ten years. One application is credit cards. He's interested in converting this process to be used by the blind. I crit his process. He can convert anything that's visual into tactile form. He's working on the process of getting different elevations. I say it isn't initially necessary

Mr. Proscia describes Mr. Gilligan's process for making maps. This process can also be used for credit cards. Mr. Gilligan is working on the process to get different elevations.

to have different elevations. One problem is to become mobile in the general environment such as sidewalks and doors. The other is to become mobile within a particular part of the environment such as buildings with various levels. Sometimes it's hard to find people to ask them directions. There are two ways to accomplish various levels of information. For example, an underpass could be illustrated by a symbol.

Mr. Proscia thinks that initially it isn't necessary to have different elevations on the map because they might be confusing.

Authors: Mrs. Bentzen said one could maximize space with different elevations.

Proscia: You could also confuse them. Mrs. Bentzen worked with very bright people who could use elevations.

There's a basic problem with thermoform. How are you going to prepare the master? The normal way is to use a manual method like gluing sandpaper or cardboard on a sheet or using a cogged wheel. You're limited by tactual representations, dotted lines to represent paths, hazards, etc. If you say you will use a symbol to represent walkways, or a symbol for discovery crossing, red light crossing, slopes, up - down stairways. If limited to 5 or 10 symbols. Take a walk to Kendal Square and back. I'm sure there are a few things you'll remember except outstanding things, like wading through a puddle. You probably won't remember the number of crossings, trees, etc. You need little information to get there and back. This is also true of the blind person. Give him important cues. Tree and pole are not necessary. Try 2 maps: One with cues, one with a lot of information.

A basic problem with thermoform is the preparation of the master and the limitations it imposes on tactual representation.

Mr. Proscia suggests using a series of symbols like a flow chart to represent a trip.

He suggests that we try two maps: One that is a flow chart of cues, and another that is more literal.

The primary purpose of mobility is safety. Make the blind person a safe and efficient traveler. You seldom see a blind person stroll in his environment to enrich himself. If he's ambulatory, he's doing it for a purpose. He could stroll with a dog.

The primary purpose of mobility is to enable the blind person to be a safe and efficient traveler.

Authors: We could do a cue map of zone to zone choices similar to a flow chart. We could also try a more literal map.

Proscia: Friedman and perhaps Bentzen are interested in pragmatic problems. I want to build a useful device for the blind. Perhaps it's too soon because we're not aware of what is the useful device.

Gilligan's process needs to have its symbolic language built upon and field tested. This is a long process.

Map textures are a function of material and economics. We have to get the technologist involved to see what is an economic way of distributing information via the tactile route.

Another problem - whatever is good tactually for the blind may also be pertinent for low vision. The problem with thermoform is that it is not a contrasting medium. Weidel is working on thermoform and colors. I think that state of the art is so old. Technology is not being used to bring this whole business of tactual information up to date. People are falling back on old make-shift methods. They're not using the technology of 1972 that could be projected 10 years from now. They're extending old methods to 1972. With thermoform you're limited as to what you can produce for the master. You are limited in the symbolic language you can use to represent various routes, cues, etc. There is an infinite number of ways of representing something tactually.

(He showed us electrical symbols.)
If a blind person is a professional he will have to work with people who are sighted. If you build a language his peers are unfamiliar with, you get a communication gap.

Mr. Proscia suggests that the map should also be for people with low vision. The authors feel that the problems of tactual representation for the blind and large graphics for low vision are incompatible on the same map.

People are falling back on old methods. People must use the technology of 1972. No one has approached the problem from a systems point of view.

If the blind build a symbolic language different than that of his sighted peers, there will be a communication gap.

Use standards that exist, but make these standards such that they have tactual meaning.

We must give tactual meaning to existing standards.

Authors: We have the problem of the size of the map and the size of braille.

Proscia: You could use symbolic language with an index. You don't have to spell out the entire word in braille. For numbers of MIT buildings, I wouldn't put them in braille, but in raised ink print. This allows me to communicate with someone who has vision. The blind person has to be taught how to read Arabic numerals. When you revert to braille, you break down communication.

Mr. Proscia suggests that building numbers should be tactually embossed arabic numerals, so that the sighted can read it when the blind person requests directions. Mr. Proscia feels that when one reverts to braille, one breaks down communication.

Authors: We could ink Arabic and not raise it, but raise braille.

Proscia: But you are compounding the economic problem - 2 processes. People are doing it their own way, they're not getting together. You need training to use a map. Who's going to do that? You could include this as mobility training. With a map you have to run over a basic concept: What is a map? There's a development process that has to be tested and then there's a training process which is a continuation. It's a step by step building process.

Map training should be part of mobility training. A lot of blind people have no concept of what a map is.

There is a testing process needed in developing the map.

There's the problem of clutter. I wasn't very impressed with the overlay technique. It has some interesting features, but I wasn't really impressed.

Mr. Proscia was not impressed with the overlay technique.

I feel that tactual information is not enough. The blind person needs supplemental information describing what he's looking at. That can only be done verbally, so you provide

Tactual information is not self-explanatory.

him with a cassette. With every map the blind person should get a compass and verbal information on cassette. Most blind people have a cassette or tape recorder, or record playback. A great amount of information they get is on recordings. No tactual information is self-explanatory. After you became familiar with it, you won't lean on verbal instructions. You'll use just the tactual information. The verbal is better than braille because it keeps your hands free to read the map. No one has approached this from a systems point of view. Up to this point, people just made tactual displays as good as possible and tested them. Not only do I need tactual information, but I need verbal information to supplement or complement what I have tactually. I need a training process to introduce me to what is a map. A lot of people have no concept of it. Once you develop basic ideas with them, then the job gets easier and easier. Unfortunately, we haven't started yet.

The blind person needs a a verbal supplement perhaps on a cassette. A verbal explanation is preferable to braille because it leaves one's hands free to explore the map. Mr. Proscia feels that also a compass should come with the map.

Authors: With a cassette with a verbal explanation, while standardization is still desirable in so far as possible, it's not critical.

Proscia: It's hard to know what to standardize until you do a complete field test which is a big job. First you go through a screening process - what symbols do I want to use? Test them. Make a map. Sift the data. This is not so bad because a group could select symbols in a scientific empirical way. Could be done in 6 months to 1 year. Construct information with educational material along with it and a training process. Develop a lot of information. Not just map mobility map information, but educational information, any other information that has meaning tactually. Distribute it.

Mr. Proscia discusses the process of developing and testing a map.

There will be changes made, but it will be based on a larger population.

Authors: Friedman's process is more symbolic than thermoform is.

Proscia: Being blind and in technology, I'm more unbiased than being emotionally captured. Things can be done now. They might not be of the best order; they might not be a final product. We can start to present information in a useful tactile form. We're looking for a quick way to solve the problem. rather than a long range solution. By doing things that way you never really solve the problem. We can use a single level now until we get a double level. There are many applications such as representing graphical material on grids or scales and geographical maps. You'd need a double level system to distinguish curves from grid. It's hard to build a master for thermoform for that. It's too time consuming on thermoform since the graph is a one shot deal. What if you want to construct a second curve?

Even though we don't have all the answers yet with respect to symbols and standardization, we can start to present information in a useful tactile form.

There are many applications of tactual representation.

6 SIMHA / LIENEMANN

INTENT: To discuss the map of MIT that the Planning Office is doing for the blind and if we could collaborate.

PRESENT: Robert Simha (Planning Officer, MIT Planning Office), Knut Lienemann (MIT Planning Office), Authors.

DATE: 18 February 1972

Simha: We are analyzing MIT circulation for all needs, for general and special (ambulatory and blind). We have just finished a map for the handicapped. Our task is to produce as quickly as possible a useful resource for the blind community and visitors. A simple guide so they have some assistance in understanding how this community is physically organized. We have a deadline and have to produce an end product.

Lienemann: We have two materials for maps which we will test. One is thermoform. The other is Mr. Gilligan's. I haven't seen Mr. Friedman's process.

Mr. Gilligan's material consists of a plastic sheet upon which raised lines can be formed.

Simha: One of the constraints is portability and cost. The work here is to review all the means which are available now or identify things which should be pursued for future development. We will produce maps in the tens.

Lienemann: Mr. Gilligan's process has a unit price, I think.

Authors: We are constrained also by the fact that things will change and we will have to update the map.

Simha: Thermoform and perceptions that people can carry around with them tend to limit (to a relatively small number) the number of information elements that can be handled.

Lienemann: We could discuss with Professor Mann (Mechanical Engineering, MIT) whether it is feasible that any other kind of electronic instrument could actually be applied here at MIT. This would change the whole concept. There might be beams along the campus that serve as guidelines, invisible, but audible.

Embedded sophisticated electronic gear is not practical as long as we are dealing with so few blind students.

Simha: A low band signal that might be carried in a plate that in the corridors might be taped along the dado someplace where normal waxing and washing wouldn't disturb it. The blind person could have a receiver, a pulsator, to receive a signal to keep him on track or warn him. We could provide a cuing system by indicating when an intersection is coming up. We will test with blind students.

Authors: The map could be a flow chart of cues, or it could be more literal.

Leonard describes several different kinds of maps - verbal, route maps, and tactual maps.

Simha: We have the problem of providing information to a changing community - student and visitor. The conclusion is that one needs a generalized resource that provides an overlay. Once in the system the individual has a very personal setup (problems and routes).

Information presented to blind student must be generalized.

Lienemann: If we represent ways by the raised line method, there's a limitation of how many symbols you can use. Most people say five symbols.

Simha: To find the door at MIT is the first critical problem, assuming that the blind person arrives here, where curb is, etc. Once they get in the system, there's another set of problems - where are bathrooms, services, etc. Therefore, maybe there ought to be supplementary devices that are also generalized to which the blind can go. You could have a map that sits in one place. We might have a more articulated gradient of the Institute whereby information devices, you could identify the pattern of where these other services are - coke machine, food, etc.

Authors: Locations of periodic information centers could be shown on a general map.

Simha: You might have large tactual maps hung up for the blind. It can be updated. How much information should there be? What's the utility level? What's the perception of the blind person in terms of what is essential information? What's the best way to communicate it to him? What's the importance of portability? Why not have audio information. You might just have a telephone recording - it could be on a cassette - with a general briefing on MIT in language that would be appropriate for the blind. People might carry the audio around with them. You could supplement this with some physical cues (intersections). So maybe there are ways to deal with the personal problem where you can use all senses, but visual. Level numbers at stairwalls could have braille index next to them. Which of these resources is most effective for the most people and most economical?

What about Perkins' attitude toward supportive systems?

Authors: A mobility instructor at Perkins whom we talked with is opposed to supportive systems that are not useful - such as the buzzers in Watertown. But the map is a way of extending their experience. It opens up choices and new ways of perceiving the world. There are very few maps that have been commercially developed that are learning vehicles to read more complicated maps. These are not mass produced today. Lessard, a mobility teacher at Perkins, was not opposed to maps. But maybe higher echelons were since Mrs. Bentzen's map of Perkins was not used.

Mrs. Bentzen used non-Perkins students to test map because she wanted people unfamiliar with the area to test her thesis. Also she wanted to deal with high mobility people.

The solution to enhancing the mobility of the blind MIT community member must be a realistic one - helpful but economical. The map should be part of a larger solution.

Lienemann: The map is a limited aid. It will be better if Professor Mann tries to work on other systems.

Simha: We're filling a gap at this time. There may be more sophisticated stuff. Once you get into supportive systems, the level of sophistication skyrockets and cost too. Who are we serving? For what the cost? What's the return to them?

Lienemann: I want to find out the imagery of the blind. What clues do they store? And use these to improve existing maps by one or two symbols perhaps, but probably not more.

Authors: Have you considered the possibility of overlays? They can convey more information. Mr. Proscia found overlays satisfactory, but not that convenient. He feels much of overlay information could be conveyed by a cassette recording that would come with the map. Verbalization plus tactual representation. It might be good to run the MIT map for the blind off in Friedman's process to test the process. We know what thermoform can and can't do. We know its limitations. It would be of more use to try some other materials and see what they are capable of doing. Friedman's process involves just one elevation. Mr. Proscia feels that the fact that you can't vary levels isn't necessarily a bad thing - it just means there might be a different kind of symbology to represent information.

Lienemann: Our objectives are: 1) Map which you can perceive tactually that shows whole campus and gives concept of the campus, what kind of environment you're in. 2) People can plan routes they want to take up to a degree. Beyond that - use tape or call someone like Alice Bailey. Use only supplements that are easiest and most worthwhile.

Alice Bailey of the Freshman Advisory Council worked with the two blind MIT Freshmen entering in 1971 during Orientation Week.

7 BENTZEN

INTENT: To learn about techniques she used to test her maps and to discuss tactual maps at further length.

INTERVIEWED: Billie Louise Bentzen - mapologist and teacher at Protestant Guild for the Blind.

DATE: 23 February 1972

Bentzen: Evaluation of the blind traveller is subjective. There are a tremendous number of variables. You approach testing by using case studies. Case studies have shown that people with map and verbal instructions travel better than those with just the map. More verbal descriptions, either recorded or braille, are needed. I gave test subjects a mobility test to see if they had the techniques they needed to find the kind of things they were going to have to find in the tests at Perkins.

Nolan doesn't seem to have much practical experience using what he's been testing. Wiedel is helpful and informative. He may have had more experience since I saw him. Symbols and surfaces that Nolan comes up with are not very helpful on maps. They're too big. He's not a mobility teacher. Wiedel has consulted with mobility instructors. Nolan's maps are geographic, not travel maps.

Nolan's symbols were generally much larger than the largest practical map size for the MIT campus could employ reasonably. In several cases we tried to reduce the Nolan symbol by a factor of four.

There were a number of cues I didn't use in order to prevent cluttering the map.

Authors: You could design a map like a subway route map where only the nodes are important. The nodes would represent a series of choices.

Bentzen: Leonard made strip maps. He reduced the route to a sequential list of instructions. Some of the maps included simple diagrams. Some just abbreviated instructions. He was working with a street, not a campus. Instructions help if you want to remember a long and complicated route. The advantage of a map that shows spatial configurations of things is that you can go any number of places that you've never been before and decide how you're going to get there. You can gain more information from something like this than just a description.

See Leonard's article, <u>Three Types of Maps For Blind Travel</u>, Ergonomics, 1970, Vol. 13, No. 2, pp. 165-179

Authors: There is a lot in the physical world that the blind person isn't going to be concerned with that would be only clutter on the map.

Does it make sense to make the buildings solid on the map to differentiate between inside and outside on the overall campus plan? But then you can't put the braille on top of the buildings. Maybe use an overlay instead?

Bentzen: First you should section the map of the MIT campus and then probably enlarge each section a little. Let the streets be the base surface. Let the texture similar to the dirty spot on the negative be everything that is not MIT or streets. Sidewalks could be a line of twenty dots per inch. Use an overlay for the braille and distort the buildings to give you the room you need for the braille.

The dirty spot was an imperfection on the Watertown Square map that suggested it might be capable of representing an intermediate tactual level.

You can even put cues on the overlay, auditory and olfactory. You should use the overlay fully.

Make a sample to test line, point, and areal symbols. You need to know the minimum size which is legible. Test the same symbol in different sizes.

We followed Mrs. Bentzen's suggestion and made a tactual test sample of line, point, and areal symbols.

A solid or dotted circumferential line is probably more distinctive than a solidly raised circle. Try it all three ways.

Friedman's crosswalks are a good symbol.

Experiment with different dotted lines to see if different dot spacings would be worthwhile.

Try parallel lines too, but remember that parallel lines take more room than a single line.

A zig-zag line should be tested. Get a list of Friedman's symbols. Do a sample in polyvinyl chloride and in Gilligan's.

8 IS / JK

INTENT: To discuss the polyvinyl chloride map of Watertown Square, Newton, Mass., and the kinds of information that could be included on a map.

INTERVIEWED: IS - age approximately 22, Harvard senior, philosophy major, congenitally blind.
JK - age approximately 22, Harvard senior, history major, congenitally blind.

DATE: 24 February 1972

JK: (Looking at Watertown map) Does it have to be this thick? You could shave it in half and put two pieces together so that you could have the braille on the back. Braille takes up a lot of room, but if you can show a word by one letter on the front. Letter your map. I think letter symbols are almost more valuable to me than all kinds of textural symbols.

JK's remarks support Leonard's verbal map and the other maps that are not physically literal.

Authors: Vito Proscia said that he thought that it would be better to include the Arabic numeral symbols instead of the braille number symbols because he says a lot of people can read them.

Vito Proscia is leaving MIT to work for Optacon, the makers of the tactual print display.

JK: But a lot of people can't. Do you know how to write numbers IS?

IS: No.

JK: I'm learning a few letters let alone numbers. Most people I've run into can't. It's difficult to read the letters on the Watertown map. It's not like reading a large blow-up letter. To me it's very complicated. What I meant was using a key type of system where you use "A" for something, "B" for something or "Th" sign for something. You could have the legend on the back. This would eliminate the disadvantage of overlays of 3 or 4 sheets. Plus you might want to put some braille on the front. Generally, if you have the room, I think you're smarter to enlarge the map rather than compress because you can get too much on it.

There were raised letters on the Watertown map which interfered with the other symbols.

JK's suggestion to replace map overlays with a front side and a back side (with braille on the back) we incorporated into the prototype polyvinyl chloride map of the MIT campus.

Authors: You can't get the map too large because you're competing against the readability of the map.

JK: I agree with you, but at the same time if it's small you'll be making it that much more difficult. I like this map (Watertown). I think it has great potential. I think the textural type of things you're talking about are the important kinds of textural things. You take up a paper map. Here is a paper map with different lines and textures. There is the problem of storage. I keep them behind these shelves to keep them uncrinkled and unripped. On the vinyl you should develop more differences in different kinds of lines, different kinds of touches.

JK's description of the conflict between the size of a map and the amount of information shown is a fundamental problem in tactual cartography that has not yet been solved.

Authors: If we can get more tactual relief into the map and that's part of the problem with the process because they claim it can't be done, and yet there's a degree of tactual relief that actually happened on the map. That's one of the things we want to investigate. It's our contention, though, that if we can't get tactual relief it still could be a very promising medium because you would be able to get as much as on paper on a medium that won't fall apart on you.

JK: Paper maps don't hold up. Like the thermoform these crease. The braille, which it doesn't do on a thermoform, wears down terribly on paper maps. The different types of textures are important. If you can develop this type of thing I think you could do a really good map. I'm really interested in this.

Polyvinyl chloride maps are waterproof, tear-proof, and crease-proof.

Authors: We'd like to talk to you about your own experiences with mobility. We've concluded from Perkins that the cane is the thing.

JK: It is, but dogs are by no means out of the question. I think it's more a problem of logistics and who we can have access to.

(Kracht had to leave).

Authors: Before we undertake the first try at the MIT map we want to try to get a recipe map of symbols, to use all the textures and dotted lines we can think of and that people like Nolan, who have done some research in, recommend, and see how they reproduce in this medium and come back to you and JK and other people to get your opinions about what things read well and what things don't. We'll do it informally since we're not set up for a scientific experiment.

IS: (Looking at Watertown map)
The braille should not be going in all directions. It should all read one way.

Authors: (Showed IS Mrs. Bentzen's thermoform map and explained overlays)

IS: I never had a map course. JK had lots of map courses for history. You have the problem of carrying the map on a windy day - you don't want it too flexible. I'm all for reducing the braille size, even if it means making the dots sharper.

I'm learning to ski. I have a walkie-talkie and my friend has a walkie-talkie and he tells me when to turn left and right and everything. There's a ski school in southern Vermont that uses poles with bells on them and I'm going to have a lesson there. I love the feeling of rapid movement. It's so much fun. I've just learned how to stem and traverse, and am about to learn how to parallel, but not quite yet.

The question of portability is an interesting one. Most MIT blind students we have talked to say they would more often than not study the map at home, memorize the route, and proceed then without the map.

9 PROSCIA / MANN / SIMHA / LIENEMANN

INTENT: To find out what other people besides the MIT Planning Office are doing to help the blind with mobility problems and spatial orientation.

PRESENT: Robert Mann (Professor in Mechanical Engineering, MIT), Vito Proscia (Director, Sensory Aids, MIT, adventiously blind at age 12), Robert Simha and Knut Lienemann (MIT Planning Office), Authors.

DATE: 25 February 1972

Lienemann: Is there a chance that MIT will apply some of the fruits of its research in sensory aids to campus problems in, say, two years?

Mann: The question is whether programs are going to be mounted and supported to conduct activity over a range of research, from basic to applied, to help blind travelers. For example, is it possible to mount a program to solve the problem of the cluttered environment at MIT, to demonstrate how architectural features could be used to make travel for the blind person more feasible - safer, prompter and more attractive? This could be done tomorrow if there were those who were willing to make a personal investment of time and energy and if negotiations for funds through Urban Transportation were successful. Then two years from now you could say yes. But there are no plans as yet.

One of the beauties and frustrations of MIT is that nobody speaks for MIT. There is, however, activity

The Sensory Aids Center has developed a high-speed braille printer with compatible software and the Travel Pathsounder.

If negotiations for funding through Urban Transportation are successful, then two years from now MIT could apply some of the fruits of its research in sensory aids. But there are no plans as yet.

going on in sensory aids and also in sensory perception, from George Wald at Harvard all the way up. Conceptually, that constitutes a possible framework for a larger effort. The Harvard-MIT program in Health-Sciences and Technology creates an arena that makes accomplishing these goals more realistic than it was five years ago. The MIT environment could become a laboratory to test the feasibility of approaches - mapmaking would be one part of the program.

Lienemann: What we want to do is to develop a map to provide a navigational and mobility aid for blind people. This problem could be approached by a sensory system on the one hand and at environmental level on the other. Conceptualization should also be employed to enhance understanding. Map modalities may be divided into two groups: static and portable - verbal and graphic. We haven't decided the techniques or methods or arrived at a set of tactual symbols. We also might employ a supplementary phone system to supplement the tactual route map.

The MIT Planning Office proposes to develop a map (perhaps as part of a larger system) to provide mobility aid to blind visitors and members of the MIT community.

Mann: There is a record of the proceedings of a meeting that was held in June 1970, at Airley House in Warrenton, Virginia, by my subcommittee on sensory aids of the National Academy of Engineering on the Evaluation of Mobility Aids for the Blind. I have a draft copy of it in my office. It is almost ready to be printed. Leonard was involved in the proceedings. This report gives an up-to-date description of the several sensory devices under development: Kay's binaural spectacles (Derik Rowell who did most of the hardware development is at MIT), the pathsounder

An excellent current report on sensory aids by Nye and Bliss has been published in the December, 1970 issue of <u>Proceedings of the IEEE</u>.

developed by Lindsay Russell also at MIT, and the laser cane developed by the Veterans' Administration. Also I have copies of the 1962 conference in New York City, the Rotterdam Conference in 1965, and St. Dunsan's conference in London, 1966. This is a small field. Of all the people who have been involved in this work, Leonard is probably the one who will be most interesting to you. He tragically died about three months ago. A psychologist within a university environment, he could approach the problem in a sophisticated way, but at the same time his work in a school for the blind in Northampton made him extremely pragmatic.

...

Discussion shifted to what the Planning Office was hoping to accomplish with its tactual map. Refer to an earlier discussion with Robert Simha on February 18, 1972, for this information.

...

Mann: What are your goals, Ann and Peter?

Authors: One of our goals is to learn more about spatial perception by examining its non-visual components. As architects, we will benefit from knowing more about how the physical stuff we build is perceived in non-visual as well as in visual terms. We felt that we could begin to learn about these 'unseen' relationships by studying the perceptual problems of blind people. At Perkins School for the Blind we met Harry Friedman who introduced us to a new polyvinyl chloride process that is being developed for tactual maps. Friedman wanted to find more out about the content and way of representing it on tactual maps. The problem he described

The authors discuss the goals of their project.

is concerned with symbolizing in a conceptual sense the non-visual and visual perceptual cues that are important for a blind person to know, and may serve as a useful vehicle for our own goals.

Mann: I have perceived a contradiction. You start out by saying that you were interested in tactual attributes of physical space. Then you are going to work with Harry on a polyvinyl chloride map.

Authors: The central problem of mapping is to decide what you are mapping - what is important for a blind person to know and what properties of physical space really are mappable. It gets to the heart of the perceptual matter.

Mann: If I can encourage you, I would stay on that side of it. Let Harry, Knut, and Bob worry about the practical aspects. Deal with the perceptual problem. This is the area that needs your attention and the perspective that you are more likely to take.

Proscia: I would suggest that instead of using Harry as your consultant in order to get some kind of control over this problem, that you should perhaps use a real gung-ho mobility instructor.

Mann: Let me suggest some of the touch-stones. Harry is fine, but you should try the Catholic Guild for all the Blind. You want to talk to Leo Riley, the Medical Director and to Dr. Balbakee, the full-time psychiatrist. Let me suggest some blind resource people who might be of some help. A guy, Hadi Madjid, an economist at A. D. Little is a talented person who has been doing work on trying

Professor Mann suggests the names of some people who would be of help on the mapping problem.

to understand the problems of the elderly blind. You should see Phil Davis who is the sensory specialist and an MIT grad at the Massachusetts Commission for the Blind. You ought to talk to Dick Held too.

I think you would make a great contribution if you did nothing more than be sensitive listener-dialoguers with this kind of spectrum of people, and then put together distilled through your own experience the facts and findings of your work. The problem is that this field is so multidisciplinary. I am particularly despondent because of Leonard's loss. Blindness is an international problem. I don't know where or how that baton is going to be picked up, but if you could fuse some of what you have learned from Leonard's writings into what you record, at least it would be a document that someone else would use.

Professor Mann suggests that the Authors be sensitive listener-dialoguers to the whole spectrum of information in this field and compile the facts and findings of their work.

Simha: One objective from all of this I hope will be forthcoming is a description of a journey that needs to be taken by people unknown at this point, but that could represent a resource for student or professional activity that might continue along these lines. And secondly of course, as a resource that might be used in conjunction with funding efforts to agencies that are beginning to get more seriously involved in this.

Mann: When you transpose from one sensory modality to another, what should the transformation matrix be to optimize the transmissibility of information?

Authors: Leonard suggested that visual processing was along parallel lines while tactual was sequentially organized.

How should visual information be transposed into tactual information? Leonard suggests that visual processing is along parallel lines while tactual is sequentially organized. Mr. Proscia feels that as much of the original visual information should be maintained as possible.

Proscia: My philosophy has been that it was always easier to transpose visual information to tactual information by maintaining as much of the original visual information as possible. Since blind people must work with sighted people, one must not develop a foreign code. Information compatible to both modalities makes for a dialogue and a better training process.

Blind people are now learning to hand write and type, two basic steps in opening new communication links. All my visual material is constructed in tactile form as close to the original as possible. It might be possible to develop two maps of MIT: a walkway map and a building location map. Then at a later time it might be possible to bring them together.

Mr. Proscia proposes two maps of MIT - a route map and a physical layout.

It turns out that a large segment of the blind have some low vision. Is it possible to develop a map to serve both needs simultaneously?

Can a map serve blind and low vision people simultaneously? We think not.

Lienemann: Aren't these problems at odds with each other? Do people with low vision read a map tactually as well? How can blind people read ink print tactually?

Proscia: I have been using an optacon which can transform print into a tactual representation.

The criterion for a tactual map is that we must be as simple and straightforward as possible. Can't we start that way for low vision too?

Authors: You have a problem of tactual clutter. Larger print for the partially sighted will compete with the tactual content for the blind reader.

Proscia: A general map of MIT must show building locations. People ask me, even when I am using my white-tipped cane, where Building 56 is. I tell them to refer to their own map. We also must show walkways, and potential hazards, differentiate streets from walkways, hedges, driveways and parking lots.

Included on an interior map, I would like to have corridor information, stairway locations, rest rooms, elevators, etc. Locating a specific room is not as much of a problem. Soliciting aid is basic to the mobility process. We all do it. I might want a map of each building corridor. I am thinking about a booklet of maps in a sequential form. But these maps must be tied into a map of the overall organization. Such a map might indicate the principal and safe arteries. I hate to walk into the parking lot off Ames St. There are other ways of bypassing this route that could be shown on a map. You might be able to blow this general map up into specific sections. I am inclined to travel without a map by studying it beforehand. Tactual information is not by itself sufficient. Verbal information must accompany it. This means that you must construct a mobility system.

Authors: How does Gilligan's map feel? It seems to have sharp edges.

Mr. Proscia suggests information that should be included on a general map and on an interior map. He tested three maps: Gilligan's, Bentzen's, and Friedman's. He demonstrated his ability to use Gilligan's map, a raised blueprint of a large section of the MIT campus, by locating Massachusetts Avenue and his own office.

Concerning Bentzen's thermoform map, Mr. Proscia remembered it as not being particularly distinct, but later when he was reintroduced to it said it was not that bad. He felt that the material confined itself to only the sandpaper texture, and did not like the way the material wrinkled and cracked. He pointed out that you could get heavier thermoform that does not fall apart so easily, but that it is more expensive.

Proscia: Yes. This process, selected for its portability, is experimental.

On the polyvinyl chloride map of Watertown Square, Mr. Proscia felt that the braille was good and the lines were strong, but he felt the map was poorly executed. Such Comments as 'Where do I start?' and 'Why are the trees so big?', 'The braille is running in all directions.' were frequent.

IO JK

INTENT: To discuss content of a tactual map, an information center, and JK's perceptual constructs.

INTERVIEWED: JK - age approximately 22, Harvard senior , History major, congenitally blind.

DATE: 29 February 1972

JK: The New York Library recorded 16,000 books last year. This semester I'm borrowing close to 30 books from New York recording studio. I have had a couple of books read by readers around here and recorded it. For the most part the quality wasn't good enough to hold on to. The reader made personal comments that you don't want. What I wanted were specialized things. IS (another Harvard senior) has not acquired any taped texts, or maybe a small amount. The college student today isn't working like that. Previously IS did have his readers record their reading as they were reading to him so he would have it for playback. You get personal comments, conversation, interruption. They're not concentrating on a quality recording. They're concentrating on reading it to IS. They didn't stop the tape if IS asked questions. If IS wanted to skip they did.

Authors: If you acquired a professional service recording then it could be duplicated for further use here. Professional in the sense of trained voice and studio recording. I don't know how expensive they are, but you could acquire in the course of the year several books that are yours that could also be recorded here that could be included in a lending library.

JK: But IS and I have not acquired any. I take notes on what I read and send it back. I have no use to duplicate books for myself from RFB (Recordings for the Blind) because if I want them again I send a postcard and get them. If you want something it can be duplicated relatively easily. You can buy a split computer tape, if you want an inexpensive tape, but it's good only for voice, through the Vista project in California. You can get a 7" reel for about a dollar. If you want to do a library for college students, you need to get machines, you need someone to coordinate. You need to organize good readers. The Library of Congress recording studio, American Foundation for the Blind and the American Printing House of the Blind are increasing their recorded voice. They use cassette, reel to reel tape, also records. They are increasing their production. They are federally funded through the Library of Congress to a large extent. Of course it's by no means complete and there is still a lot to be done. Sciences for the Blind is recording scientifically oriented books that students at MIT would know about. There is a Best Sellers taping group. There are all kinds of efforts.

According to MIT students, the math books done by Recordings for the Blind are not especially clear or accurately read. It would make for a better recording to use student readers who understand the material.

Authors: What would be helpful to MIT students to orient themselves besides maps?

JK: I don't see that there has to be a lot besides the map. If you can work out a substantial map system that if you have an individual who has been trained in mobility that can read braille, that can get around relatively well and relatively independently, that you will be bridging the largest gap. If the school is interested let them work out a mobility training and orientation program for blind students to familiarize them with the campus through the aid of a trained mobility instructor, rather than the individual having to make contacts in an area which is not familiar and to arrange for an instructor. I had trouble getting an instructor when I came to Harvard since I wasn't a Massachusetts resident. I'm skeptical about an information center. It's a good idea, but I can't see myself making a phone call to Harvard to find something out. I have enough social contacts and of course I'm married which helps a lot. What kind of communication is going to feed into this information center to keep the paths clear of snow and what means clear to you may not be clear to me. I'm having a hard time walking in this snow. When snow comes landmarks disappear, paths change, the surface of paths change, inclines and angles change, where you walk changes. Not having been raised in snow and not having had very much experience with it, I'm having a hard time. I would deemphasize the information office in comparison to other things.

It might be possible to use volunteer students training in peripatology at Boston College to help orient the entering blind MIT students during the first month of school.

Mr. Proscia aptly called snow "Blind Man's Fog".

Authors: Could you tell us something about the information you use around here going from one place to another place? A familiar trip. On a tactual map there may be cues that a blind person would respond to that a sighted person may find redundant. In some cases we will have to editorialize. That's one reason we think of an information center. It could be a person who has a more detailed map with other cues that would be available in emergencies, that would be available at anytime. This is a person you're familiar with, that you've worked with before who has familiarized you originally with the campus. Perhaps you would have been less hesitant to call that person.

JK: Yes. I think it can work into something.

Authors: We're interested in the cues you pick up.

JK: I think you're making an extremely important point when you talk about the fact that a lot of information will have to be cut off the map simply for simplicity sake. I would say that outline maps indicating buildings, names of buildings and entrances, streets, paths are important in and of themselves. When you add other things on, you have to be extremely careful because you're talking about a great confusion problem. Something indicating steps into a building strikes me as very useful. I was walking to a building a few months ago and I was thinking about something else and I went off of my path onto another path and assumed I was all right, not realizing that I had changed paths. My cane technique was not quite what it should be when I tend to be too confident and too lazy. I came to a series of stairs going down to the basement of a building when I was expecting to go up. Going up these stairs everyday I do not take the time to look at the stairs. Something like this could create quite a few problems. When I realized what had happened I had no idea where these stairs were, what I had done wrong and what I could do without sighted help to get out of the situation. I got someone to help me. It was not for several days that I got my wife down there to tell me what I had done. So entrances to buildings and indicating stairs is a great idea.

JK finds that if he becomes too confident and lax in his mobility technique, he will make mistakes.

Authors: What about indicating danger spots?

JK: I hate and will go miles out of my way to avoid making these horrible crossings with islands in the middle of the street. The kiosk at Harvard Square doesn't bother me anymore. I use, unless it's covered by snow, the surface. Maybe you could have a code and indicate blacktop or macadam, cement, gravel, brick, grass, dirt, or building. To me and a lot of people I know this is pretty important, if you can do it without confusion. Where this helps is where driveways cross paths. In one instance the driveway is cement and paths are blacktop. Also when you're distinguishing a path from what's on both sides of you. Maybe it would be possible to indicate with one texture paths for walking, another tactile sensation for streets. Instead of giving types of pavement just indicate paths different from street. Maybe you won't even have to do that. If you're talking about a downtown block and shopping center it's not important to indicate whether that's blacktop or cement. It's more important to concentrate on what's in those buildings, where those building are in relation to a pedestrian sidewalk. 99% of the time the student does not spend his time walking down the street. He will stay on the sidewalk. Knowing the texture of paths around Harvard Yard is important, but the yard is atypical.

Surface pavements are nice to know.

Authors: Perhaps we should make a distinction between walkway that is both vehicular street and walkway.

JK: IS and I regard service roads differently. When IS came to Harvard he came with a mobility instructor and they spent a lot of time here. I walk along the edge of the service road. It's most direct to walk up the edge of the service road from Mass. Ave. to Emerson Hall. IS goes the long way around on the path. Each blind person develops his own ways. I tend to be not so careful. I cross Mass. Ave. at Plimpton Street where there is no light.

JK describes how he handles a service road, and two different methods to cross a busy intersection.

Most of the time I get someone to help me across. IS goes out and stops traffic. I cross the street very fast here. Do you indicate that it's a street without a sidewalk?

Authors: What information would be useful on a map of the inside of a building?

JK: Don't worry about vending machines. If you find them and you've never used them before, you can't use them. Braille instructions on machine are not useful because they come off, and the coke man switches stuff. Keeping up with coke machines around here is impossible. Restrooms are extremely important to indicate.

When you talk about feedback, you're talking about something like a shoreline - wall, doors, cubby holes, openings, lobbies give off sounds. If you take a building like Emerson and indicate the main corridor and trace the fact that when you come into the building and go straight there are two doors across the hall beyond the stairs. So you trace the fact that the walkway is narrowing maybe by 2 lines indicating a doorway. As you go on you have a small cutout opening that goes to an office. You can hear and sense the opening. Then you go on and on the left side pass a large opening - the other doorway. These clues would be helpful. Room numbers are hard unless you're using thermoform and produce a directory. You could have a large map of the outside using the polyvinyl chloride process. Then take thermoform sheets. Make thermoform a simple 2 line map indicating corridor and entrances off it. Do them of floors the student needs and he has a simple tool. It's not helpful to have the map on the wall inside the entrance of the building. It's more helpful to have a book and study the trip before I go there and figure out where I'm going to go and plot my course. Nine chances out of ten when I go to a building,

Lines that are capable of feeding back to the map are shorelines, walls, doors, lobbies, etc.

I only learn to go to places in the building I'm going to.

Another problem is when you get into a large lecture room you don't know where the seats are, which way they face, or where the podium is. Someone might show you a seat and you spend the period thinking about how you're going to get out.

II AMENDOLA

INTENT: To find out methods for teaching spatial orientation.

INTERVIEWED: Robert Amendola - instructor in spatial orientation at St. Paul's Rehabilitation Center, Catholic Guild for all the Blind, and a sculptor by training.

DATE: 1 March 1972

(Before the interview we witnessed Mr. Amendola working with subjects in developing their alarm cues. He approached the subject who was walking towards him and held a picture at the subject's face level. Ss had to sense the object, stop in time to prevent a collision, and step around it. Mr. Amendola eventually put the picture down and used himself as the object.)

Amendola: Father Carroll, working at Avon Ulthant's (?) Convalescence Hospital with newly-blinded adults, developed techniques for rehabilitating the blind. The blind man's cane consisted of short, heavy, stout walking stick, painted white. Shuffling down the corridor, these men looked as though they were very lame. In the first instance, Dr. Hoover, sensing that the cane was acting as a bumper, felt the men really needed an antenna. He experimented with lighter longer sticks and finally arrived at the present day technique. A cane is chosen according to a person's stride and height so that if you strike the ground with the cane when you are stepping on your right foot, it will be striking the position you will be stepping in,in two paces. You will, in other words, be touching ground where your next step will be. The alternate technique is to cross the body with the cane giving you a step and

The cane is a good device as evidenced by the fact that the three principle sensory aid prototypes, the laser cane, pathsounder, and binaural spectacles, are either modifications of the cane or meant to be used in conjunction with it.

a half leeway. The two step technique leaves you more room to stop, but is counter to the natural swing of the body. With this one idea Hoover released all blind persons from the blind man's shuffle forever.

Carroll's particular idea was to break the blinds' handicaps into categories - realizing that the adventiously blind have a wealth of visual imagery stored within their visual cortex. Among blinded persons, those who seem to have good orientation and mobility techniques,were actively visualizing. Those who bungled around, but were on a par with respect to sensory acuity, either were not visualizing or were visualizing, but were allowing their visual imaginations to run away. New trainees, here, have to walk 100 yards to get to the dining room. As they start to make this trip, the first few times that they hear conversation on the way to the dining hall, they see a whole line of people watching, even if there are only several engaged in a conversation. If they come to a little incline, they see an abyss. A couple of steps become an endless flight. Their imagination derived from reality is running wild. Then the opposite reaction is the person who says that I can't see so I am going to imagine a world of my own. I don't mean a psychotic state. I mean they walk around in a garden so they imagine a great beautiful paradise. This kind of person is distracted from what is really going on. Then there is the other kind who drops the whole thing. They can't see so they refuse to make believe that they're seeing. Such a person will just exist in a vacuum. They take someone's arm and arrive at where they want to go. What is in between is nothing except conversation.

Amendola describes people's reactions to becoming adventiously blind.

Authors: Where do the congenitally blind fit into this picture?

Amendola: It is another kind of spatial orientation, and very few do orient. The general impression is that a place like Perkins is where most of the children get around just fine. But in fact most of the children are led from class to class by their partially sighted classmates. Most of them are very poor at all the things you think they are adept at, but a few do really well, those who grow up like porpoises, bats, etc. They are using various degrees of echo perception. Not that they are sending out signals like a porpoise (although in some instances they do with clicking sounds or the use of their hard heels) but usually they are using just ambient sounds and the reflections of them. What we were doing today is caused by sound, but it is not heard as sound. There is this impression of closeness and a reaction in the vascular system and in the muscles of the skin. There is a slight tensing of the face and an apparent change in the temperature of the skin. Therefore the person feels suddenly that there is something close by. This is an alarm reaction. It is just like this girl did. (in the experiment witnessed before the interview) The first thing she really did was jump. With a little practice against walls and other objects she would soon learn to sense these obstacles at a little greater distance so that it would be an alert rather than an alarm.

Amendola describes echo perception and "facial vision."

Authors: Then what you describe is a sensory technique that anyone can develop?

Amendola: Yes. Almost anyone. If the ear's acuity can receive these vibrations and if one's temperament can handle so vague a thing. When most Ss are introduced to it, it is like a short gift of sight. There's the wall over there and something over here etc. All of a sudden they can take it in.

Useful echo location requires the perception of frequencies over 8000 hz.

We had a conference a few years ago to discuss what was wrong with maps as they existed. There were some useful notes. (He could not find them.) An interesting talk by Mr. Mayer Spivak, a Harvard Professor. His notes and articles will be right up your alley with respect to environmental design.

I will describe how an artist gets involved in this field. By observing those people who functioned well, one could see that they could actively tie their imagination to the input from the other senses in such a way that the object touched was not felt for only feeling's sake, but for seeing's sake, that the thing that was heard was heard for seeing's sake. If you come to the blackboard I will show you. By the way, this aspect of mapping might interest you (referring to a diagram that was already on the board). One of my duties is teaching spatial orientation. As a part of the class I teach "videation" - a word coined by Father Carroll meaning concentrating the imagination on what you would see if you could see it at a given moment, constructed from the information coming in from the rest of the senses and the information you have already collected. We simplify - maybe even oversimplify - in order to get quick mental mapping for spatial orientation. For example, this wavy line symbolizes the Charles River on its way to Boston, but really doesn't show what it does.

Psychologists frequently refer to "optification" which is synonomous with "videation."

Authors: Have you read Kevin Lynch's Image of the City in which he studies similar conceptual problems?

Amendola: No, I haven't. You can see Centre St. and Mass. Ave. This whole thing would have to be canted up to give true north, south, east, west. I locate for the trainees the Charles River Road, Washington Street, Massachusetts Turnpike, Beacon Street and Commonwealth Avenue - all main thoroughfares going across, and then Route 9. Commonwealth intersects what was Washington Street which has changed names a couple of times. Then Beacon Street comes up and crosses and goes up to the river. This Back Bay section was at one time water. It's all been filled in except the Public Garden pond. Flowing toward thesea, the river runs into Beacon Hill, which is roughly a circle. The river, trying to get out, flooded the area behind the hill and formed a little channel to the south, but did find its way out by North Station. Then they built South Station and the railroad tracks adjoining all the piers going out.

The hill itself is divided by the early settlers. First you have the residential area, the old Beacon Hill homes - Massachusetts General is now there too, but it was all old Boston. The Common was always a common feeding ground, grazing ground for the animals. They still find stables under some of the houses. When they were building the chapel at Park Street and were working on the foundations, they found the remains of several stables. The northeast quadrant was the tenement area which was built by old settlers to bring in the Irish during the Potato Famine period to work in the mills around here. Then the Irish moved down to the South End as they came up the social ladder. The wave of Italian immigration came to build the railroads on the east coast (the Chinese on the west coast and the Italians on the east coast). This (North End) then became the Italian section and to this day remains Little Italy except for the part that is now Government Center. The mercantile area was the southeast quadrant. If you take a walk from Atlantic Avenue down here back through these streets you can still get the pattern of first shipping and fisheries, move in a little and it's all warehouses, then processing (leather processing etc.), then manufacture, then wholesale and then retail. Here the goods come and go from the sea or from North and South Station and the people on Beacon Hill just walk

The map Amendola describes is very easy to understand and remember because its structure has been defined historically. He also analyzes the commercial district - wharves, processors, wholesalers, and retailers - in a way that lends itself to using non-visual, as well as visual cues.

across the Common to Filene's, Jordan's or Gilchrist's, and the theater district just a little below here. And this is Tremont Street, a reminder that Boston was once Tres Montagnes. And this is Washington Street and then your ladder of rungs of these sidestreets. So we simplify the map. It's not that far from the actual thing, but if you'd try to follow the actual thing you'd go crazy.

Authors: It's a conceptualization that makes sense.

Amendola: Beside the physical business of apprehension of what's on the paper there, you have, in mapping in general, the necessity of conceptualizing in a way that can be remembered.

To get to the point I was trying to make - new ways to use the senses. We are trying to take a lost human perception, in this case, a last ditch alarm that something is about to hit you that you haven't caught with sight. It's something that happens in the dark. You feel something close. Usually it's not that good in a human being, but can almost always prevent the collision. We don't realize it until we analyze it. We avoid really being hurt because we're rolling, we're backing up from the punch, or backing up from the blow, the collision. At that last minute we pull back just in time so that we save ourselves that horrible bump where you're still going forward.

Amendola is describing a form of obstacle perception that is commonly called "facial vision".

Across the street from St. Paul's there is a hockey field 100 yards long with a goal cage at each end where girls from the Academy of the Sacred Heart play. (Amendola drew a diagram) Here's Centre Street with a constant stream of cars going by. Here's our driveway coming in here onto the street. I walk the trainees down the driveway and as we do, just for an exercise in visualizing or videation, I say,

Amendola describes a class that he conducts on a hockey field across from St. Paul's in which he teaches newly blind to use videation.

"What kind of a car was that that just went by?"

They say that it was a truck or trailer truck, it had 6 wheels or that it was a light sports car, or that it was a VW. I'm just playing around with that as we come down with an ulterior motive. We cross the street and we come over here and there's a gate, a small hill. It goes up here. We go through the gate. I describe the field for the first time to them. We move over to the goal cage.

"There's a slope down here. When you feel the level, it's the goal line."

We move over here. As sort of a side thing, I ask them to try to detect the goal cage before we reach it through "facial vision". We move into the cage with our backs to the back looking out across the field to the other goal cage. I describe what's to the right of the field, to the left and straight ahead. I give them no direction. While we're standing here, as if I were still keeping up the conversation back near the road, I say, "Oh, what was that that just went by?" So I know that they have listened to and are aware of Centre Street being on the left. Our goal is to get into the goal cage directly opposite. I avoid the word "straight", "walk a straight line across", or anything like that. I say, "Our objective is to get into that goal cage." They start out. What happens as an extreme is walking in a circle or walking off the field before the 50 yard line.(1,2) Most of them walk off the field from the 50 yard line on.(3) Occasionally someone makes a bull's eye. Let's take an average instance. A person will come out here and will take this path.(4) This is the path they think they are taking.(5) I will arrest them at the sidelines and say, "Good, you've arrived at mid-line of the field and we're still on the field." The person is here.(6) Here is where the person thinks he is.(7) Then I say, "What was that that just went by?" There might be a truck going by

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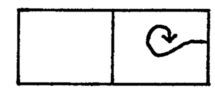

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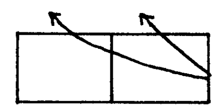

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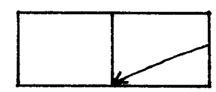

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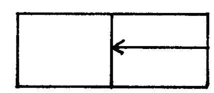

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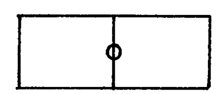

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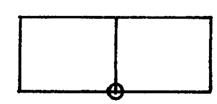

just under his nose. Then I say, "Where do you visualize the goal cage? He points straight ahead. Then I ask, "Where's Centre Street?" Either the person comes to, or if he points to his left instead of straight ahead, I say, "Where do you hear Centre Street?"

That's the real thing. The first time this happened to me, it was a young woman. She was a Ph.D. She had had a terrible blow with her loss of sight. It was complete and quite sudden - a matter of days. It was a tremendous emotional catastrophe. At first she didn't catch the picture at all. I said "Where is Centre Street?"

She said "To the left."

I said, "Where do you hear Centre Street?"

She said, "How stupid can you be! It's right out front. I just old you a car went by."

We tried to figure out what went on. It's not stupidity at all. It's just a completely different correlation than you have ever done. She had said to herself when she left the goal cage that she had to walk in a straight line to the other goal cage. What helps to keep you in a straight line is your kinesthetic sense. Muscles move one foot approximately in front of another with an accumulation of error, usually all in one direction so that you really walk a great circle. Or your sense of turn - the organ in your inner ear associated with balance. The semi-circular canal lying flat has to do with turns whether you do the turning or whether something is turning you. You don't have to originate the turn. Another good exercise is to turn someone who is sitting in a swivel chair. You ask the person if they can think in terms of degrees. "How much have I turned you?" If they can't locate objects using degrees, I let them tell me by using an object instead.

The obverse of this happens in the case of a person who has newly acquired vision. Of course when I say "grown up blind" it couldn't be total or there would have been atrophy. Receptor cells had been active, but they could make no image. Then a person maybe has a cornea transplant and gets 20-20 vision from zero vision for the first time ever and he doesn't know what to do with it. As he walks and the picture starts to move out of the plane of his vision, it doesn't mean anymore to him than the cars on the road mean to the newly blind on the hockey field. The moment he becomes aware of it because the instructor has said, "all right, where is it?" he comes to.

A newly blinded person has to learn to correlate the incoming sensory information. Amendola believes that visualizing is an effective way to organize the non-visual cues.

That's what we try to do. First, the instructor makes the person aware by a demonstration like this. The person makes himself do it and then it becomes habit. Then it becomes sub-conscious. They don't have to think of it. If you had to think of these new coordinations, you'd go crazy. The point of the exercise is to learn to hear, or seeing say. Take all of the functions of sight (and there are many) and distribute them among the other senses, as back-up systems. Training them to work this way we begin to get sufficient information coming in so that with what one remembers of the usual aspects of the environment, one can picture the rest.

One kind of trainee who sometimes comes here says he won't have anything to do with visualization: "I don't believe in it. I'm a realist. I'm blind and the only thing I know is what I touch, and what I hear." And if he runs into a table, he'll back away. He simply says, "obstacle" and moves aside and starts again in the direction he wants - a trial and error process. Another person will come and bump into the table, touch it, and say, "Friend, give me some information." And then he finds the table height and deduces its shape from the part he is touching. If I want to walk around it, I'll walk around it like so. In this way visualizing, projecting ahead to what is coming, permits a person to operate much more smoothly. And meanwhile it was always his nature to have this imagery, whether he was actually pulling these pictures out of his memory bank, his visual memory bank. This helps him to correlate everything that is coming in, otherwise you wouldn't recognize the door. The person functions more normally this way.

Videation is not fantasy, but a rational correlation of non-visual cues with visual memories.

On the way back from the far goal cage, I make a point of telling them that there's absolutely no need to walk this straight line. We're going to walk the craziest line ever going back before walking into that cage. I have the trainees come out of the goal cage and line up. I have them confuse themselves and then aim at Centre Street. Pretty soon they find that they can aim at Centre Street. If they're a little bit off, I say "You're not exactly on the ball, which side would you turn in order to center yourself?" They always get it right.

Time and time again, when they ask me, I say "You have enough to answer that. You can answer that." I ask them questions and then they realize they have all the information, they just have to put it together. You have the answers. What you don't have are the questions.

I have them walk out straight from the goal cage first until we're in the clear and then we walk crazy patterns, usually a sort of snap-the-whip. I tell them that they have to pay attention to the traffic and also they can use the sun on a sunny day. With the traffic, they have to ask two questions. Am I nearer or further than when I started? And am I walking parallel to the traffic? We find that they can judge the distance from the street very accurately without training just by bringing attention to it. We face the street and then come back to the center line, I then say, "Go all the way to the side line and then bounce all the way to the other side line, then bounce over to the other, back to the center line and in. Almost invariably everyone hits it right in.

We bring out the fact that we have two guidance systems - an internal guidance system which consists of a kinesthetic sense of turn and balance which orients our own bodies in space, but tells us absolutely nothing about the environment. Sometimes we think we have a sense of direction. We think we know where we are going, but we don't because if you take off in the wrong direction all your turns from there on are wrong. Then there is the external guidance system which comprises the senses that reach out, hearing, next to sight, then smell and touch etc.

Amendola describes two guidance systems, internal and external, that a person possesses. The internal, kinesthetic and balance, is not sufficient in itself to tell us where we are with respect to external objects.

On our way back for the first time (this is one of the early exercises in our 15 week program), we start here just outside the goal cage and they walk up this grade behind the goal cage. And I say, "Now, I'd like you to walk right through that gate."

"How can I walk through that gate?"

If you listen, you'll find that every car that goes by, the gate is talking to. As a car goes by the engine nose and the tire noise, being low to the ground, come in very sharp and clear only through that opening. Pretty soon they realize that they can from anywhere, 25-30 yards around here, walk directly to that gate and out by using the sound shadow of the wall.

Authors: When do you usually do this exercise?

Amendola: With each group, up to 24 people at a time, usually 17-18 people at a time, for a period of 15 weeks. So it occurs every 15 weeks. The next time would be in April. Usually we go from one group to the next without a break. This time of year we intersperse one week of evaluation. We rehash everything that went on during the year - where we think we've failed, where we might improve. It's an agonizing reappraisal every year.

Authors: The exercise on the field would be good to film.

Amendola: About three years ago B.C. filmed it. They used B.C. peripatologist trainees instead of real subjects. I have structured my course in two parts - an indoor sequence and an outdoor sequence, and I jump from one to the other depending on weather conditions. This exercise would probably occur near the end of the third week of April. The B.C. film was silent, with dubbed commentary on tape.

B.C. = Boston College

Spivak is gung-ho on "umbrations", sound shadows. He has made a lot of studies on how visual inputs mash other inputs.

According to public opinion, when a person is blinded, all of the other senses miraculously increase in acuity. In fact, the opposite happens. The subject will not function with hearing or touch, as well as he functioned when he had sight - for awhile and maybe forever, it just depends on the way he develops, unless he is trained. The reason is that sight has always served as the sensor for information. It monitors all the information coming from the other senses.

When a person is blinded, his other senses do not miraculously increase in acuity.

A person smells smoke and he looks to see it. You stop in a phone booth. You know you only have a dime in your pocket. It can't be anything, but the way you feel it, but for the life of you, you can't put it in that slot without looking at it. All of a sudden the monitor is gone. All the other senses fail suddenly to have any confidence in themselves. Like the man earlier who was doing the facial perception exercise. You could see it in his face. His muscles muscles tightened. His neck reared back. And he walked right on time after time. He doesn't believe it. It's this kind of thing that has to be overcome. Confidence in the remaining senses is an extremely important part of this rehabilitation process, so that signals are believed and coordinated well.

To gain confidence in the remaining senses, one must practice using them to receive feedback from the environment. (i.e. recognize cues and signals.)

12 BAILEY

INTENT: To find out what the Freshman Advisory Council does to help blind students at MIT.

INTERVIEWED: Alice Bailey - Freshman Advisory Council

DATE: 2 March 1972

Bailey: When CN first came as a freshman to MIT, she and I brailled a map of the campus to help her orient. We got a map of the campus and brailled building numbers on it. The map fit right into the brailler. I showed her where the buildings were and she brailled the numbers of the building of all the classes she had to go to. She did not braille the outline of the buildings. She has incredible orientation. She had some picture in her head of where things were. She lives in McCormick (MIT dorm). She's totally blind and uses a cane. The other blind freshman is partially sighted and doesn't use a cane.

CN is now using a map brailled for her by a friend which shows the physical layout of the MIT campus.

Authors: Do you know how many blind people there are on the campus?

There are only three blind students living on campus.

Bailey: No, I don't because being on the Freshman Advisory Council, I've talked only with the two freshmen. Have you talked with Jackie Buck the social worker?

There was, in fact, no list of blind students attending MIT. A list had to be researched from the files of the Medical Department, the Admissions Office, and the Freshman Advisory Council.

Authors: Yes. Would an orientation week at the beginning of the term be helpful? And if so, what kinds of things might you have in the orientation week?

Bailey: I think that an orientation week would be good. I got guides for both of the freshmen when they first came so that when they were here during rush week they were taken around to all the fraternities and other places so they could find out where everything was.

An orientation week for the blind at MIT is recommended.

Authors: That might be something the APO Service return might do.

Have you talked to the Admissions Office to find out whether there's an increasing tendency to admit more handicapped students, including blind students? It would be interesting to know how many blind apply of their own accord, realizing that MIT does have a reputation for being extremely hospitable and receptive to handicapped students. It might be as programs are implemented that it would be more desirable for blind students to apply here. Part of the problem is to analyze statistically what blind people really do and if there are enough inroads here at MIT into professions that would be within a blind person's capabilities.

Subsequent conversations with Mrs. McLellan of the Graduate Admissions Office, Dr. Sam Clark of the Medical Department and Mr. R.B. Greeley, Director of Admissions, all confirm that not more than one or two blind students enter MIT per year.

Were there any other things that CN was interested in getting more information about besides the location of the buildings?

Bailey: She needed readers. I work with Recordings for the Blind in New York and sent notes down to get the recordings.

Authors: Is it realistic to propose a cassette library here at MIT?

Bailey: I think it would be. They could use recordings of the basic texts of required courses here. They could send to New York for other readings. Their good readers and a large collection might as well be utilized.

A subsequent meeting with Miss Natalie Nicholson, Associate Director of the Libraries, MIT, leads us to believe a tape library is feasible using currently available resources.

If you are going to have an information center, you should have a list of volunteer readers there. I had a list that I got from Mrs. Buck's office because they had always handled it before. It was difficult to make up a list because there were no resource channels through which to get information.

A list of volunteer readers should be available. GL suggested that students could check a box on registration material to volunteer to read.

Authors: We should make contact with APO and sound them out.

Bailey: One of the counseling deans came down to me several days ago and said that CN really was having problems in one of her math courses because she was expecting the teaching assistants to do reading for her and they didn't want to do it. She wasn't getting the material at all. This is such a high pressured place for everyone including the volunteer readers. There may be working people here who could read.

Authors: If the reader could record the material, you would be taking the initial pressures off of everyone. Then you would be freer to record when you had the time to do it. You wouldn't necessarily be needed at awkward, odd times. We have to find out what facilities are available here at MIT to do this.

Do you have an idea of what should be mapped at MIT? On the larger map we may indicate places to eat.

Bailey: Yes, you should indicate that. I worked at Perkins two years ago in the deaf-blind department evaluating deaf-blind so I didn't have much contact with educable blind. That's how I got into working with the two blind MIT freshmen. I took CN out to Perkins at the beginning of the year and got her braille paper and stuff like that. It might be useful to have that in an information center. It's made at Howe Press. That's where everyone gets it.

Authors: Through the information center the blind could get braille paper and a list of available readers. We need a facility available to readers and the blind where they can record. A library of tapes could be started. There might be a directory of personnel and a redefining of roles. We could have a tactual map of the campus at the information center.

Bailey: The existing information center in Building 7 and the Freshman Advisory Council office are open from 9-5. Three men work all night in Bldg. 7 and provide information.

Authors: Maybe this information center could be realistically implemented by the Freshman Advisory Council. There are as many freshmen as anyone else around campus who need orientation. The blind need more service earlier in their career at MIT than later and this would probably be concentrated in the freshman year. Therefore perhaps the Freshman Advisory Council office should have the tactual map and they could communicate further instructions to the blind as they are needed.

Bailey: The Freshman Advisory Council might be able to coordinate some kind of orientation to go along. There are graduate students coming in too. I'll speak to the student who's running orientation week for next year and ask her. I'll know in a month or so if there will be any blind new students.

13 PROSCIA

INTENT: To ask Mr. Proscia a questionnaire based on Kevin Lynch's questionnaire from Image of the City and to discuss content for a tactual map of the MIT campus.

INTERVIEWED: Mr. Vito Proscia - Director, Sensory Aids Evaluation and Development Center at MIT, adventitiously blind at age 12.

ALSO PRESENT: Knut Lienemann (MIT Planning Office)

DATE: 7 March 1972

Lienemann: Do you know Kevin Lynch's Image of the City?

Prosica: No.

Lienemann: I'll use his questionnaire that he used for his study, only to see if it makes any sense to use this for our purposes. First question: What first comes to your mind, what symbolizes the word MIT for you? How would you broadly describe MIT in the physical sense?

Proscia: When I think of MIT, I think of a location of a large number of buildings that runs along a strip along Memorial Drive. And that the river is nearby. When I come down to MIT in particular I think of where I normally describe to people where to meet me or where they can be picked up. That's at the front entrance at the dome, 77 Mass. Ave. From there I would trace out a path of how to go from my facility either outside or inside, either way depending

When Mr. Proscia conceptualizes MIT, he thinks of a group of buildings along Memorial Drive, and the places he frequently experiences, especially the dome on 77 Mass. Ave.

on the weather or what have you, of how to get to that location. That's how I think of MIT. I don't think of anything specific - well except for the front entry - I don't think of any other features about what MIT is. I can't describe any particular building, except I know that there's a dome there, only because people told me.

Lienemann: So your focal point is Bldg. 7, the dome?

Proscia: Yes.

Lienemann: And you try to relate every point to this?

Proscia: Right.

Lienemann: Next question. We would like to make a quick map of MIT. Make it just as if you were making a rapid description of MIT to a stranger covering all of the main features. Have you ever tried to draw something? You use handwriting.

Proscia: No, mainly I describe. I've never really tried to draw even though I can. I have devices that will allow me to draw. Plastic mylar on a rubber sheet. It consists of a 10"X12" board with a rubber top. It's a masonite board with about an 1/8" rubber glued to it. If you put a very thin sheet of mylar on top of that, maybe 1/10,000 or less. If you run a ballpoint pen across that with pressure you will get a stretching of the mylar where the point makes contact with the mylar. You get a bubbled line effect, a very thin, well defined line. It's difficult to feel it because it crinkles up, so I attach the mylar to paper.

ML had a similar drawing device - a slate that could produce raised lines using any kind of stylus - which he frequently used.

When we met with him there was a Cambridge intersection on the board. He was trying to understand the angular street relationships.

I used to use it a great deal in college, but now I don't use it at all.

Lienemann: Can you make a mental map of MIT just as if you were making a rapid description of MIT to a blind stranger covering all the main features? Would this be different from your first point?

Proscia: No. I would mainly provide him with minimal information as to how to get around MIT rather than inside MIT. Rather than going through the campus, the easiest way for a blind person to travel is to travel around the perimeter and go into the quickest access point. I won't plunk him into the middle of the campus and say go to building so and so, but I would direct him around the campus. It might be the long way, but it turns out to be the easiest way, because the cues might be better for him to follow around the perimeter. The perimeter of MIT that I'm knowledgable with is this present block area and the boundary lines are Mass. Ave., Memorial Drive, Vassar St. and Ames St. That's what I consider to be the main campus. Then I would become familiar with the various entry points. This gives you orientation. When I travel up from the subway alone, I do not travel through the campus. I could do it, but I find it's a more comfortable experience to travel around the perimeter of the campus. The boundary lines are confined. You have a sidewalk and a building.

Mr. Proscia favors the perimeter of the campus as a main route to various buildings even though it might take longer than a more direct route. Others we have talked to opt for the more direct route. All have said that any route becomes easier the more it is traveled.

Lienemann: What do you mean by comfortable? Not so frightening?

Proscia: It's easier to lose your orientation in a wide open expanse than if you have trailing cues - a sidewalk grassline.

A wide, open area is more difficult than a sidewalk because it has fewer trailing cues than a sidewalk.

Lienemann: Next question. Please give me complete and explicit directions for the trip that you normally take going from the place where you park your car to this place where you work (Bldg. 31). Picture yourself making the trip and describe the sequence of things you would feel, hear or smell along the way including the path markers that have become important to you and the clues that a stranger would need to make the same decisions that you have to make.

Proscia: I would come out of the garage (West Garage) and walk down the sidewalk that comes out and trail along the garage - north sidewalk. There are several driveways one crosses. They are going into a building which is a very large warehouse. I would come to the corner and my tendency would be to cross going south at the corner of Mass. Ave. and Vassar St. I would cross Vassar going south. Then I would cross Mass. Ave. going east and I'd be on the southeast corner of Mass. Ave. and Vassar. Then I would follow Vassar on the southside, I would cross the first driveway which is a fire entry. Then I would come up to the second driveway which goes under Bldg. 39. I would trail along that driveway since it's a curving driveway, trail the curbstone, since as you come in under the building the driveway bears left and then it comes around slightly to the right. I would trail that sidewalk and then I'd step over and trail the grassline to follow the sidewalk all the way around until I got to the entry sidewalk coming towards the door here. I would come in the door. So I mainly followed cues that were visible to my cane and were visible to my feet. I'd use a second cue on crossing both streets - Vassar and Mass. Ave. That's the traffic cue, but I'd mainly use mobility and trailing to follow the sidewalks and to locate driveways...step-downs and step-ups. I use "mobility" meaning normal mobility of trying to straddle a straight line down sidewalks.

Mr. Proscia describes a trip he makes from the MIT West Garage to his office in Bldg. 31.

Lienemann: Would you give this kind of an explanation to a stranger who is coming to see you?

Proscia: If he started there, yes. I wouldn't give it to a sighted person.

Lienemann: Do you have any particular emotional feelings about various parts of this trip? How long would it take you? Are there parts of the trip where you feel uncertain of your location?

Proscia: I would not feel uncertain of my location, but I may, depending on traffic flow on Mass. Ave. solicit aid to get across that very broad street.

Lienemann: Any special emotional feelings about any other part?

Proscia: No. There are hazards that I must be aware of. And the hazards of going across the driveways, along Vassar after coming out of the garage, are very large trucks could be parked in those driveways and I would have to go out into the street to get around those trucks, and they could be rather sensitive and slow my mobility down. I'd be very cautious going around those obstacles.

Hazards of the trip to his office include loading zones on Vassar Street.

Lienemann: Could you try the same now with a different route? Could you try to walk from the Student Center to Hayden Library?

Proscia: I would come out of the Student Center. If I were upstairs, I'd go down the stairs and come around the stairs. The stairs point in the opposite direction that one normally travels going towards the main building, 77 Mass. Ave.

Mr. Proscia describes his trip from the Student Center to Hayden Library.

So you come out of the building and you have to go down the stairs which takes you away from MIT, 77 Mass Ave., and then you make 180° and walk down the walkway. You have to be careful there because there are several stairways you come down. Like there are four steps and then there are three steps as I recall. Then you walk straight out to the light. Then you would cross that light when traffic came to a standstill or there was pedestrian traffic flow and I would cross to the other side of the main entry of MIT. Then I would make a right turn and go down to the corner of Mass. Ave. and Memorial Drive and I would make a left turn and go down along Memorial Drive. There would be a problem associated with finding the entry to Hayden Library which would be on your left. It's quite a long walk down to Hayden Library at that point. I would either solicit aid or do some trailing, but I think I might have a little difficulty in locating that entryway if I hadn't done it once or twice before. I would do some trailing along my left edge to locate sidewalk entries. Perhaps if someone said it's the fifth or the second, or the third sidewalk entry, then I would go in and explore and I could be fooled because there are a lot of ins and outs there that go nowhere. I think they just go to bushes or little openings like patio type things. Then I would have to explore that. Or what I might do is go all the way to the corner and come back. That corner is the tennis courts I believe. You come back and I would count 1, 2, 3 - the third sidewalk going in and I think that might be it. It would be a guess. I never went directly to Hayden. This is my picture of where it would be.

Mr. Proscia remembered the organization of the Memorial Drive sidewalks in far more detail than we did who had traveled that route more often than he had.

Lienemann: If you were describing the route to a blind stranger, would you describe it this way?

Proscia:	Yes. I would add this additional information: the steps are going down and not up. That could be a hazardous situation. You just can't say stairway. you have to teel them which direction the stairway is in. I would also add that coming from the Student Center I would tell him to walk towards the traffic flow, street traffic, to get to this street - to give him an extra sound cue. And there would be a crossing there. I would tell him that that is a crosswalk and that he would wait for the traffic pattern to cross that.	Mr. Proscia recommends that stairs be shown going up or down, because the information would provide a useful mobility cue.
Lienemann:	Why tell him the direction of stairs if he has a cane?	
Proscia:	Because there might be situations where he might get to a step-up. His cane might indicate to him step-up. He might be off his track - like a curb line. He may think it's a stairway instead of a curb line.	
Lienemann:	What elements of MIT do you think are most distinctive? Large or small, but tell us those that for you are the easiest to identify and remember.	
Proscia:	Outside wise, the sidewalk pattern is pretty good around the perimeter. Except there are hazardous areas and one of the big hazards is the Main St. garage which is on the other side of Bldg. 20. That's a very funny traffic flow area because it's a three-cornered area and plus you have the garage driveway. That's a very hazardous area for a blind person and making that crossing is a diagonal crossing. You could miss it and get out into the middle of the traffic flow. There's a technique to cross. You have to indicate that technique. When you come to that driveway, say going down Vassar, the technique to use to get across that is to walk up the driveway slightly, maybe 20 feet, then cross the driveway until you get to the building.	Mr. Proscia describes specific hazardous sidewalk areas. He cites the area around Building 20 which was also mentioned by AD.

Then come back down the driveway till you get to the corner. Otherwise you would have to point yourself in the right direction. You would have to align yourself properly to hit that corner, to hit the sidewalk properly. That's distinctive. That requires further description if you want to help a blind person to get around the perimeter of MIT. The other distinctive parts about MIT are the corridors. The corridors are pretty wide. They usually have traffic flow. On the ground floor level sometimes you come to rather large openings and you could become disoriented like the great hall area. You have to indicate to the person, depending on what direction you're moving in (towards the main entry or away) what side of that main corridor he should stay on in-order to continue his path. Location of stairways is not easy at MIT or some elevators - they're recessed and out of the way. The doglegs present a problem, particularly on the second floors. They're confusing. You might come out on the second floor and you're inside of a large vestibule area. It's difficult to find your way out of that because of the way the corridor is designed. Sometimes going from building to building, there are different levels. The corridors are not continuous. You may have to jog about to go from one building to another. Another thing that's confusing, on some second floor levels due to the domes and main area, you might hit dead ends or have to go around along catwalk like arrangements (they're not really catwalks). You have to direct your path either left or right to go around these dome areas which go up several stories. These are the confusing parts about MIT. I don't know the inside campus that well. I think the inside campus is not a regular pattern. The difficulty of Bldg. 7 is to locate that main corridor, going from the front door.

Corridors are a distinctive part of MIT.

Blind students we have interviewed say that the stairways in the main complex are so easy to locate that they serve as landmarks.

Jogs in corridors are confusing. So are the connections between buildings whose floors don't line up.

Lienemann: Could you describe Bldg. 7?

Proscia: It's a large expanse in both directions. As you come in, if you travel a number of feet from the doorway, there is a corridor on your right going to the Naval Science Building. If you try to maintain a route going straight ahead, you will either locate walls or the opening of the main corridor. Going to the left are some rooms, corridors and stairways. I know there are some obstacles randomly placed in that expanse. They could be removed in a day's time. You can go upstairs around the catwalk to the President's Office and there are lounges up there too.

Lienemann: Do you think MIT is an easy place to find your way in or identify its parts?

Mr. Proscia thinks that MIT is not an easy place to find your way around in.

Proscia: I don't think it's easy. If you do it by coming in the perimeter, it's a lot easier. If you travel through the campus, it's not very easy at all. It takes a period of time to adjust oneself.

Lienemann: What places are you acquainted with that have good orientation?

Proscia: Generally speaking, a checkerboard pattern like N.Y.C. has excellent orientation. The avenues run north and south, and the streets run east and west.

The grid pattern - i.e. N.Y.C. - is an easier place to orient oneself within.

This makes it a lot easier for sidewalk mobility. A checkerboard pattern is the easiest to travel in. City campus was not an easy campus to learn, but you learn routes and try not to deviate from these routes. There are main route flows you use even though they may be the longer path. You would use the easiest route all the time. If inside route is easy, use that. If outside route is easy, use that.

Lienemann: Can you describe how you visualize Bldg. 7?

Proscia: The way I visualize it for mobility purposes, I would describe it as a rectangular area of so wide and so long with possibly hallways running off of it. As I recall, there is a rubber mat that one can trail along from the front door to the main corridor. I visualize it as being space rather than a corridor. A large space - x-y rather than being vertical. Vertical presents different auditory cues. I don't imagine there are balconies hanging all over the place. I think there are, but I don't imagine it that way.

Mr. Proscia is not the only blind member of the MIT community to specifically indicate that the Building 7 doormat is an aid.

Authors: In Bldg. 7 how do auditory cues, changes, affect your conceptualization of Bldg. 7 because there are other large spaces on the order of Bldg. 7 approximately the same shape that won't give you the same auditory cues. Can you use that differentiation to help make that distinction?

Proscia: Yes. When you walk from a corridor to a large area like towards the front door from the main corridor, when you step out of the corridor, you know you're in a large space due to echo environment. There's even a difference in air flow.

Mr. Proscia can distinguish large interior spaces from small ones by echo perception and a difference in air flow.

Authors: How do you negotiate the door in Bldg. 7?

Proscia: I use my cane a great deal near the electric door. It's nice to learn ahead of time that it is a swinging, revolving or electric door. That's an important symbol that has to be developed. That gives me another point of information. It tells me if I'm in the right location.

It is helpful to know the kind of entrance - swinging, revolving, or electrical door.

Authors: Have you used smell cues for other routes?

Proscia: Yes. In the Nutrition Department there is formaldehyde. Once I get to the door in Bldg. 56, I can go through that whole area, down that corridor, through the firedoors, up the stairway that goes to the left, come into Bldg. 8, go through the doorway and up to the main corridor which takes you directly out to the main entry. It wasn't an easy route to learn, but I learned it with a mobility instructor. There are odors associated with the Nutrition Building - formaldehyde, cooking, etc. I pick up Brigham's candy factory, but I don't use it as mobility cue. There are more hazards on Ames St. I would point hazards out (trucks). Could be a good cue -- when you start smelling Brigham's, watch out!

Authors: We should indicate the location of loading docks.

Proscia: Loading docks for driveways especially. It's hard to detect a truck with a cane. You try to use sound cues. I seldom use the pathfinder alone. To avoid trucks, you could cross Vasser St. in front of the garage, but this is in the middle of the block and this presents problems. But then you could walk along the other side of the street and they're no obstacles to contend with except one driveway. That's a clear sidewalk area. Mobility instructors frown on crossing at

Loading docks should be indicated.

mid block unless you solicit aid. I don't use an odor cue as often as I should because I'm concentrating on the terrain. Trailing is good when you're lost. You want to get a sense of direction - either grassline or building line.

Authors: In places like Bldg. 7, would it be helpful if there were mats?

Proscia: It would be great. Then you're less conspicuous because you can be more ambulatory.

Simple things like door mats may be more effective than sophistocated electronic gear in orienting the blind traveler in large or otherwise ambiguous interior spaces.

Authors: It might be a recommended guidepost for several main routes. An interior route might be complex, but direct if you could trail a mat.

Proscia: That's a good idea.

Authors: When disoriented, what is helpful to get oriented? When you said oriented before did you mean with respect to north, south, east, west, or in a more specific sense of finding the entrance you overshot.

Proscia: In a more specific sense than north, south, east, west, you could be going in the wrong direction unless you know that the curb line should be on your right or left. That's one way to orient yourself.

Authors: Are there other helpful auditory cues?

Proscia:	People climbing stairs. They walk differently. I cheat. I have metal on my shoes. When I'm on a sidewalk going from blacktop to concrete, there's an entirely different auditory cue.	People walk differently when they climb stairs. This is a helpful auditory cue.
Authors:	Would it be helpful to indicate these surfaces on a map?	
Proscia:	It's a good idea, but you can't get hung up on too much information.	
Lienemann:	The building over there under construction. You hear it everyday and know about it. Another blind traveler doesn't relate the noise necessarily to what's going on. He'd have to have a person the first time point it out and say what it relates to. These relations are difficult for you.	
Proscia:	Mailboxes are good cues if they're located in specific areas. The blind person needs to know where mailboxes are anyway.	It would be helpful to a blind person to know where mailboxes are located.
	Navigation and orientation are integrated, but it's important to separate what you mean. Navigation may imply going from one environmental cue to another. Orientation implies whether you're going in the right direction. To travel down the middle of a sidewalk use traffic flow and echoes from building line.	
	Navigation is dependent on orientation. They try to teach you how to project yourself across space. In a larger space you could turn and not even be aware of it. Snow is a problem. Snow is a blind man's fog. You lose auditory cues.	Snow is a "Blind Man's Fog". You lose auditory cues.

You try to use the sun, air flow as information for orientation. Air flow plays an important part in navigation. When you're crossing corridors there might not be an appropriate auditory cue, so there you get fall-out or fall away of air. This is true of a shaft. When you're walking down a sidewalk and there's an alley, you'll get a fall-out of air and you'll know that's an opening. You stand in front of an elevator. You press the button. Sometimes you can't hear the door open because engineers are good these days. You will feel an air flow. You can tell if this elevator is going down or up, or went by, whether the doors are open or shut because air is forced out of the shaft. If air comes down and hits your head first, you know the elevator is going down. These things are not learned. You get them from experience. Temperature plays an important part. In the summer when you walk across an opening you feel cool air. The air flow might not be distinct, but the temperature difference might be.

Air pressure cues are useful for navigational purposes to supplement auditory cues.

The clues I use for orientation are sound, air flow, sunlight, curb lines, grasslines, and slopes. I use the cane and a sense of direction for mobility.

Mr. Proscia describes orientation and navigational cues he uses.

(Mr. Proscia explained an experiment)
A blind person walks down the middle of a path across a big space. There is a wire on each side of the path. Without touching the wires, the blind person must walk down the path to a wall at the end of the path, turn around and come back. It's quite difficult.

From buildings, I get orientation from echoes. Another orientation cue could be walking under a tree. There is sun or absence of sun and you get a different echo pattern walking under a tree. When you pass the truck of a tree, you get sound bouncing off. Poles too, depending on the environment, give orientation or navigation information. You can trail along a curb and tap and count poles - third pole up and make a right turn. Driveways slope differently so they are identifiable.

Lienemann: What about guiding points?

Proscia: Certain things have to be tried. Tac-Com makes an interesting point cue. At 77 Mass. Ave., or at another important entry, you could install a permanent transmitter. Let's say it has a limitation on its range of 6, 12 or 20 feet. The receiver would be in your pocket. As you walk up to the transmitter, you would get a buzzing in your pocket. The transmitter could be located at various key points around the campus. It could be useful at lights. It could give you a cue to get ready to cross the intersection. In crossing an intersection, if you miss that one step advantage, you should wait for the next cycle. Some truck drivers psych you out because they sit there reving the engine. The Tac-Com costs about $50 mass produced.

Mr. Proscia describes the Tac-Com.

The Laser Cane is not a good mobility device. It's a beacon. You get dependent on it. What do you do when it's not there?

General Motors put a track in buses in the center of the aisle. You hook yours in the track and follow it down the bus. That's stupid. You lose mobility. It's the wrong attitude for mobility. You want to make a person as independent as possible. If you provide him with certain signals at various points - like the Tac-Com - that's fine because we do that with stoplights anyway. Forget total controlled mobility. It's great if you assist him, like giving him an elbow.

Mr. Proscia says forget total controlled mobility. He describes good mobility aids.

Water flow, like a sewer, is another aid. You can hear the water drop into the sewer. As you approach a corner, you might hear the sewer. You can also hear water fountains. It might be good to indicate drinking fountains.

Water flow can be a helpful auditory cue.

Lienemann: Can you tell us please how one specific clue could relate to another one?

Proscia: In driveways there is a depression and then a rise, a step-down and a step-up. Stairwells may have landings. You look for a handrail because it can tell you you're coming to a landing. A sequence or series of events that takes place gives you a great deal of information.

To cross an intersection at a curved corner, you move to the straight part, cross the street, find the other sidewalk, and then find the crosswalk.

Another cue in crossing a street is the crown which your feet can detect.

Lienemann: Do you carry a compass?

Proscia: Yes, for orientation. Not so much on campus though since I know it.

14 BC

INTENT: To find out BC's concept of the MIT campus, her mode of orientation, and her ideas of what information would be useful on a map of MIT.

INTERVIEWED: BC - age approximately 26, MIT grad in Economics and MIT Economics teacher, 4 years on campus, congenitally blind with some residual vision. She had previous campus experience as an undergraduate at the University of Washington.

ALSO PRESENT: Knut Lienemann (MIT Planning Office)

DATE: 9 March 1972

Lienemann: What symbolizes the MIT campus for you?

BC: Symmetric. The buildings fit together in a nice logical pattern.

BC's conceptualization of the MIT campus is represented by the symmetric arrangement of building numbers.

Authors: Is that the physical arrangement or the way the buildings are numbered?

BC: The numbers.

Lienemann: What are special characteristics that you associate with MIT?

BC:	Cambridge streets and their non-level characteristics are my biggest complaint. Besides learning where the buildings are, you have to know where the pot-holes are and where the sidewalks are cracked.	BC finds the unlevel, pot-holed Cambridge streets and cracked sidewalks a problem.
Authors:	Is this true of the MIT crosswalks?	
BC:	On Ames Street.	
Lienemann:	What kinds of trips do you make?	
BC:	I work in the main building and live in Eastgate. I go many different ways not to get bored. My technique is automatic. The only time I have to think about it is when it's icy. Then I have to remember where the large pot-holes are and what sidewalks drain into street at the border line. My biggest complaint is people chaining their bikes to the railings. You catch your cane in the spokes. As far as the mapping question is concerned, when I want to find a new room, I ask what building it is in and then walk over once with my husband to make sure that I know where it is. I've done a lot of traveling so I am used to asking for directions and following them.	BC uses different routes through the campus so as not to get bored. Her technique is automatic except when it is icy. She complains of bikes being chained to railings on steps. Her husband usually shows her new rooms on campus. She has traveled a lot so she is used to asking for directions.
Lienemann:	Do you use a cane?	BC uses a cane except in a familiar environment.
BC:	Yes, to detect objects, curbs, etc. When I first was here, I had to think about every step I took.	

Lienemann: What kind of information do you need to find a new place?

BC: The relationships of buildings that I already know. Whether the numbers are odd or even.

Lienemann: Does the campus change during the day?

BC: The delivery trucks on the sidewalk make things confusing.

Lienemann: What information would you like to see on a map?

BC: Rest rooms in the main building. Room numbers. I like MIT because you can always walk inside which is easier than walking outside.

BC would like rest rooms and room numbers to be indicated on a map. She finds it easier to walk inside than outside on the campus.

Lienemann: Is there a part of the MIT campus you especially like?

BC: I usually spend most of my time inside.

Lienemann: Can you tell us about any elements you find distinctive?

BC: You can tell where you are by the echoes. You can tell when you're near Mass. Avenue by the noise, so you know when to turn. The air conditioning in the computer center lets you know where you are.

BC uses echoes, traffic noise and air conditioning in the computer center for orientation.

Most of my problems happen outside the campus, because of the beasts that drive around.

Lienemann: Have you studied mobility techniques?

BC: I have had mobility training. When I came here, I handed my husband a map and had him explain the campus to me. It took me two years to learn Boston stores etc. My biggest complaint was how unlevel the streets were. I was used to walking on level ground and not worrying about curbs and walking in a straight line, not up and down. I used to carry a collapsible cane. One day the elastic broke and I fell down three flights of stairs. Now I carry a rigid one.

After the elastic broke in her folding cane and she fell down three flights of stairs, she changed to a rigid cane.

Authors: Do you have any sight?

BC: A little in one eye, and if I am not extremely tired, I can see a little more.

Lienemann: Are you congenitally blind?

BC: Yes. I had more sight because I used to be able to read large print. Congenital cataracts.

BC is congenitally blind, but has a little sight in one eye if she is not overly-tired.

Lienemann: Did your husband develop a method for explaining things to you?

BC: He gave me directions like he gives them to anyone else, except that he would tell me specifically where to watch out for steps and certain other things.

Lienemann: Does he explain by using north-south directions?

BC prefers right and left directions to north-south.

BC: No, I can't tell the difference between them. I prefer right and left.

Lienemann: What kinds of clues would you teach to someone else?

BC: I did teach someone else, using echo and sound a lot. She didn't want to learn other buildings except from my apartment to Ashdown House. We walked along Mass. Ave. and crossed the side streets so she would encounter every conceivable street pattern. She found buildings from memory. Walking through a building, I showed her the echoes that indicate where to make turns.

Authors: Can you describe the way they work?

BC: I think you could hear it if you thought about it. Just as you can tell when to turn by the way the corners fit together, so you can tell by their sound patterns. It would be interesting to know which buildings connect exactly which way.

BC would like to know which buildings connect and how they connect.

Lienemann: Do you think a map of the indoor areas would be more helpful than one of the outdoors?

BC: The outdoors would be interesting, but probably more people would be concerned with the indoors. My main complaint is not in the physical set-up. The problem is that you cannot get anyone to do something about the bicycles. Soon you learn not to complain or say anything. I also had a problem finding readers because there was no existing channel for obtaining them.

BC feels that more people would be concerned with an indoor map of MIT than outdoor.

BC had a problem finding readers because there was no existing channel for obtaining them. An information clearing house would be helpful in obtaining readers, such as professors' wives. BC finds that outside agencies do not record math well so she takes notes on a dictaphone.

Authors: Would an information clearing house be of potential use?

BC: It might be useful in obtaining readers say, by enlisting the help of professors' wives. You need one group of people to read at odd hours and another group to read during the day.

Authors: What do you use for reading matter?

BC: I have a dictaphone which I can take notes on. I have never used tapes much. The outside agencies do not record math very well.

Authors: Would a circulating library limited to MIT material help matters?

BC: That would be useful for undergrads. A reading system would help. If you could join Harvard you might be able to make it work. Also of help would be an orientation period to acquaint the new blind student where things are and the services offered. Also about little things: like how to get through the lunch lines.

BC recommends a recorded library for undergrads in conjunction with Harvard, and an orientation week.

BC:	As a teaching aid I use magnetic rubber refrigerator strips cut by the Mechanical Engineering Department down to size.	BC demonstrated how she attaches magnetic rubber refrigerator strips to a magnetic chalk board to construct graphs of economic relationships.
Authors:	Is there an organizational framework that allows you to understand the basic layout of the campus?	
BC:	In my first year the things I knew were the Bursar's Office, the Medical Department and the Graduate Dean's Office. If you could teach new students these things first, the other details would come later.	BC suggests that new students should know the location of the Bursar's Office, Medical Dept., Graduate Dean's Office.
Authors:	What cues do you think would be helpful to show on a map?	
BC:	Where the buildings go through and where you can cut through them. A large map for each student showing just the things he needed to know and a more generalized map. A person should have someone who could go over it once with him. When I first came, the people were not used to having blind people around and didn't know how to help.	Where one can cut through buildings should be shown on the map. The blind person should have someone introduce the map to him.
Lienemann:	Could you describe the Green Building?	
BC:	If you were facing the Great Sail with your back towards Walker, you would be looking at the Green Building. You walk around the circle of grass, not through it, to get to it.	Unlike AD, BC used the Great Sail as a landmark because she could perceive echoes from it.

Lienemann: What are reference points for you?

BC: The circle of grass I was describing, Building 26 which you pass through on your way to the computer center. Also a guard station and driveway. One should know where the revolving doors are.

One should know the location of revolving doors.

Lienemann: Is there anything else you can define as reference points?

BC: The lobby in Building 10, the information center in Building 7. It depends on where you have to go. I define these points functionally rather than spatially.

Authors: Is it hard to find bathrooms? Phones? Other things?

BC: I have my own phone, but if I didn't, I would have to look for them. If you are looking for a drinking fountain, you can listen for running water. Vending machines are another problem because they always change the order of the food. As for bathrooms, all women hunt for them around the Institute.

It would be good to indicate telephones and bathrooms.

Authors: How do you solve the vending machine problem?

BC: I use a machine that doesn't change or ask someone. It would help if the vending machine people would always put things in the same place. I have a problem with elevators, finding the right buttons to push. Raised letters could solve the problem.

BC suggests raised letters on elevator buttons. She can discern arabic numbers.

Authors: Can you discern arabic numbers?

BC: Yes, I learned to when I had enough sight to read them. Now I have readers read the exams of my students to me.

Authors: Are there any other problems you encounter?

BC: Some people think that a person who cannot see is an easy target. Physically getting there is not the problem, but rather the local hoods that make it dangerous to walk around at night. A good way to foul up is to have someone like that grab your cane.

Local hoods make it dangerous for BC to walk around at night.

15 GL

INTENT: To find out how GL adjusted to the MIT campus and to hear his recommendations for changes.

INTERVIEWED: GL - Harvard grad student who did his undergrad at MIT. GL is legally blind, but has some vision. Astro-physics major.

ALSO PRESENT: Knut Lienemann (MIT Planning Office).

DATE: 9 March 1972

Lienemann: What kind of mobility training did you have?

GL: None, self-taught.

Lienemann: Do you use a cane?

GL: I do work in the lab areas using the sight I have.

Authors: How much do you have?

GL: That's a tough question. It is constant and very hard to describe. I can recognize objects which I use as cues for getting around. I can see things, but do not recognize what they are.

Even though minimal, GL's vision is sufficient to see objects he uses as cues, and streets on a map.

Authors: Can you read?

GL: Well, I can read things on a large scale, but also I have a very strong magnifier which I use to read. But I also use braille and tape recordings.

He uses a magnifier, braille, and tape recordings. He proved to be a good braille reader.

Lienemann: What first comes to mind when you conceptualize the MIT campus?

GL: I think of the main complex of buildings in a schematic structure of how they are set up. I think of the way the buildings branch off the main hall. I also think of the part of the campus in which I lived, Baker House, and the things on the way - like the Student Center, the Kresge area, Amherst St. and Memorial Drive.

GL describes his conceptualization of the MIT campus.

Authors: Where did you work on physics?

GL: I spent a lot of time in Bldg. 20, a grungy place and in its basement. Of course, a lot of the classes were scattered around the main building.

Lienemann: Do you associate any special qualities with specific parts of the campus?

GL: Yes, it's hard to describe. I have vague impressions of everywhere. Around the Student Center I wonder where the steps are. I kind of know, but must figure it out. When I went from the main building to Baker House, when I saw the moat, I knew exactly where I was. If I went by Kresge, when I reached the brick area I could establish the position I was in.

Lienemann: Is there anything characteristic that you could associate with MIT?

GL: I have vague impressions of not really liking the physical set-up of MIT too well - vague and impersonal.

Authors: How much did your vision assist you in getting around MIT as opposed to your non-visual senses?

GL: Exceedingly much. Like everybody else, I thought I was lost initially. I learned very quickly to recognize the visual cues I could pick up, and I think I relied on those heavily to learn my way around. I can't think of them specifically, but there are millions of them.

GL used visual cues in learning his way around the MIT campus.

Lienemann: Can you give us an example?

GL: It's hard to say because I think that they are like the way anybody recognizes things except on a more vague scale. I might be watching for sidewalks and know I was bound to come to it eventually, and I would see it - and know exactly where it was - whereas someone else would probably see it from a greater distance. I could be walking down the hall, and if I wanted to go to Bldg. 4, I would know that it was the second hallway or first hallway after the Bldg. 10 lobby, so I would just watch for it. Or where the stairs are, I have a structural picture of where the stairs are, and I watch for an opening in the wall.

Lienemann: Could you give us a description of the campus?

GL: By looking very carefully I could usually read numbers on the doors. I have to put my nose right up to the pane of glass. If I knew ahead of time where Bldg. 6 was and I knew what floor it was, then I could usually make a final localization of the room by looking at the number. As for the campus as a whole, I think of Memorial Drive on one side and Ames St. as another boundary.

GL can read room numbers painted on glass doors. He can also read, by touch, raised letters on doors.

Lienemann: Did you ever see a map of MIT?

GL: No. On the Baker House side of Mass. Ave. along Memorial Drive the dorms - with my own particular knowledge of the vicinity: McCormick to McGregor, Baker House and Burton House in between and there's a fraternity around there ... that's the same way around Memorial Drive and there's a couple of little streets that come in between - and there's a parking lot there. I used to get lost in parking lots because they were flat and there was nothing - no sidewalks or anything parallel to Mass. Ave. away from the dorms, then the chapel and opposite that a crosswalk - beyond there's Kresge in between and further on there's the Student Center, beyond that the Armory of which I haven't had much dealings. The main building is a schematic long hallway that branches and each of the branches branch into various buildings. For instance, you might be in Bldg. 5 and if you keep going you're in Bldg. 1 - then there's the connecting hallway which brings you to Bldg. 3. It's like a loop - then there's the Great Court. You cut across there to Bldg. 4 - then you see the other side of Bldgs. 12 and 24. I have a very elaborate schematic picture of where everything is.

GL describes an elaborate schematic picture of the MIT campus.

Authors: What is your mobility technique? Do you use a cane?

GL: I don't in the areas that I know. I guess its partially because I really don't need one, and I feel less conspicuous, so around MIT I hardly ever use the cane because I always know where I'm going. If I went off to some unknown part of Boston, then I would use the cane, at least carry one.

GL uses a cane only in unfamiliar places.

Lienemann: Would you describe your mental imagery, if you can?

GL: I have lots of impressions of things - like in front of Kresge and the steps up the Student Center. I have pictures of the lawn in between Kresge and the chapel of which you just cut across. I like Memorial Drive and I like the river. I guess that's what I associate with MIT. I don't really think of buildings; I don't think of much outside of campus. I think of mainly streets and sidewalks.

GL's impression of campus outdoors consists principally of streets and sidewalks.

Lienemann: Noises?

GL: There are things I can identify by noise that I can't think of off-hand. Like using the Xerox. I can identify the noise of the machine. I have impressions of noises like the absence of noise in the library. There are subtle noises that I guess from - perhaps the difference in echoes in various parts of the buildings. You can recognize places by their echoes. Of course blind or partially blind people will tell you that you can anticipate the presence of a wall or a tree by hearing it. I use that too. Sometimes I can see the things, sometimes I can't.

GL describes noises he uses as cues. He also uses echo perception.

Lienemann:	What kind of trips did you make?	
GL:	I walked around a lot during the time I was there (MIT), at least in respect to the main building. I became familiar with all of it, at least in terms of getting places. I know Baker House, I know some of the dorms. Some I don't know very well at all. I know the Student Center pretty well and Kresge pretty well.	GL lived in Baker House while he attended MIT so he is most familiar with the campus from Baker House over to and including the main building complex.
Lienemann:	Which building is your department?	
GL:	I spent a lot of time in Bldg. 20.	
Lienemann:	Could you describe the trip from Baker House to Bldg. 20?	
GL:	There are 2 main ways: I leave Baker House and follow the path to the street up the stairs and around or across the grass lawn in front of Kresge and probably come out near the chapel on one of those little paths. I follow that until I get to the main plaza in front of the Student Center and by doing that I could avoid the steps because the path comes out below them. I would cross Mass. Ave. right there.	GL describes the trip from Baker House to Bldg. 20.
Lienemann:	How do you know when to cross with the walk cycle?	
GL:	Once in a while I can see it at night, but usually I can tell by the traffic and by the people.	

Lienemann: Could you see other people walking across?

GL: Yes. Well that wasn't always reliable because lots of people walk at the wrong time. So once I cross Mass. Ave. I either go into the main building or Bldg. 7, or else I'd turn left and go down and there's an opening at the end of Bldg. 39 - sort of a driveway that's usually blocked off and I walked along there. If I went inside I'd just go along the main corridor and turn left and go on to Bldg. 26 that would bring me eventually to Bldg. 20, and then it would just be following the corridor until I came to where I spent my time. If I took the outside way, it's the same thing. You eventually come to a door which would be Bldg. 26 just go in and it would be like the inside route. I guess if I knew where I was going I'd have visual cues, and also just by habit, I could do it in my sleep pretty well.

Authors: When you came up to the building in the main corridor, you made a left turn to Bldg. 1. What told you to turn?

GL: I could see that I was at the end of the hall. One of the things that helped was when they painted some of those walls. I'm sure I had no less trouble getting around before they painted them, but after they were painted I recognized them. It may have reinforced them. Those things are easy to see if I know there's a wall coming up or the end of a hallway. If I've done it before, once or twice, then I have no problem recognizing it again. It's visual and memory. When I originally try to learn a place I try to memorize these and recognize them with the vision I have.

GL used the bright colors of the newly pained walls (previously drab gray) to reinforce his orientation.

Lienemann: You have some one show you where to go and you memorize that?

GL: I try to memorize a pattern.

GL tries to memorize a route.

Lienemann: Sub-consciously?

GL: Quite consciously by picturing a logical circuit in my mind. Schematically I don't worry about all the tiny details, but I try to build up a spatial picture in my mind of how it works and try to follow it.

Authors: What comes to your mind when you think of the Bldg. 7 lobby?

GL: They have a lot of things in there now that I wasn't used to. It is very big, dimensionally very high. I picture the balconies around it. I picture the door opposite the main hallway. If you turn right or left you go to Bldg. 5 or 9. If you come from the other way going out and you turn left, you'll come to the Information Booth, right, there's stairs.

GL's conceptualization of the large domed entrance on Mass. Ave. is one based on size, not shape.

Authors: Did this picture build because you experienced everything you described one or more times? Did you pick these things up without actually getting close to them or using them?

GL: Not because I used them. I wouldn't have been aware of the Information unless I'd gone there on one or more occasions. I had pictures of the big columns in there because I have to avoid them. I have pictures of the telephones. I had occasion to use them.

Lienemann:	Could you mention what cues you use when you take these trips?	
GL:	I try to memorize turns. Maybe I do count them, but I don't think of it as counting. When do I turn? Inevitably if it's at the end of a hallway it's no problem. There's no choice if I have to turn at a specific place. I remember that it is the second possible hallway to turn. Maybe I remember because it's beside a red fire door. I know I want to go up the stairs where there's a red door so I watch for the red door. There are places where there are little lights. I can see those. Maybe there were elevators I could recognize. Maybe I had to turn after the elevators.	GL describes inside cues he uses.
Lienemann:	And outside?	
GL:	Things like sidewalks. I know I came to Mass. Ave. because of the traffic. I crossed one street already and Mass. Ave. was the next street because I probably could recognize things visually having been there before and seen the structure of the buildings. It's things like sidewalks, big intersections, in getting around the city.	GL describes outside cues he uses.
Authors:	What do you think of when you say a big intersection?	
GL:	I think of Prospect St. and Mass. Ave. as opposed to Mass. Ave. and a side street.	
Authors:	What modality comes to mind?	

GL: Sounds of traffic. If I've never been there before, I'll always be very cautious in a new environment because I'm not sure what to expect. I notice things like sound. When I get right to the place I can see cars whizzing around me. I can perceive when it's a very long distance across the street. One thing that's useful in getting across the street is the painted white lines, I can follow those very well when they're not worn away, as they usually are. I like it at MIT when they'd repaint the lines across.

Authors: Can you distinguish brick, asphalt, concrete pavement?

GL: Yes, in fact I use it as a cue of some sort. It's the visual part.

Authors: Can you recall textural differences in the Bldg. 7 lobby?

GL: One thing I noticed in the winter was that they would lay a mat near the front door. It went down 15-20 feet into the corridor. I used it leaving the building. Once I was on it if I could see where the edges were and follow it right to the door, which is easier. When it wasn't there it would take time to find exactly where the door was. The main objective once I got in the door was to find the entrance way to the long hallway. Either I could see it from the door or after I had gotten in. All I had to do was keep going straight. Lighting and time of day -- I get confused by patterns of sun and shadows. I get around better when it's cloudy.

GL describes useful accidental cues.

Lienemann: What are the most distinctive elements of MIT?

GL:	It's hard to say. It all seems to fit very well together in my mind. I think everything is in terms of this schematic structure, not totally schematic like lines, but like patterns I know where a thing is because it fits in this pattern I have in my mind. Or else I don't know what it is, or I have this vague idea what it is, or I associate it with some part of this pattern I have in my mind. So I can't say there's anything distinctive.
Authors:	You don't have any landmarks that you use to direct you to other less familiar places?
Lienemann:	Is the pattern of equal importance or do you have landmarks?
GL:	There are central landmarks. For example, the intersections of hallways in the main lobby. If I want to go to Bldg. 12 I think of going down the hallway to a particular hallway, turn left at that particular intersection, follow it and coming out to where I want to or if I want to get to the Computer Center, I think of going in the main door, turning at a certain intersection of hallways following that. I frequently take less direct routes, but because they fit into my structural pattern I take the route I know.
Authors:	Where did you generally eat?
GL	Usually Baker House, occasionally Ashdown House and the Student Center.

Authors: Were there any reference points in your living group or places that were different from the institutionalized ones?

GL: I think that every location is unique in one or more ways. I try to fasten on to what's unique about a place with respect to what I can perceive visually. In Baker House there's a doorway, the hallway bends close to the stairs, but not through certain doors.

GL perceives uniqueness of places and locations.

Authors: This might be visual?

GL: In the hall, where I was, people painted their door different colors so when I came to the red door I knew it was so and so's room. That helps. I then leave the elevator, go left until I see a red door.

Lienemann: If we dropped you in front of the Computer Center, how long would it take you to figure out where you were?

We wondered if we disoriented GL and then dropped him off someplace on the MIT campus, how long it would take him to find out where he was.

GL: I'd probably have trouble finding out where I was. If there was a door I'd go look at the number. No number, I'd be very disoriented. All the cues are the same, but in different places. If you put me in an intersection of a certain hallway - the reason I could recognize it before is because I knew it was the intersection after Bldg. 10. If I was just put there out of the blue, I wouldn't know which intersection it was. It might be 3 of the same. I just recognize it by knowing its relationship to something else.

In fact, we performed this test with GL in front of Bldg. 13, a relatively new five story, concrete structure. He was able to locate himself by sensing the long columnar walkway and the distance of traffic sounds of Mass. Ave.

Authors: Would you know if you were on the 2nd or 3rd floor as opposed to the 1st floor?

GL: Probably not. I might know the 1st floor, but I could not tell the 2nd from the 3rd. One time I went to a lecture and realized that it wasn't the room. It was directly under.

Lienemann: Do you still visit MIT?

GL: Occasionally.

Lienemann: Would you know where you were in a car?

GL: It might be hard by car. Certain turns I'd probably know where we were.

Lienemann: Do you think MIT is an easy place to get around?

GL: It's easy, once you understand how it's set up. Once you know the pattern of building numbers it's quite compact. Once one has an image of where Bldg. 1 is in relation to another building, it's pretty easy.

GL discusses MIT's numbering system.

Lienemann: You conceptualize it by numbers?

GL: I associate certain things with numbers like Bldg. 13. I picture it geographically.

Authors: You conceptualize in numbers?

GL: I know most of the building numbers. I got a card saying your physics class meets in room 8-21. I had to find out where Bldg. 8 was.

Authors: Did you have the number set up at Harvard?

GL: No, building numbers there use names.

Authors: At MIT the number became the name?

GL: Yes, if it had names I would have learned them. All the new buildings are named at random. There is no reason why Bldg. 39 is Bldg. 39.

Authors: It's strange that the dorms have names and are referred to them by name. It's kind of a depersonalization that the students go through.

GL: I know the building by the names that most undergrads know them by.

Lienemann: When you select the routes you take, do you plan in advance?

GL: If someone tells me to go to a new room, I do plan in advance. I have a standard route to get to Bldg. 26.

Lienemann: You select your routes by what you know?

GL: Yes.

Lienemann: Did you ever select routes because you liked them?

GL: Yes. As I got to know the place better, there were alternative routes. Then I'd choose by which pattern I liked that day.

Lienemann: An example of what you like?

GL: If I went to Bldg. 20 I could either go down the main corridor or through the buildings on the side route. Frequently I prefer the outside.

Lienemann: What place is easier to move around in?

GL: I'd say Harvard is harder.

Authors: Why?

GL: The buildings I use are not especially easy to get around in. It's hard to go from building to building or one room in a building to another in the same building. At classes it takes me 20 minutes to go between because they are a half mile apart. Some places are easy to get around: places with very straight hallways and right angle intersections, very schematic, simple geometric.

Harvard is more difficult than MIT for GL to negotiate.

Authors: Sounds like MIT.

GL: Parts of MIT are very easy because of long and perpendicular hallways. It's difficult to get around Boston because the squares and intersections are not perpendicular.

Authors: In Boston and Cambridge you can get from one place to another because there are so many diagonals.

GL: One of the hardest places I've ever had to learn is Harvard Square. I've had a lot of trouble.

Authors: Some people avoid it.

Lienemann: I like it.

Authors: In Harvard Square is the problem pedestrian, as well as vehicular?

GL: I don't mind that too much.

Lienemann: What other kinds of information would you have liked to get when you came to MIT?

GL: It would have been nice if there was a map I could read. For awhile I was very lost.

Authors: Did anyone help you as a freshman?

GL:	At the very beginning other freshman helped me. The first few days there was a formalized assistance. Then I struck out on my own a few times and found the cues I am talking about. When I first started at MIT something was East or West, left or right of something else. I would have liked to have something that told me whether the athletic field was on the same side of Mass. Ave. as MIT and where it was. Details like where the bathrooms were would be good for transmitting that information.	GL says he would have liked a map of the campus when he first came to MIT.
Authors:	What did you do about text books?	
GL:	Initially I tried to get as many things in braille as possible. They are available through certain libraries.	GL got what textbooks he could in braille. The rest he had read to him and recorded.
Authors:	Did you use standard MIT text?	
GL:	A few are in braille. What I could get in braille I'd get. What I couldn't, I'd get read to me and I'd record on tape so I could refer to it and that's essentially what I do now. Very little of what I use now is available on tape.	
Authors:	How did you find the readers? MIT people.	
GL:	Some people I got to know. The freshman did quite a bit for me. Later on, I put up notes on notice boards. Last year I had a physics course with a lot of reading. People are a little bit afraid of reading physics. So I put up a note in the Physics Reading Room and I got several people who were interested. They've got a good thing at Harvard. On Registration Day everybody has the opportunity of checking	Ways GL got readers.

a box which says would you be interested in reading aloud to a blind student. All blind students at Harvard get sent out a list of readers who they can call on. I've used them.

Authors: Is that all volunteer?

GL: There's always talk of people paying readers. I would have been willing to pay readers, but usually readers read not because they want to be paid, but for other motivations, so I'm at the point where I don't even think about paying readers.

GL: Any formalized system of finding readers would be helpful because sometimes I'd have some problems.

Authors: We were thinking of groups - the service fraternity. I've never heard that as one of their services.

GL: That would be a great thing.

Authors: Were there any facilities at MIT that were good reading things or did you use your own equipment?

GL: Essentially I used my own. Sometimes there were special books on reserve that they didn't want people taking out and I'd have to get special permission from the librarian. In fact, I ran into the same problem at Harvard. Sometimes they wouldn't let you take out the book so I'd have to get a reader in there.

The problem of having library reserve books read.

Authors: What did you use, a cassette machine or open reel?

GL: Both. Reading on location I use a cassette and transfer it to an open reel because you get so much more on the tape.

Authors: It might be possible to start an open reel or cassette library. As students record things, duplicates could be made as a matter of course as a resource.

GL: That would take a tremendous amount of technical planning. I don't think the overlap is that great really, except in the early courses.

Authors: Also possible by combining Harvard and MIT.

GL: That would be good. I have one pet peeve about the physical situation at MIT. I'm sure if I lived there any longer I'd knock someone off a ladder some day. I always have trouble seeing those ladders and there's always ladders in the hallway.

GL find that ladders are obstacles

Authors: Do you have problems with bicycles?

GL: I've tripped over a bicycle before, but I don't worry about that so much as knocking a guy off a ladder in one of the corridors.

Lienemann: What do you think about introducing a phone service for any of the details we can't show on the map?

GL:	I think I might not use them very often - a couple of times a year.	GL would not use a supplementary phone service often.
Authors:	A lot of people say they've got their friends.	
GL:	It's very hard being independant. Sometimes I happen to be going with somebody, but if I had somewhere to go on my own, I'd find it on my own somehow. Occasionally I might ask for help from someone.	
Authors:	Have you had any experience in reading tactual maps? What maps or visual material have you used?	
GL:	I've used geographical maps. I've seen orientation maps that describe buildings. Generally the ones I've seen weren't terribly helpful. They are too complicated and difficult or else very easy to follow, and not enough details.	GL's experience with tactual charts and maps suggests a scarcity of tactually legible graphics.
Authors:	Have you used a system of overlays, or just maps that have it all on the one sheet?	
GL:	Largely a one shot deal. Once or twice I saw maps with fairly good details, but they were so huge. To follow something you had to feel over huge dimensions. It wasn't very easy.	
Lienemann:	What do you consider huge?	

GL: Three or four feet. They aren't any good. I'd like a map I could sit in front of me on a table.

Lienemann: Do you think the grid system of over-laying would be helpful?

GL would like a map that was not so big that he couldn't put it on a desk in front of him. A grid system might be helpful.

GL: Depending on how the grid was formed. It might be if the grid was lines on something which was composed of lines of something else. It would be very complicated. I once thought that there could be a kind of street directories which aren't really maps, just verbal description in terms of streets in the city. I think that that would be better than a spatial map.

Lienemann: As far as I know, these verbal descriptions on maps are for people who know the city pretty well, who need some additional clue.

GL: If I understood MIT and had a little guide that said Bldg. 16 lecture hall with a little description of where it was relative to some major thing, that would be good.

A verbal supplement to the map would be good.

Lienemann: What about phone service to get information on mobility, detailed information, steps and trees?

GL: I would have asked where is this room relative to something else.

Authors: Did you have problems finding your seat in a classroom in relation to where the lecture is, to the door?

GL: Yes. In the new lecture halls I have that problem. If I come late to a lecture, it's a little awkward sometimes because I have trouble finding a place to sit. On the first time, I'm not sure how things are aimed. Where was the lecture. Some lecture halls have two doors. I wasn't sure if I was at the front or the back. That problem was resolved after the first time usually.

GL describes problems of initially orienting himself within a classroom.

16 AD

INTENT: To find out AD's concept of the MIT campus, his mode of orientation, and his ideas of what information would be helpful on a map of MIT.

INTERVIEWED AD - age approximately 23, MIT Senior, Aero & Astro major, 2½ years on campus, adventitiously blinded at age 5.

ALSO PRESENT: Knut Lienemann (MIT Planning Office)

DATE: 11 March 1972

Lienemann: What first comes to mind when you think of MIT?

AD: A maze. Larger than anything else I was used to before. So many buildings. The most striking thing about them is the fact that you can't guarantee that they will all come together on the same floor. It's an incredible learning process to try to recall where this particular building meets another because unless you know the short cuts, you can't get around in the time that you have between classes. I just think of it as a big conglomeration of buildings just stuck together without much clue as to what position one building has to another.

Lienemann: What special characteristics do you associate with the campus?

AD: I really memorize. Things like what the floor feels like. The floors in certain corridors are much different than in others. For instance, the main corridor from Bldg. 8 to 77 Mass. Ave. is very rough; the corridor from Bldg. 6 to Humanities is very smooth. Many times you can tell when you are coming to an intersection because the floor changes. This is the biggest help in getting around. You can feel the expanse of the lobbies --77 Mass. Ave. and Bldg. 10. I know when I'm going past the Admissions Office because someone's always typing. I don't think you go on smells too much as your environment - the floor expansiveness of the area you're in, noises -- machine noises.

Physical characteristics of the MIT campus are expressed by tactual, and auditory sensations.

Lienemann: Can you subdivide the campus into certain areas?

AD: I think of specific places. I don't think of, "Here's a large area." I consider everything differently, many things. I couldn't express what I do look for. There's all sorts of subtle things. You might walk to a certain place and feel a lot of heat; it might be the sun coming through the window -- things that you're really not aware of.

Subtle cues identify places.

Lienemann: MIT consists of small elements, like the corridor; elements that are not interrelated?

AD: I don't think you can make any generalization about any large area. I don't think there's any place that's exactly the same. It was quite a process in the beginning. If you go and ask anybody, they always give you the wrong directions. I have no doubt in my mind that I know MIT better than anybody. It didn't take too long, but it was an awful lot of memorization.

Like the other blind students interviewed, AD's biggest effort to learn the campus occurred the first year he attended MIT.

Lienemann: You started to say something about street patterns.

AD: I think of it as a large rectangle, two squares with perpendicular side streets. If I ask someone where a certain building is, I'll memorize it as being north 3 blocks or east. You can describe things as being north, south, west around here.

Lienemann: Do you use a compass?

AD: No. I have a good sense of direction. The sensory aid center has a compass; I tried it out of curiosity's sake.

Lienemann: How do you find where north is?

AD: In the beginning you are initialized. I know the river runs east-west; as far as turning corners, I remember. It's abstract.

Lienemann: Could you give a map-like description of the campus?

AD: A bunch of perpendicular streets. I think of the middle being Mass. Ave. I think of the east side of Mass. Ave. You have a big set of buildings around the Great Court. I think of that as a great conglomerate. There's a big horseshoe shape set of 10 buildings. Then off of this big horseshoe, there's a bunch of other things sticking out. You have the humanities off on one side of it.

Massachusetts Avenue is a principle reference point for all the MIT blind students.

Lienemann: Have you ever seen a map?

AD: No. I think of the tunnel buildings going north toward Vassar, Bldg. 9. Then off of that you have a big string--33, 35, 37, 39--going around the computer building. A few more in back of that--24. I use Mass. Ave. as a reference point--think of things being east or west of it or how close they are to Vassar Street. I have a picture in my mind where each of these buildings sticks off into something else.

AD has never seen a map.

Lienemann: Do you relate them to the street, next building, or both?

AD: I think it's both; I think of them connected to each other like dominoes - a bunch of things sticking off in all crazy directions. I recall in my mind where this building is connected to something else, then think that's somewhat north of here or 3 blocks south.

Lienemann: Streets and buildings - are these the only two elements of your mental map?

AD: You associate a certain building with its function. If someone says the computer building, I don't stop to think if it's Bldg. 39 next to 37. You associate and become familiar with what that building is for.

Lienemann: I'm thinking of grass areas - in front of the Green Bldg.

AD: No. I don't consider things like where the grass is. Grass can foul you up because there is no reference point beyond the middle of that. I think of where certain sidewalks are. In the beginning I didn't know the way from here (Senior House) to the humanities library, how that fit in the main buildings, how to cross Mass. Ave. I used to walk down Ames Street, down Memorial Drive, all the way to Mass. Ave. and up Mass. Ave. It was twice as far.

Lienemann: What kind of main trips do you make?

AD: My time is spent at the Sensory Aids Center or Bldg. 31 so right in back of that is Bldg. 39. I spend a lot of time there on project MAC. Project MAC is a very interesting case because you've got to cross Main St., which is the worst crossing I've ever had to make. You just have to listen for when the traffic is not going and go and hope. In an area with a lot of trucks, it's very hard because of all the noise. It's amazing how much I depend on being able to hear, even if you're not hearing anything in particular. A loud truck can screw you up completely. You can't tell when you're going by a doorway; you do that with your ears -- I think it's facial perception.

Main Street and Vassar Street intersect obliquely. This kind of intersection is much more difficult for a blind person to negotiate than a perpendicular one.

Lienemann: Would you describe your way from project MAC as you would describe it to another blind person?

AD: Go out of this room, turn right and find the door on that wall, go through the door and you're out on the landing, turn right and there's 4 stairs, turn

AD's route description is sequential.

right and walk a few paces, turn 90 degrees and go down the step to the gate house, go down 4 stairs, cross Ames Street and walk up Ames St. on the opposite side, turn right and walk straight along following the shoreline until you come to the first real street -- you can tell by the traffic -- Main St., turn left and walk and you'll come to a curb right near the parking garage entrance (Main St. has a bit of an angle here so you have to go down that curb and head in somewhat to your left; if you go straight, you end up in the middle of Main St.), go down that entrance to the parking garage listening for cars, you will be on the corner of Vassar St. and the parking garage, cross Vassar St. and when you're up on the far curb, you're on the corner of Vassar and Main St. Walk down Main St. 30 ft. or so, turn right on to the curb. You stand there and listen to the traffic. When you hear nothing coming, step down from the curb and walk across fast so that nothing will come meanwhile. On the opposite side turn left, walk on that rotten sidewalk, come to your first entrance which is project MAC. Go up on your curb, turn right. It's your first opening on the left which are the stairs going into there.

The physical landmarks he uses are walks, steps, streets, curbs, and entrances.

Authors: How did you learn this route?

AD: I don't remember originally - walk there with someone or have someone describe pretty much where it was and then just learn the minor details as I went -- just experience.

Authors: I wondered how you understood the connection between Vassar and Main St.?

AD: Something like that you have to either have somebody describe pretty much in detail or you go there with someone, showing you all the details. A blind person cannot make this diagonal process. Some are very pointed on the other side and you miss it. You have to cross one street at a time. It's more accurate. In Boston, when you're walking down Winter St. and you come to Washington, and you want to cross over to Summer St. on the other side of Washington St., but to the left, you have to round the corner of Winter and Summer first before crossing .

Lienemann: Could you do a trip from the Computer Center to Bldg. 7?

AD: If I was going to describe it to somebody, I would have him go out of the computer building to Vassar St., out through the revolving door, turn left, cross 2 driveways, the entrance between 37 and 39 -- watch out for some cement pillars in that area, walk along in front of 37 past 37 and go down a curb and cross another inlet going between 37 and 35 up on the other side, walk and walk straight, and you'll come to the corner of Mass. Ave. and Vassar St. Turn left on the sidewalk, walk down. I use a post to tell me how close I am to a bus stop. Go down Mass. Ave. past the entrance into 35, walk past the entrance into Bldg. 9, come to the 77 Mass. Ave. steps.

Authors: How does he find the steps outside?

AD: The steps are right on the shoreline if you are walking on the left-hand side and you had a cane following the grass on the edge, you'd hit steps.

Lienemann: Is there a distinction between shoreline and guideline?

To find the steps outside the main entrance at 77 Mass. Ave., AD goes along the shoreline until his cane hits the steps and he uses the sound cue of people walking up and down the steps.

AD: That's just a term I use. My mobility instructor gave it to me. So he would find the steps, follow the shoreline. Also you can hear people walk up them. Sometimes I'll just go till I hear the people walking up the steps - cars also stop at the crosswalk - walk ten paces once he's got to the beginning of the steps so he won't go off the edge.

Authors: Describe the Building 7 lobby.

AD: It's spatial. You get the impression the ceilings are way up there, big open area with bleachers, seats. Tight by the electric door is the table with the night watchman. Hallways to the right and to the left. If you walked all the way in, you come to the main corridor which there are telephones in that area, there are pillars around the edges, there are stairs, there's an elevator on the left, deep in the lobby on the left-hand side. Information office. There's a rubber runner going down part of it to wipe your feet on.

AD describes the Bldg. 7 lobby. The floor mat running in from the entrance door, noted by several other blind students, proved to be a helpful cue for them to cross the lobby. Most sighted people are not even aware that it exists.

Authors: Is that helpful in finding out where you are?

AD: Yes, especially coming from the corridor going out. Once you hit that you can line up good. The other way it's not too much trouble because the corridors are pretty wide.

Lienemann: Is it more easy to walk indoors than outdoors?

AD: It is, once you know it. You don't have to put up with rotten sidewalks, but it's not easier to learn initially because you can't say look for a door, etc.

It is easier to walk inside than outside when you know the route. But an inside route is more difficult to learn initially than an outside.

Lienemann:	Would you say that indoors mobility is not too much of a problem, but orientation is?	
AD:	Yes.	
Lienemann:	Do you have clues that you use for mobility and others for orientation?	
AD:	I use "facial perception" when I come to a corridor. I know just from experience where a certain set of doors are. I know I'm on the right track if the doors come at the right place. I probably use these aides more for orientation. The only thing you use for mobility is your cane. When you listen for people, keep aware of what's going on. Your environment - door jambs, slippery floors - it's very hard to express what you use because most of it is so engrained in you from experience. It would have been very different if I had a map. I learned by certain gimicks and brute force.	AD uses "facial perception", another name for "obstacle detection." AD would have had a different experience learning the campus if he had had a map.
Authors:	You've been here since a freshman?	
AD:	I came as a sophomore.	
Authors:	How long did it take you to comfortable get around?	
AD:	The first year I was here, I didn't know about project MAC. When I first came, I concentrated on the places where I had classes. The main building and connected buildings I learned in a week. I learn pretty fast.	AD learned the main building and connected buildings in a week.

When I was taking mobility lessons in junior high school, the fellow took me to downtown Boston. He showed me Washington St., Jordon Marsh and said, "I'll meet you and we'll do the same thing next week." I said, "I'll meet you in here." With that one 2-hour walk downtown, I knew it.

Authors: Do you have any technique for learning this?

AD: It's like something that's born in you. A lot of people who have a lot of mobility training travel a lot slower than me. It's something I'm lucky enough to have. Since I have a fairly good sense of direction, I can extrapolate in my head.

AD has a good sense of direction and can travel quickly. He thinks in terms of a coordinate system.

Authors: Do you think out this process sequentially as a flow chart of movements or do you think of it spatially?

AD: It's a hard, fast set of coordinates. I have to go somewhere. How do you go? Well, I know the area so I know there's roads up to there, etc. I think of it as things being relative to each other. All these things are located in the coordinate system.

Authors: You map your route accordingly?

AD's co-ordinate conceptualization is a physical-spatial map.

AD: It's not as if someone said to me I'm going to put you in place A and you have to go to place C. I wouldn't say I can't get from C to A because I've never done it before. If I've never been to place 1 to 3, but I've been from 2 to 3, I've been from 1 to 2. It would be no problem for me to get to 1 to 3. You think of the thing as a whole.

Authors: What constitutes a nice way to go?

AD: It's personal preferences on what kind of things you like to stay away from. How many busy streets do you have to cross? Are the sidewalks bad? If it 's a longer trip, you decide if it's longer by bus or train. I stay away from buses.

AD stresses the importance of negative qualities in choosing routes.

Authors: What are the positive qualities that make one route better than the next?

AD: If there's a way you walk along a particular sidewalk and when you come to an exact area the sidewalk changes consistency, or all of a sudden there are millions of trees around you, then that is preferable to some plain old thing that is consistent all the way. Then there's no way of gauging where you are unless you have a feeling for how far you've gone. If there's some variety in the area, you know exactly where you are.

Authors: How do you experience this variety, i.e., the tree?

AD: The tree you get from "facial perception". I sense that it's there. If you are under the branches, you don't feel the sun too much. A sidewalk you can tell when you touch down on it. Maybe even small.

Lienemann: Do you like Memorial Drive more than other streets?

AD: Yes. It's a fine place because there's plenty of traffic. You make sure you're lined up to where-ever it is you want to go; the traffic helps you go in the right direction. An interesting thing occurred to me last year on Memorial Drive. I was walking back from Boston across the Harvard Bridge and was going to cross Memorial Drive. So I went off the curb and out in the middle. Of course I was over the underpass. Out in the middle I hear this truck coming straight at me. I don't know how to describe it. So much fear! I stopped. I knew it was all over. He was coming right at me and then a second later he was under my feet. I knew the underpass was there, but I forgot. It really faked me out!

Traffic noise helps to orient AD.

Authors: What about sensory illusions?

AD: If you walk along the hall, there's a typewriter typing. Sometimes it sounds like it's on the left and sometimes on the right. You can never tell till you're right up to it because it echoes back and forth. On some machines you can't tell exactly where they are.

Authors: Do you have any favorite places on campus?

AD: I spend most of my time in the computer buildings because I like computers. Bldg. 20 is probably the worst building in the world. You walk down it; it feels like you're on a trampoline. But I don't think there's any one building better than another, maybe the newer ones.

Authors: What makes a building new?

AD: Generally by what kind of floor it has, walls along it.

AD describes qualities implied in old and new buildings.

Authors: What kind of floor do new buildings have?

AD: All the new buildings, 9, 37, 39, have very hard floors. The echo in these buildings seems to be completely different than the echo in the main corridor of Bldg. 8. Although that has a hard floor too. It seems like the echo is different. It's hard to describe how the echo is different.

Authors: Are there classifications of echoes? Do some buildings have similar echoes?

AD: Yes. Buildings like 13 and 9 are pretty much the same, whereas Bldg. 2 or 6 -- they sound alike, but it is a different category.

Authors: Are there any textural differences? How do you figure out the quality of a building?

AD: You probably wouldn't be able to understand the qualities I detect in a building. I can visualize what the architecture might be like, partly because I could see till I was 5. I think new buildings are a lot deader, the echo is deader than an older type.

Authors: Have people referred to these buildings as old and new or do you perceive this?

AD: No. I can tell if the building's new.

Authors: Is there a characteristic smell?

AD: Yes. A cement building wouldn't smell like a wooden one. You can always be fooled - as going into a remodeled building.

Authors: What category does the Student Center fall into?

AD: I would classify that as a new building. The Student Center is not too hard to get around because it's fairly well laid out.

Authors: Do you use the stairs or elevators?

AD: For the library, the elevator; for the post office, the stairs.

Authors: Do you spend much time in libraries?

AD does not spend much time in libraries.

AD: No, because the libraries here aren't conducive to anything I could study there. In my honors course, I can't take any material out of the library; it's a challenge. Another real aid would be some kind of braille buttons on elevators. Another thing is numbers on pay phones - not dialing, but the number you call from.

AD's suggestions for improving the MIT environs embrace simple modifications, not major environmental changes. He suggests braille buttons on elevators and braille numbers you call from on pay phones.

Authors: How do you communicate when you're doing a program on the printer?

AD: The braille machine is connected in parallel to the Mult. 35 teletype.

Authors: Can you read alphabetic letters that are tactually embossed?

AD: Yes, but braille is better. I can read arabic raised numbers. I can read the letters off an optacon. What is impossible is handwriting.

AD can read tactually embossed alphabetic letters, but prefers braille. He can use an optacon to read printed letters and numerals.

Lienemann: More things that would help you.

AD: It would be good to have the room numbers in raised numbers. In bathrooms it would be good to have a symbol L or M or you might have a list saying men's room between 822 and 824.

AD suggests room numbers should be in raised numbers. It would be good to indicate bathrooms. Map should indicate elevators, exits, stairways, major offices, telephones, and post boxes.

Authors: Have you had any experience in using maps?

AD: I have maps of the U. S. But in going anywhere, I try to figure it out myself or ask someone who would be reliable. Maps should indicate elevators, exits, stairways, major offices, telephones, post boxes.

Authors: How do you handle the addressing of a letter?

AD: Type.

Lienemann: We were afraid the map might be cluttered with all this information. Do you think you would use a phone service?

AD: I think it would be better if you had a map with all corridors, general layout, and if you called this phone number and asked for room 26-100, she would direct you from your map.

Lienemann: What about outside?

AD: Outdoors would be hard to map. You could indicate streets, entrances, directions for getting into an entrance. It would be helpful on the phone, but on the map it would just clutter it up.

Map could indicate buildings and building entrances.

Authors: How do you plan your routes out for the first time?

AD: For the first time I would use the phone service.

AD would use phone service to plan a route for the first time.

Lienemann: Do you ever find you don't know where you are?

AD: It happened in the winter outside when I was coming back from outside and got mixed up in the snow because the streets are never plowed.

Lienemann: What about reference points - you relate one building to the next?

AD: Mass. Ave. is a reference point. I think of it like the trunk of a tree.

Lienemann: What other reference points?

AD: Probably the main corridors, smaller streets, the walkway to Kresge, the lobby.

Major MIT reference points for AD include Mass. Ave., Main corridors, and the walkway to Kresge, Bldg. 7 lobby.

Authors: I'm beginning to read the trunk, Mass. Ave. crossed by the corridor network and Kresge plaza running up to the Student Center.

AD: Yes, with another one on top, Vassar St., and Memorial Drive south like the root. Some corridors are more main than the corridor to Bldg. 12.

Authors: How about Bldg. 16 and 56?

AD: I don't usually go that way. I usually go down the main corridor, turn right, go through Bldg. 6, go left in the Hayden library, come out on the far end of Hayden. If it's warm, I go down the main corridor and go outside and walk along Bldg. 6 or go under the Chemistry building and go by the Green building, but I don't like the Great Sail, and when you hit it, it really hurts. I can't hear any echo. Another thing that aggravated me was the random sculptures; they were put right in my way going into the Student Center.

AD cannot detect Calder's steel sculpture on the East of the campus. BC (see interview) can.

Authors: They moved it.

AD:	Yes, because I yelled at them.	
Authors:	Would the TAC-COM help you if one was put on the sculpture?	The 'TAC-COM' is a small pocket receiver that vibrates when it up transmissions from transmitters that could be placed in hazardous areas like the sculpture.
AD:	It would warn you that something was coming, but you wouldn't know from which direction. Braille menus in restaurants would help. Street signs are important on a post in braille.	AD suggests braille menus and street names in braille on street sign posts.
Lienemann:	Do you use a sequence in organizing your clues?	
AD:	No areas are the same. I know that a specific place I want to go has certain attributes; I don't try to relate them to anything else, just take it as it comes. When I step down I expect to step up again unless you come to something like a gas station or incline - a row of parked cars.	
Authors:	How do you divide entrances into types? Would certain kinds be helpful if they were indicated on a map?	AD would like to know what entrances are revolving, electric and swinging.
AD:	It would be nice if they showed whether they're on the same level you're on or if there are stairs. You would want to know whether it was a revolving door or not, if it is electric, which way does it open, if its a swinging door, if there are posts on the stairs - railings.	See IS's interview for a description of how he goes through a revolving door.

17 CN

INTENT: To find out CN's concept of the MIT campus, her mode of orientation, and her ideas of what information would be helpful on a map of MIT.

INTERVIEWED: CN - age approximately 19, MIT Freshman, 3/4 year on campus, adventitiously blind at age 11, a little residual vision.

ALSO PRESENT: Knut Lienemann (MIT Planning Office), a friend of CN who had made a tactual map.

DATE: 11 March 1972

Lienemann: What comes to mind when you think of MIT in a physical sense?

CN: The main corridor and the main building. That's the part I know best.

Lienemann: What is your image of MIT?

CN describes her image of MIT.

CN: A bunch of buildings sprawled together.

Authors: How much of MIT are you familiar with now?

CN: Mostly the buildings where I have classes or have gone before.

Authors: Do you know them by number? Where are some of the buildings?

CN: Seven, three, ten, four, all the buildings on the main corridor, building 26, 4 and 24, 2, and 15, Student Center.

Authors: What about other buildings?

CN: The Student Center and Kresge, I know where they are. That's all, and the Green building.

Lienemann: Do you associate any special characteristics with MIT -- items, materials, street patterns?

CN: Generally Mass. Ave. by all the traffic; main building, student traffic.

Lienemann: Could you describe your trip from Bldg. 26 to McCormick or the other way?

CN: Bldg. 26 to here. Go up those 11 stairs (usually you can tell where the stairs are because there are lots of people walking up), walk down the main corridor, cross Mass. Ave. right in front of Bldg. 7, walk along Mass. Ave. to Amherst St., cross, then go past Ashdown. I know when I'm at Amherst St. because of the curb.

CN describes her trip from Bldg. 26 to McCormick, her dorm.

Lienemann: Going from here to 26, after the main corridor, there are several turns. How do you find them?

CN:	At the end of the main corridor, you can tell there is a door to the outside. Just before you turn right to go downstairs, there's a set of doors. For all the turns you have to make, there are doors telling you where you have to turn.	CN probably uses echo perception to find intersecting corridors.
Lienemann:	Do you use a cane?	
CN:	Yes, I always take it wherever I go.	CN uses a cane wherever she goes.
Authors:	How did you understand 26-100 when you walked in?	
CN:	Not so much about the orientation of the seat and where the lecture was. The doors (there are a couple of different sets) took me a while.	
Authors:	What door do you use?	
CN:	One in the middle - in the middle back.	
Lienemann:	Before you go somewhere, do you try to get a clear picture of where you have to go?	
CN:	If I'm going someplace I've never been before -- not consciously, but sometimes I think about it.	
Lienemann:	What kind of information would you like to plan this trip? Do you go places you've never been before by yourself?	

CN:	Usually I try to have someone go with me unless it's impossible	Usually CN has someone show her new places.
Lienemann:	What kind of information would you like from a map?	
CN:	First, the general outline of the building. Also pathways. If I'm going somewhere in the main building, the outline is important.	CN would like the following information on a map: general outline of buildings, pathways.
Lienemann:	Would you describe another trip, Bldg. 5 to Bldg. 26?	
CN:	I'm in 26-100. I walk to the back of the room, listen for where the doors are, turn left, go through one set of doors (usually, people hold doors open for me), follow the people, go up 11 steps, turn left, go through another set of doors (there's a door jamb before you hit the main corridor), turn right (in walking down the main corridor, I don't tap my cane, I just follow someone in front of me, occasionally bump into someone reading a bulletin board), Bldg. 7 lobby. If you want to turn left to go to Bldg. 1, sometimes I have problems because of all the obstructions finding the hallway to Bldg. 1 and 5 and walking down that hallway.	
Lienemann:	Do you ever feel lost?	
CN:	No, in finding a staircase, I can sort of sense it.	
Authors:	What do you think of when I say, Bldg. 7, the lobby?	
CN:	This big open space, at least it's open in the middle.	CN's concept of the Bldg. 7 lobby is a big open space.

There's a bunch of garbage on the sides of it. Main plaza.

Authors: Why do you say big?

CN: Just more open than the main corridor and in comparison with the rest.

Lienemann: Have you had some mobility training?

CN: Yes, I had cane travel.

Lienemann: Do you use the procedures you learned there?

CN: Yes.

CN had cane travel and uses the procedures she learned in mobility training

Lienemann: Have you told us all clues you use for orientation?

CN: I have a bit of residual vision which I use.

Authors: How much vision?

CN: On a sunny day, I can tell the difference between the sidewalk and the shoreline.

CN has some residual vision. On a sunny day she can distinguish between the sidewalk and shoreline.

Authors: Has your vision deteriorated?

CN: Yes, I could see till I was 11. Using my sight, I can sense when a street is coming up.

Lienemann: Is traffic noise very important to you?

CN: In crossing a street, I listen to whether the traffic is going parallel to me.

CN uses traffic noise as a cue. She describes how she crosses a street.

Authors: Can you tell traffic patterns? One way, two way streets?

CN: I've never tried to do that. I could if I thought about it.

Authors: Tell us how you cross the street.

CN: If the traffic is stopped when I get to the corner, I wait till the next light because the light could be changing.

Authors: Can you see the light?

CN: No. I can tell whether the traffic is standing still or not. When the light changes, I walk across. Sometimes finding the curb on the other side is difficult, but not usually.

Authors: How's that?

CN: If you go a little to an angle -- especially if you walk out into the intersection. Usually that doesn't happen.

Lienemann: What kind of directions do you ask for?

CN: In finding a certain room, you can tell when you are getting to the general area. But if you wanted to go to 136, you can tell where the general area is, but not that particular room unless there is a marking like a stairway.

CN describes the common problem most blind people have: Namely that of maintaining a straight direction when there is no shoreline to follow.

Lienemann: You don't normally ask for stairways or elevators?

CN: I ask where a certain room is.

Lienemann: Do you have any suggestions for this map?

CN: It would be nice to have pathways.

Lienemann: Tell us a little about that?

A friend: (Responding to the question because he had made a crude map of the building 10-7-5 complex using braille.) Ninety percent of the structure is determined by the geometry of the braille cells. You're left with very little freedom.

Authors:	We have 3 possibilities. One is a thermoform process, which enables you to construct a collage using any material glued together to develop the tactual levels that you want. You don't use braille cells. The maps are clear and you have a variety of tactual levels. Another process, one that is utilized on plastic credit cards, is a little less flexible as you can arrive at only one tactual level. Third process involves a vinyl foam material; you can get a couple of tactual levels.	In the second process, the plastic one, it is possible to use two tactual levels.
CN:	The big lawn area by Kresge and the Student Center; I'd like to have the steps put in.	For orientation purposes, CN would like the steps by Kresge and the Student Center to be indicated on on the map.
Lienemann:	Are they a hazard to you or would you like them for orientation purposes?	
CN:	Orientation purposes.	
Lienemann:	We were thinking of a phone service that would cover everything. Would you use this?	CN would use phone service for additional information occasionally. Bathroom locations should be on the map.
CN:	Not very much. Occasionally. They should put bathrooms on the maps.	
Authors:	What about readers? Is it hard to find someone to do that?	At the beginning of her Freshman year CN found it hard to find readers. A recorded library would be good. CN prefers braille to recordings.
CN:	At the beginning of the term, but there are a lot of people willing to read -- students, etc.	
Authors:	Would a list of people be good? Or a recorded library?	

CN: Yes. Last term I had a physics course, and I know several blind people had used the book. Each had had it read.

Authors: Any other things that could be developed at MIT to help you? Is it easier to study Thomas in braille or recordings?

Thomas refers to a basic calculus text that is used by many freshmen, sophmore math classes.

CN: I like braille better than recordings, but recordings are a good, second-best depending on the quality of the reader.

Authors: Some people can't handle the technical stuff. If you could establish the channels at MIT, you might get a better recording.

A friend: It might be a good idea for MIT students to record for these established companies which probably need technical people.

Authors: I can see where these people in New York have trouble transferring technical illustrations into tactual representation.

Lienemann: Do you have a book here with graphic material which has not yet been transcribed into braille? We could test to see whether we could photo-chemically transfer the diagrams directly.

A friend: The Physics book is easier to transcribe than chemical formulae.

Lienemann: Can you read arabic letters? How big do they have to be? (Goes on to describe new type of diagram.)

CN: Yes. I am not sure what size.

> CN can read printed letters, but isn't sure how big they have to be.

Lienemann: Do you have any material that contains diagrams?

CN: I have a math book.

Lienemann: Yes, I see. Transferring these diagrams is somewhat more difficult than I thought.

> Problem of transferring graphic material in books to tactual presentation.

Authors: How are the diagrams communicated to you?

CN: So far in that book, I haven't had very many diagrams.

Authors: How far have you gone?

CN: Usually the text describes the graphs pretty well.

Authors: There are many diagrams that the text has already described to you. How do you solve these problems?

CN: In my head -- a little more than most people.

Authors: How do you express functions?

CN:	Special functions sometimes braille notes.	
Authors:	Do you have to integrate strange functions? Do you have a table of integrals in braille?	
Lienemann:	Doesn't this exist?	
CN:	I don't know, it might be listed in this catalogue, <u>Science for the Blind</u>.	An examination of <u>Science for the Blind</u> showed that only scientific equipment was listed.
Authors:	Would an orientation manual be helpful?	
CN:	Yes, I felt really miserable at first trying to find my way around.	An orientation manual would be helpful.
Authors:	From talking to some seniors and grad students, it took them at least a year or more to become familiar with the campus, but their abilities now are amazing. If you have Thomas, you certainly have integral tables.	
CN:	Yes. They are in a separate volume, but it is not the most comprehensive set of integrals. Recordings for the Blind would not have anything like that unless it came along with a book.	Integral tables are not comprehensive.
Authors:	That might be something the Math Dept. at MIT could produce. That would be something that would have a resale market for a number of years.	

Lienemann:	Is there an area which you like?	
CN:	The most important thing to me is my room. I hardly ever use libraries at all.	CN seldom uses libraries.

18 BUCK

INTENT: To find out about the blind at MIT - their problems, what is presently being done to solve these problems and what could be done.

INTERVIEWED: Mrs. Buck - Chief Social Worker, MIT Medical Department

DATE: 14 March 1972

Buck: I think what you're doing is really important and I really need to say that very vigorously. For a long time some of these ideas have floated around, but it's important that another thrust be made administratively to pull them together and get some of these innovations into practical use.

I have felt for a long time that there should be a buzzer at 77 Mass. Ave., for example.

Authors: Cues for crossing there are good and the blind can use their mobility techniques easily there.

Buck: But cars often go through the red light at the 77 Mass. Ave. crossing.

Authors: A buzzer won't help this. The blind and the sighted have the problem of the reckless driver.

Buck: I feel that the locations of drinking fountains,

The buzzers used at Watertown Square confuse the blind traveler because he cannot distinguish which buzzer goes with what light. Most mobility instructors prefer that the blind learn to cross using traffic cues.

elevators and restrooms should be indicated on a map.

The library situation is much more of a hassle and I think that's going to take a lot of people thinking together to make that system more accessible. My own feeling is that blind students are entitled to some basic texts in braille. After they are accepted, blind freshmen write "How shall we find reading material and what courses are we going to take? Is there any plan?" Peter Buttner's office (Student Affairs) replied, "We don't know what courses you're going to take and you'll have to pick those out first. Then we'll try to get in touch with the professors, which is difficult often. We'll have to get a reading list to you. Then you'll have to turn to the National Braille Press or Recordings for the Blind or some other agency (which all of the students do know about) which will transcribe reading material into recorded material or into braille." Getting the first batch of material is extremely hard for these students and it must be remembered that just getting accustomed to the pressures of MIT and trying to cope with the physical system is incredibly rough for normal students let alone one who is incumbered by a disability. We ought to be able to make the entry to MIT simpler and less cumbersome.

Authors: We have the feeling that the libraries on the MIT campus are completely unaware that there is a problem. They may even be unaware that there are blind students on the campus. It's often impossible for blind students to take reserve books out of the library to get them copied. That means that they have to get a volunteer to come and read in the library softly and record. They need a quiet place to record and make a quality recording that could then be duplicated and filed in the library system. Maybe it would be used again, maybe it wouldn't,

A subsequent conversation with Miss Natalie Nicholson, Associate Director of the Libraries, MIT, revealed that there was much the libraries can do now with existing resources and personnel to help the situation.

but effort wouldn't have to be expended on that material again.

Buck: When GL was doing a Physics project, Mrs. Martin in the Physics Library let the students zerox the material there since she couldn't let the books go out. This is a major problem: how to get at library materials. It becomes even more of a problem when theses are due and people need to gather material.

Authors: The answer maybe to find some person or develop a position that could coordinate all the library activities, be responsible for setting up the filing system for tapes and maintaining a reading room.

Buck: We should try to pool thoughts from a number of sources and then approach Professor Locke, Director of Libraries or Miss Nicholson, Associate Director as to how this could be done. When they are aware of the problem they could undoubtedly suggest ways to make the library system more responsive to the special needs of the blind students.

Authors: The library may be able to underwrite the cost of duplicating and storing materials. Luckily readers are volunteer students, etc. Blind students find that technical recordings from New York are not always good and so they prefer student readers.

We found out from Marianna Owens of the Language Lab, located in the basement of Haydn that they have the equipment and would duplicate tapes.

Buck: Outside volunteers can read humanities, but often not technical material. MIT students can read, but it takes energy and time that MIT doesn't easily allow for in terms of pressures it puts on students.

(Mrs. Buck had a list of recording agencies that had been rated by an MIT blind student.)

Buck: In 1970 MIT got involved for awhile in providing some audio visual services for a particular blind student which turned out to be very expensive.

The recurring wish is for a reading room where tapes can be made of books that are on reserve.

Authors: The library could invest in basic texts in braille like Samuelson or a good math book.

Buck: Perhaps the high speed brailler at MIT could be of more use.

I have a letter from Mr. Proscia to Dean Hammerness November 1970, in which Mr. Proscia described the possibility of setting up a resource room for blind students which would contain a tape recorder, a braille recorder and perhaps tape duplication facilities. The resource room could also be used as a reading room and small library for storing tapes. Mr. Proscia said the braille emboss system was being made available - a braille input/output device for time sharing computers at MIT.

This resource room never materialized.

Authors: Blind students need a quiet corner for taping. They need to be able to take out reserve books to record. We should assemble basic textbooks that can be utilized by blind freshmen coming into the Institute.

Buck: This would help the incoming Freshman immensely. We could do something quickly about putting a box on the registration form for volunteer readers to check. Getting readers on their own is one more emotional burden for the blind.

Authors: If only 10% of the student body volunteered, they probably would be pretty well distributed in virtually every department and every course. You could get people volunteering their services reading material they would have to read anyhow.

19 ML

INTENT: To test the polyvinyl chloride map of MIT and Gilligan's process. To find out ML's concept of the MIT campus and his mode of orientation.

INTERVIEWED: ML - MIT graduate student, economics, congenitally blind although he had monocular vision until age 4. Four years on campus

ALSO PRESENT: Knut Lienemann (MIT Planning Department)

DATE: 12 April 1972

ML: Maps made for blind people ought to be clear for sighted people as well. This is a map of Central London.

Authors: There is a copy of that map on Harry Friedman's wall.

ML: It also has with it a rather lengthy book, which describes all kinds of things in braille. The other maps are even more interesting. I'll just show you one pair of physical and political maps of the same area. Each one comes with a book which provides a lot of information. There are several different textures fairly easily distinguishable for mountain ranges, etc. I don't know why we don't have maps like this produced here in America. What it comes down to, is that we have very poor maps for the blind in this country, and the ones that are any good are expensive. As far as mobility, we know almost nothing about how such a map should be used. It is an interesting question how a blind person uses a map like this and why it's so much less successful than with a sighted person.

The maps ML showed us were of Great Britain. They were geographical in nature, not local. Accompanying each map was a written guide. The maps in the U.S. for the blind are poor.

A blind person's conception of space is so much more localized than a sighted person's. When you look at a map, you have a visual template that you can fit your environment against. You look around, maybe several blocks and say, "Ah, that's the building at Central Square". You can orient yourself so that minor discontinuities don't hang you up too much except maybe at night. Searching around back streets at dark is a closer approximation to a blind experience. Typically, a blind person has a perceptual range of only a few feet. He of course can hear major traffic streets and people going in and out of buildings, but it is a fairly limited kind of perception.

A blind person's conception of space is based on localized experiences. Typically he has a perceptual range of only a few feet.

The other things is, if you draw a sidewalk as straight, and the sidewalk widens before a building or service road, you may not know when you've gotten into it, and all of a sudden you encounter grass and wonder. That doesn't happen with a dog very often, but with a cane it certainly does happen. You wonder where you are even though you got hung up in such a minor discontinuity.

Authors: Then you are approaching everything successively.

ML: Right.

Authors: Are you still attending MIT?

ML: Yes. I am writing a thesis in economics.

Authors: Are you congenitally or adventitiously blinded?

ML: Probably by definition congenitally. I had some monocular vision up till I was four, and after that point, it diminished.

Authors: Do you have any visual memories?

ML: A few. Most of them were reinforced afterwards by an awful lot of exposure. I think, by definition, I am congenitally blind.

ML has a few visual memories which were later reinforced by non-visual sensory information.

Lienemann: When you think of MIT in physical terms, what comes to mind?

ML: My primary area of MIT is over towards the Sloan Building which is somewhat out of the way from normal MIT. Thinking of the major campus, I guess the thing I think of most if you start from Mass. Ave is the Main Building which is of course a bunch of buildings interconnected. Behind that and northwards basicly, is a large open area that has a lot of buildings and cross sidewalks in it. I think that would be useful to delineate because it's very easy to get around MIT by going around (the outside boundaries of the campus). That is to say, by going the Memorial Drive route or by going on Vassar St., which is really torn up now, you can locate most of the buildings or at least get access that way through another building. Sometimes the middle area, particularly when they were doing construction a year or so ago, gets complicated.

Peripheral campus routes (Memorial Drive, Vassar Street) are accessible to most MIT buildings.

It seems to me that the area over to the Student Center is fairly straightforward. It should, however, be delineated on a map, particularly the fact that there are steps on that sidewalk that lead you up into that little area that has Kresge on it and the Student Center. It would be useful to indicate to a blind person, and I don't know how you do this, the fact that when you go to the Student Center, there is one potential great danger: the way the steps are built. The ones that go up to the Student Center itself you can walk under. This is something that would have to be explained. I doubt that you could show it, but it is worth indicating.

The steps up to the second level of the Student Center are a potential danger. ML thinks it is a difficult problem to show those steps clearly on a map. We can verify this fact from the difficulties we had with those steps on the first tactual map we did of MIT.

Another thing that I haven't had any trouble with, but have been told by other people is "the great pine tree" that is up by Vassar St. I heard stories about somebody being hung up in this pine tree for ten minutes. This is a guywho used a dog and his dog died. Thinking that he knew how to get where he wanted to go he started out alone with his cane. I wondered why he was so late arriving. Well he got hung up in the pine tree. This can happen in a few areas, and it seems to me that it is important not only to show the location of buildings and sidewalks, but also to indicate the heavily trafficked streets - Memorial Drive, Mass. Ave., and Main St. These streets are good reference points if you happen to get mixed up or lost.

It is important to show buildings and streets on the map. ML can make qualitative distinctions between the traffic on Memorial Drive and Mass. Ave.

Lienemann: Acoustically?

ML: Yes, just by listening. Have I gotten turned around? Where is the heavily trafficked street? Actually the traffic on Memorial Drive is quite different from the traffic on Mass. Ave. The Memorial Drive traffic is faster flowing with more cars. Mass. Ave. is slower.

There are stops and starts. Also more trucks. You would want to indicate where the crosswalk is in front of the Main Building, and if you were writing a description, you would want to say how you could locate that crosswalk.

Authors: What are some other cues that could be expressed on a map? Maybe some you find useful that could not be put on a map?

ML: There are a few cues that are sometimes useful. Suppose you are going to Bldg. 20, which is the old research lab for electronics on Vassar St. If you are coming to MIT, there are two ways you probably would come: the Mass. Ave. buses or by the MTA which leaves you off at Kendall. Now if you come by Kendall, the easiest route to Bldg. 20 is to go up Main St., for example. There are certain cues there like the fire station which has a lot of little driveways and the F&T Diner, which you can usually smell and hear. Food shops would be interesting information to show on a map.

ML uses the F&T Diner as an olfactory cue. He also can detect the driveways of the fire station.

The insides of buildings are fairly complicated. The Student Center is supposed to have an interesting architectural design, but in fact, it's a fairly complicated one. For instance, you go where you expect the stairs to be and they are not always there. In the Sloan Bldg. several of the floors are quite different. The first is quite different from the second and the third different from those two. Those are the things you can't really indicate on any kind of a map, unless you're going to map each building individually.

Lienemann: Do you remember, during the first week you spent in the Sloan Bldg., how you found your way around?

ML:	I was oriented to it. I had somebody take me through it, although I could have found my way around it.	ML initially was oriented to the Sloan Bldg. by a peripatologist.
Lienemann:	What did he show you? Did he show you the right things?	
ML:	Yes. Well he was a peripatologist and carefully explained to me the structure of each floor. I usually came in the Sloan School from the entrance on the library side.	

He said, "When you walk in through a double set of doors, you will be in a little foyer and to your right is a bathroom, but you have to be careful because the second door is a women's bathroom (which I actually went into once. Who knows how?). To your left is a bank of elevators (and he went on to explain about the elevators). Now as you go through, there is a large open area, a lounge area. You have to be careful because there are a lot of lounge chairs, but it is very easy to find your way around because there is a carpet and the chairs are on the carpet. If you want to get through to the front door, follow it around either way to a double set of doors going out."

When you go up to the second floor, the first thing that strikes you coming out of the elevators if you turn left you will be on a balcony. Of course this can be confusing. It's echoey and you don't know exactly what it is. But it is also a good landmark. What you have are like little squares coming off of this with offices all around it. You can go up this way to the right and around. (He indicated this route by pointing his finger on the table.) That kind of thing.

Lienemann: That's fascinating. We have never had that. He made a drawing while explaining it. Why did you do that?

ML: So that you would understand what I was saying.

Lienemann: Do you make drawings sometimes?

ML: Yes. I use a sewell board, a raised line drawing kit. Have you seen it?

ML uses a sewell board to make raised line drawings.

Lienemann: No.

ML: I'll show it to you. It actually has a raised line drawing of part of Cambridge on it. When you draw on it the line comes up. You put the paper on top of the board and use a regular ball-point pen.

Lienemann: This is Kendall Square?

ML: No, this is Mass. Ave. where Mt. Auburn and Putnam intersect. I was confused about some of the crossings because normally I didn't walk that way. It was a long walk and the sidewalks were torn up so it was easier to take the MTA up to Harvard Square and trace back if you wanted to get to something. I don't make drawings too much of a place I've been to myself, but I may ask somebody. People are generally imprecise in what they say. I mean I am too. In describing an area they will say that two streets will come together

He finds it helpful to get others to draw intersections of streets because verbal descriptions are often not adequate.

at an angle. Well, it's important to know what kind of an angle they come together at. (He draws on the board.) Well, does the intersection look like this (acutely) or does it look like that (obtusely). There is a difference as to how you would plan you're crossings.

Authors: We are interested in knowing more about what cues will tell you about the quality of places? Can you sense or tell...What is your impression of old buildings vs. new buildings?

ML: An old building, of course, very often still has wooden floors. It has a creaking sound and a different kind of echo when people walk through it or even if you were just to stand there. If a new building were not acoustically tiled, it would have a brighter sound than a wooden building. If you have acoustical tiling, very often you will walk into a corridor and it will seem quite dead. You snap your fingers and there will be very little echo. These are corridors that are tougher to handle. There is an optimal point in between. If the sound is too bright, it's confusing because there is too much echo. You can't hear individual things if it is too dimmed. You can't hear doorways.

Echoes differ from building to building. Acoustic tile makes a difference in the perceptual environment.

Authors: Is a building that is acoustically optimal for its purpose, necessarily optimal for locating things by echoes?

ML: Well, I don't know anything about the acoustic design of a building. Normally, a really good lecture hall is neither too bright nor too deadening. Of course the same thing could be said for a concert hall and a concert hall is big enough and, in a certain sense, featureless enough that it may be disorienting if you are stuck in the middle of it. You might not know how to get out without some sound source around, but a lecture hall very often has more details to it - aisles, not so many balconies, etc.

A lecture hall with good acoustics is generally a good environment for echo location.

Lienemann: Are you a cane traveller?

ML: I was, but recently acquired a guide dog.

Lienemann: Do you prefer a dog?

ML: Yes, I think so. I consider myself a pretty good cane traveler and I have also fooled around with most of the travel devices that are available, particularly the Kay spectacles, quite a remarkable device. They are much less useful with a dog than with a cane, but extremely useful with a cane. Also, they are far too complicated for an average person to use, unfortunately. I am not really that well co-ordinated with my dog. It is quite a period of adjustment, but the dog is really quite an amazing guidance device.

ML prefers a dog to a cane for mobility. He used the Kay spectacles with the cane, but has not yet been able to use them with his dog.

Authors: What kinds of spatial representations do you get from the Kay spectacles?

ML: You get a lot of information first of all. With the new ear molds, you can hear essentially all of the ambient noise which is important.

Authors: What does the earmold look like?

ML: (He shows us his pair of spectacles.) When I first used them the molds were very occluding. They were a full shell mold like those used in hearing aids. A two or three decibel loss in hearing is not critical for a deaf person wearing the hearing aid. It is for me. I complained a lot and others corroborated my reports, so we did get them changed. The mold won't fit your ear, but I'll put them on. The original mold had much more filled in within the ear piece. Consequently, it was occluding and increased the cone of confusion. If you snap your fingers either to the front or back of your ears, it is hard to tell precisely where, with the old ear piece on.

Authors: This is with respect to your actual environment and not what you're getting through the spectacles?

ML: Yes. It's very important when you're listening to traffic to know where it's starting, so that you don't make a mistake, and there were mistakes made with the original shell molds.

It is important to be able to hear raw auditory environmental information, as well as the sounds emanating from the spectacles themselves.

Authors: How can you describe the auditory information from the spectacles?

ML: There's a lot of information, really a lot.

Authors: Does it provide a full frequency band of information?

ML: Oh yes. First of all, every object is delineated as to its location: left, right center, that kind of thing.

Authors: The stereo-effect.

ML: Right. Each object has a different characteristic as to whether it's thin or wide. Again, the same kind of stereo effect. A pole right in the middle is a thin sound. A thicker kind of thing, like a post, has a wider sound to it which is proportional to the distance. The further away it is the higher the pitch.

The spectacles locate objects in space, and relative changes in pitches indicate the distance you are away from an object.

And then, perhaps, most remarkable to the environmental sensing aspect (the other things were specifically directed towards obstacle perception) is the fact that each object has a very different sound because of the surface qualities of the object. Surfaces reflect very differently. You are using a very high pitched sound, around 40 to 90 khz, so you have a really short wave length which can read these surfaces. If you look at a wall made of plaster and compare it to a wall made out of pine paneling with the slotted holes. You can hear discontinuities less than a quarter of an inch. If you come up to a pole, we used a bamboo pole in the original training program, and touch it, it will go WHUUUAWHUUAWHUAWHA. You can hear it vibrate. You have a tremendous amount of environmental information. Now for the mobility question much of this is irrelevant, of course.

The spectacles enable you to make qualitative judgments about surfaces because of the small wave length that is reflected.

Lienemann: What angle do you perceive?

Authors: We have read that the field of perception is a fifty degree solid angle.

ML: It's actually more like about thirty degrees. That's an unfortunate problem that they have run into. It should be more like fifty or sixty degrees.

ML reports that the field of perception in the Kay spectacles is a 30 degree solid angle. Nye & Bliss say that it is a 50 degree solid angle.

Lienemann: To what distance can you perceive things?

ML: About 20 feet. Now you would not be able to attend to objects out about 20 feet if there are a lot of things close to you. It's difficult to detect multiple objects and figure them out without scanning in particular. If you scan around, you can tell a lot. But when you're actually moving along, you don't want to do much scanning because while you're looking over to the right, something is creeping in on the left. You want to keep a safe corridor in front of you.

ML says it's hard to scan to the right or left while he is walking because he must concentrate on what is straight ahead.

You probably also know that the Kay spectacles are not good for low obstacle detection. It's meant as a supplement to the cane or a dog. When you move into a room that is not cluttered, aside from the normal echo sounds you get, you can sense something sticking up (you may not know what it is). As in all guidance work, you make problematic judgments. If you're in the middle of a corridor and there's something sticking up, well, you may be at a loss, but notice something higher than the rest. You figure that might be the podium or projector on a table. So you have to make these kind of judgments.

Kay spectacles are meant to supplement a cane or dog.

A lot of training with the spectacles after you get the basics down - the kinesthetic integration - involves getting out and integrating this with your normal travel skills

The skillful use of the Kay spectacles requires continual use to build up a vocabulary of sounds.

and just building up the language by going around and hearing all kinds of things.so that you have an idea of what they sound like. For example, chain link fences have very characteristic sounds. Going into Bldg. 20, there is a big fence and then an opening. It's hard to pick that up by sounds unless there are people coming out, and its hard to pick up with a cane because it keeps getting stuck in the fence when you're trailing. With the Kay device, what you do is to walk along the fence, adjust your angle so that you are picking up the fence on the left lobe, and as soon as the sound drops out, take a couple more steps and turn left. It's beautiful for locating flush doors in a shopping center. You walk along and the glass is a good reflector so that you get almost no sound as you're walking parallel to it. But what you do hear are the metal supports. All of a sudden you'll hear a chord which means there are two supports close together. Well, you look at one and then the other. Put yourself in between and that's the middle of the door.

Authors: You are receiving auditory sensations of physical relationships at a distance?

ML: Yes. You've increased the range of your perception. You can home in on a pole fifteen feet away by making kinesthetic adjustments.

Authors: Do you fatigue easily when you use the spectacles?

ML: In the beginning it was very fatiguing. There was an awful lot to attend to. Later on, no. It was more relaxing because there are a lot of things it helps you with. If you are traveling with a cane, it keeps you from contacting a lot of objects. It warns you about pedestrians standing in the middle of the street. It warns you about poles and tall garbage cans you might run into, particularly if you are being buffeted by pedestrians. Running into these things is not serious, but it slows you down. You've got to be alert about it. If you start day-dreaming, you're in trouble. With the Kay spectacles you are likely to have much fewer contacts. In a well known area, the spectacles can make you much more graceful.

After familiarizing himself with the spectacles, ML found them relaxing to use. He implied they removed some of the stress associated with cane travel.

Lienemann: Do you actually use them?

ML: I'm not using them right now because adjusting to the dog requires all my attention. From the time that I got it which was last June to when I went to get the dog in late February, I made a point of using them almost all the time. You've really got to do that, to give them a good shake. You might wonder why I put them on to go a few blocks that I know really well. Well, if you force yourself to do that, it is very useful. You'll find that it comes in handy lots of times.

Lienemann: Do you use them only for utilitarian purposes or for pleasure exploring?

ML: I must say I haven't integrated them aesthetically to the point of looking at a female and being able to judge the measurements or something like that, which you probably could do in time. I have used them for just going to an area and sort of mapping it out to get an idea of what I would like to get near and touch.

Lienemann: Would you please count the buildings on the west side of Mass. Ave. starting from Vassar St. going down to Memorial Drive?

ML: I know there are other buildings there, but as far as I'm concerned the only place there that I have occasion to go is the Student Center or Kresge. I know the gymnasium is back in there, but I haven't gone there.

Lienemann: Where do you go frequently?

ML: Not really many places in the middle of MIT. I walk along Vassar St. to the Computation Center and the Aero-Space Building.

Lienemann: How do you support your mental image?

ML: I think of a mental image in terms of sounds. I would think of the echoey underpass that goes beneath the Comp. Center. I would think about the fact that there are two driveways there. I support it with how the area seems to me kinesthetically. I also remember hearing a building, for example, but it almost feels that it is there.

ML supports his mental image with sounds and kinesthetic sensations.

Lienemann: The sequence is essential. If you forget one point, then you would have more difficulty to get to the next one?

ML: Perhaps. But the things is, you can pick up in the middle of a sequence so that if you get off, it might surprise you, but you can still come around.

Lienemann: In your mind, would the analogy be correct with learning a poem by heart?

ML: Yes. It's a sequential thing, but it can be picked up.

Authors: Do you find in those areas where you have used the Kay spectacles, you're getting another kind of auditory imagery that's much more defined?

ML: Very often, yes. You may also get more confusion, but there's a lot more information. You start counting things like hedges, hedges coming through fences, fences, etc.

Authors: Are hedges really conceived of in sound terms?

ML: Yes, if I were trying to reconstruct the experience.

Authors: Is there a correlation between tactual-kinesthetic and auditory experiences?

ML: Yes. The sidewalk's characteristics, the feel of the bushes, comprise a kind of milieu that you move through. Sometimes when you're lost, you'll get into an area which all of a sudden feels right. You'll hear a cue and you'll say, "Ah, I know where I am now. I'm in the middle of this poem."

Lienemann: Can you relate one poem to another?

ML: Yes.

Lienemann: The drives that are in front of the fire house may remind you of another area?

ML: Yes, exactly. Also you make these problematic judgments I mentioned before. You come to a building in a place you know has a lot of the same architectural structure. You reach a doorway and you figure this is an open area, the elevators must be nearby, and a lot of other things like that.

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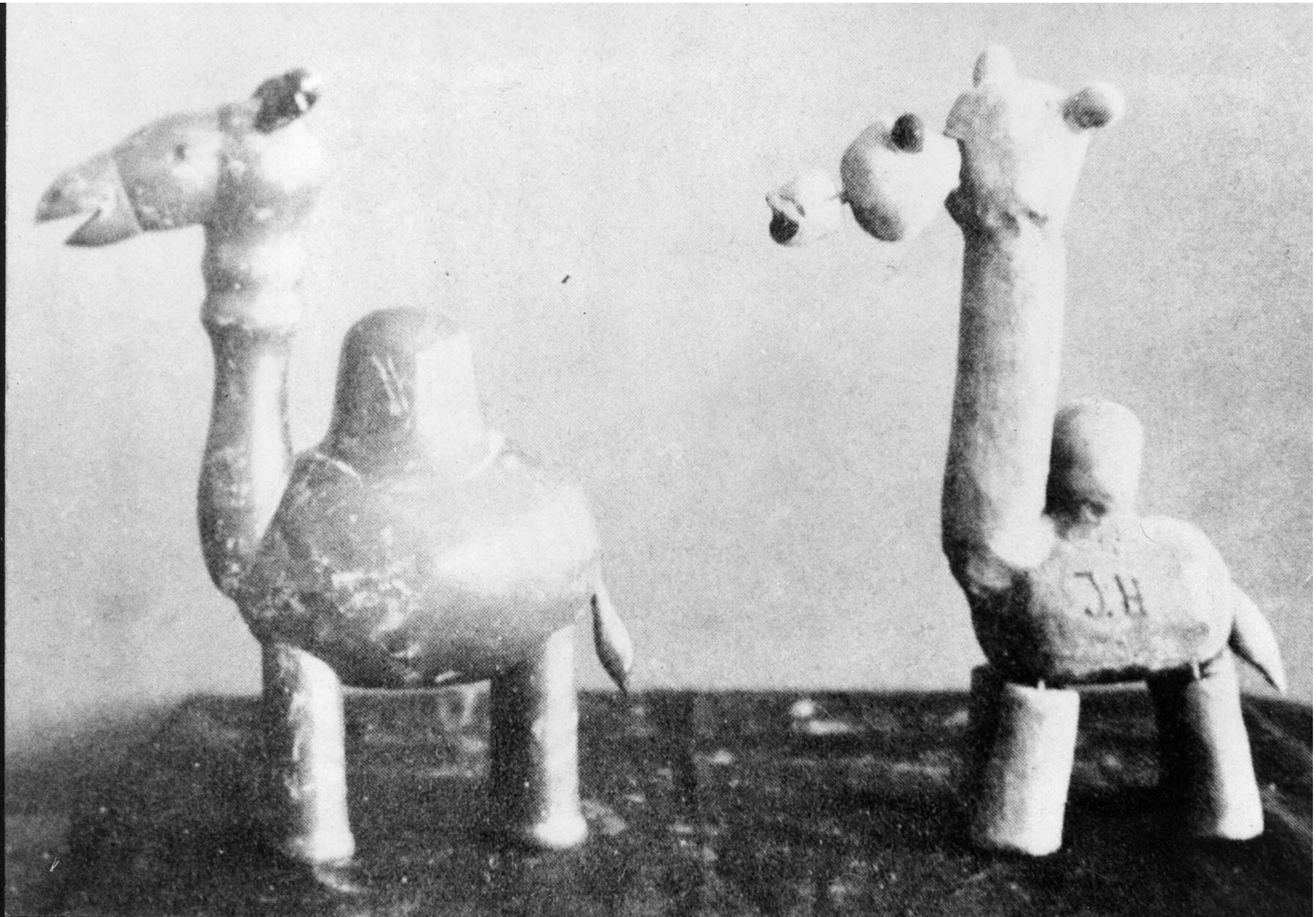
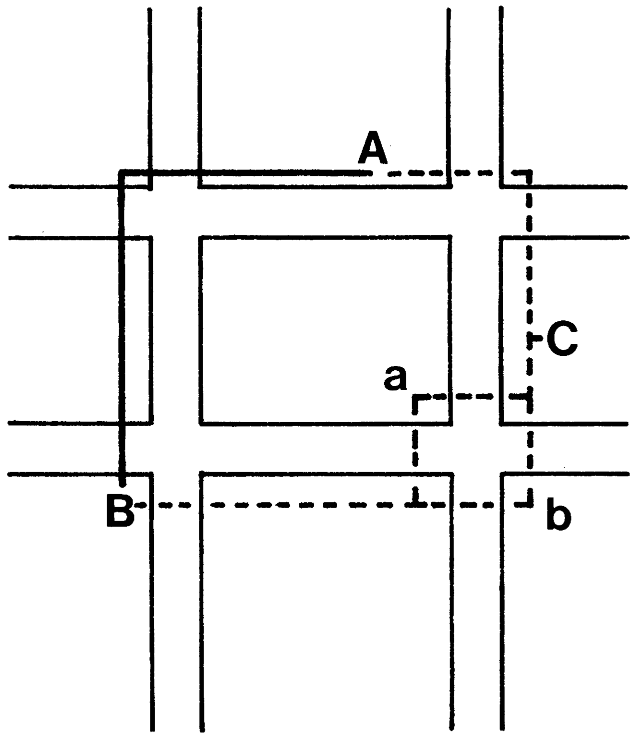


FIG I



HOW TO GO FROM "A" TO "B"

Directly

turn right
walk to corner
cross street
turn left
cross street
walk to corner
cross street
arrival

Indirectly through C

turn left
walk to corner
cross street
turn right
walk to C
turn left to C
turn left from C
walk to corner

a	b
turn right	cross street
cross street	turn right
turn left	cross street
cross street	
turn right	

walk to corner
cross street
arrival

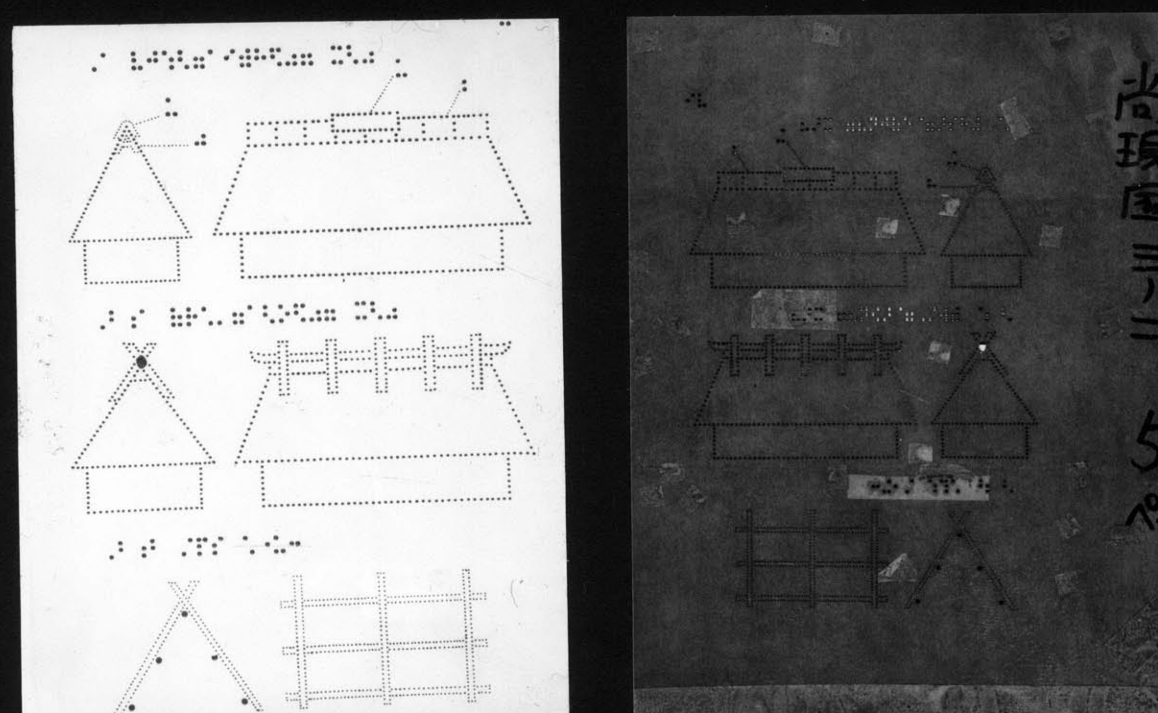
physical - spatial

sequential

FIG. 2

FIG 3

FIG 5



a b

1968

DELAWARE

19

LEGEND

STATE LINE	– – – – –	MAJOR HIGHWAY	- - - - - - -
COUNTY LINE	···············	CANAL	●●●●●●●●●●
NATURAL BOUNDARY	————	BRIDGE (DELAWARE MEMORIAL BRIDGE)	◆
STATE CAPITAL	★	LARGE WATER BODIES	
COUNTY SEAT	⊙		
CITIES AND TOWNS	●		

INDEX OF CITIES AND TOWNS

★ ⊙	DOVER CAPITAL	10.340	E-2	LONG. 75° 31' LAT. 39° 9'
⊙	GEORGETOWN	1.765	G-3	
⊙	WILMINGTON	93.827	A-2	
1	ARDEN	632	A-3	
2	BELLEFONT	1.530	A-3	
3	BRIDGEVILLE	1.570	H-2	
4	CAMDEN	1.200	F-2	
5	CLAYTON	1.028	D-2	
6	DELAWARE CITY	1.665	B-2	
7	ELSMERE	7.319	A-2	
8	HARRINGTOWN	2.495	F-2	
9	LAUREL	2.709	I-2	
10	MIDDLETOWN	2.401	C-2	
11	MILFORD	6.300	G-3	
12	NEWARK	15.341	B-1	
13	NEW CASTLE	4.469	B-2	
14	REHOBOTH BEACH	1.507	G-5	
15	SEAFORD	4.430	H-2	
16	SMYRNA	3.240	D-2	
17	WYOMING	1.172	E-2	

WATER BODIES

18	DELAWARE RIVER	D-3
19	CHESAPEAKE AND DELAWARE CANAL	B-2

HOWE PRESS OF PERKINS SCHOOL WATERTOWN, MASS.

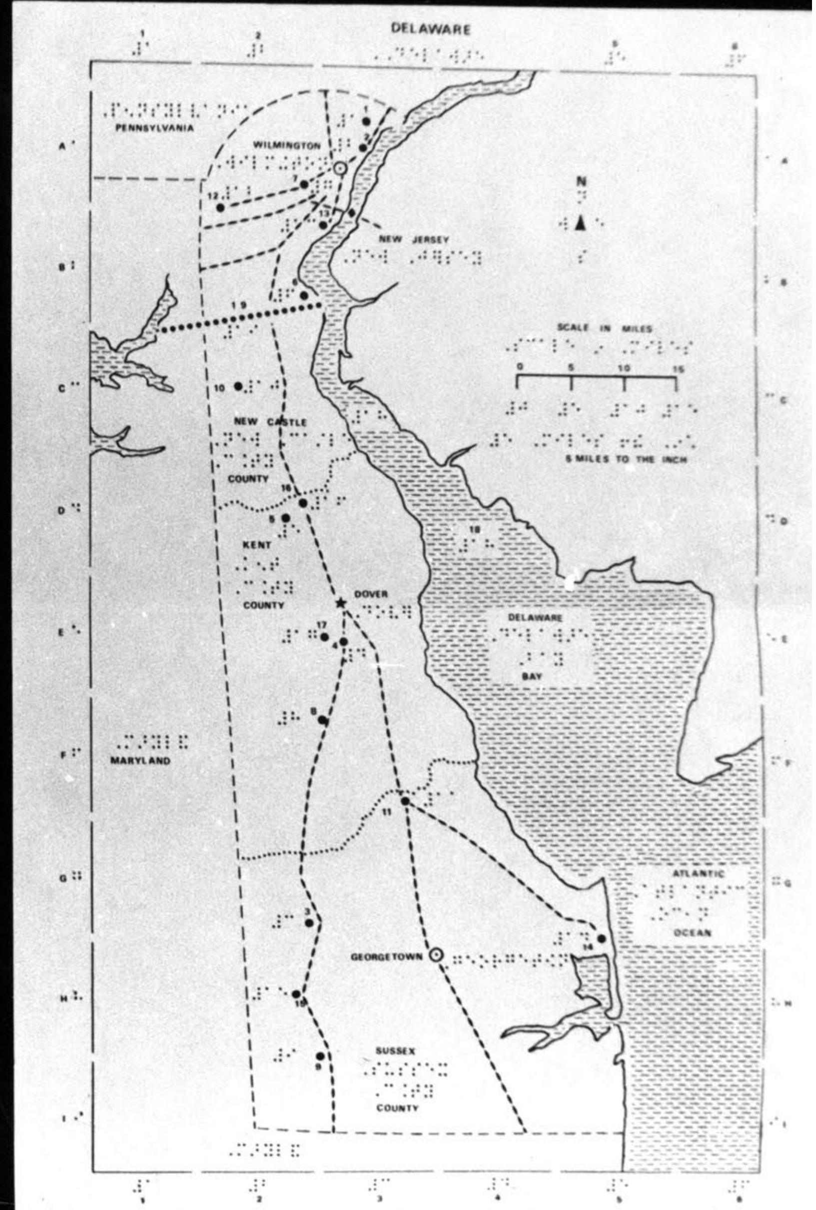


FIG 4

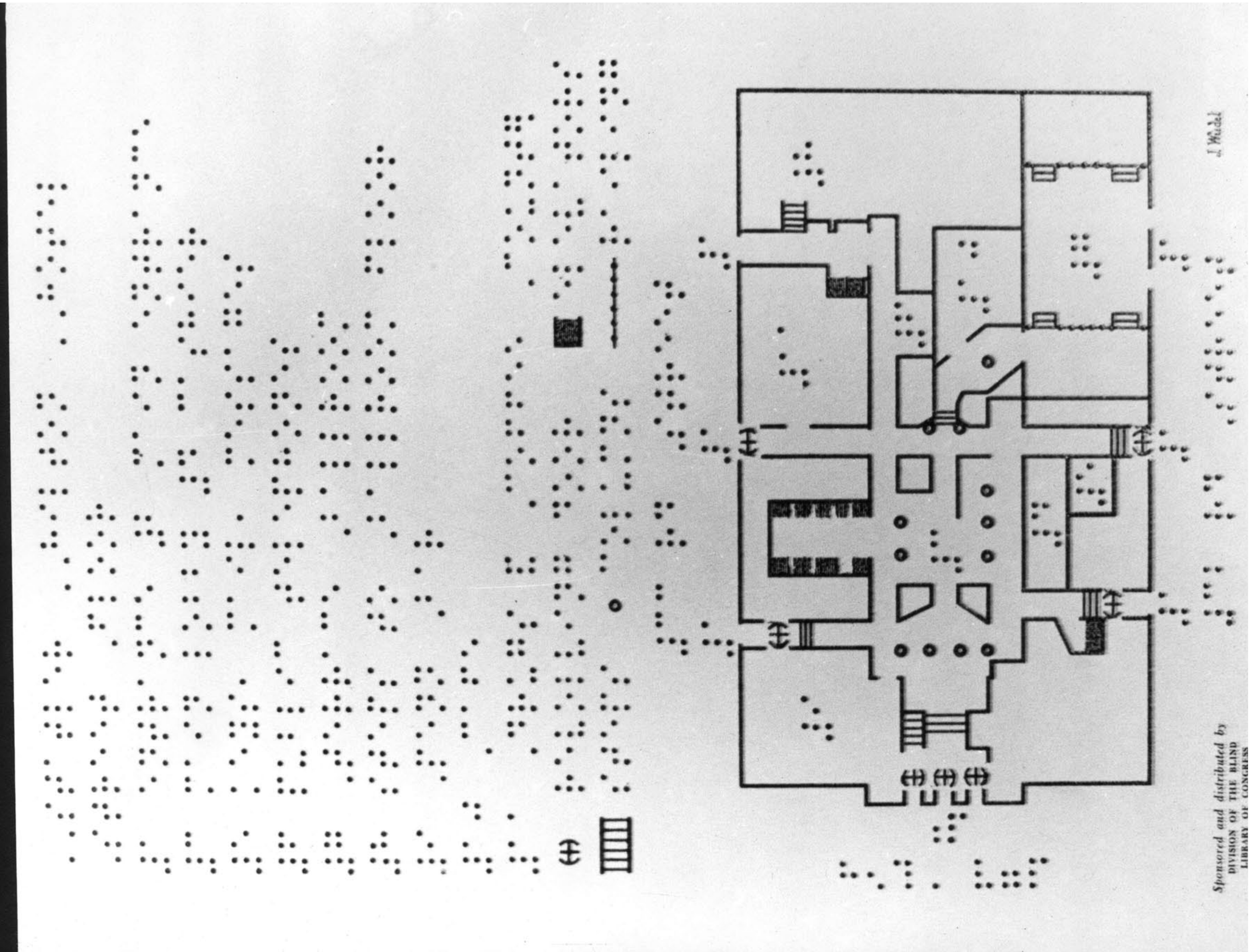

Sponsored and distributed by
DIVISION OF THE BLIND
LIBRARY OF CONGRESS

FIG 6

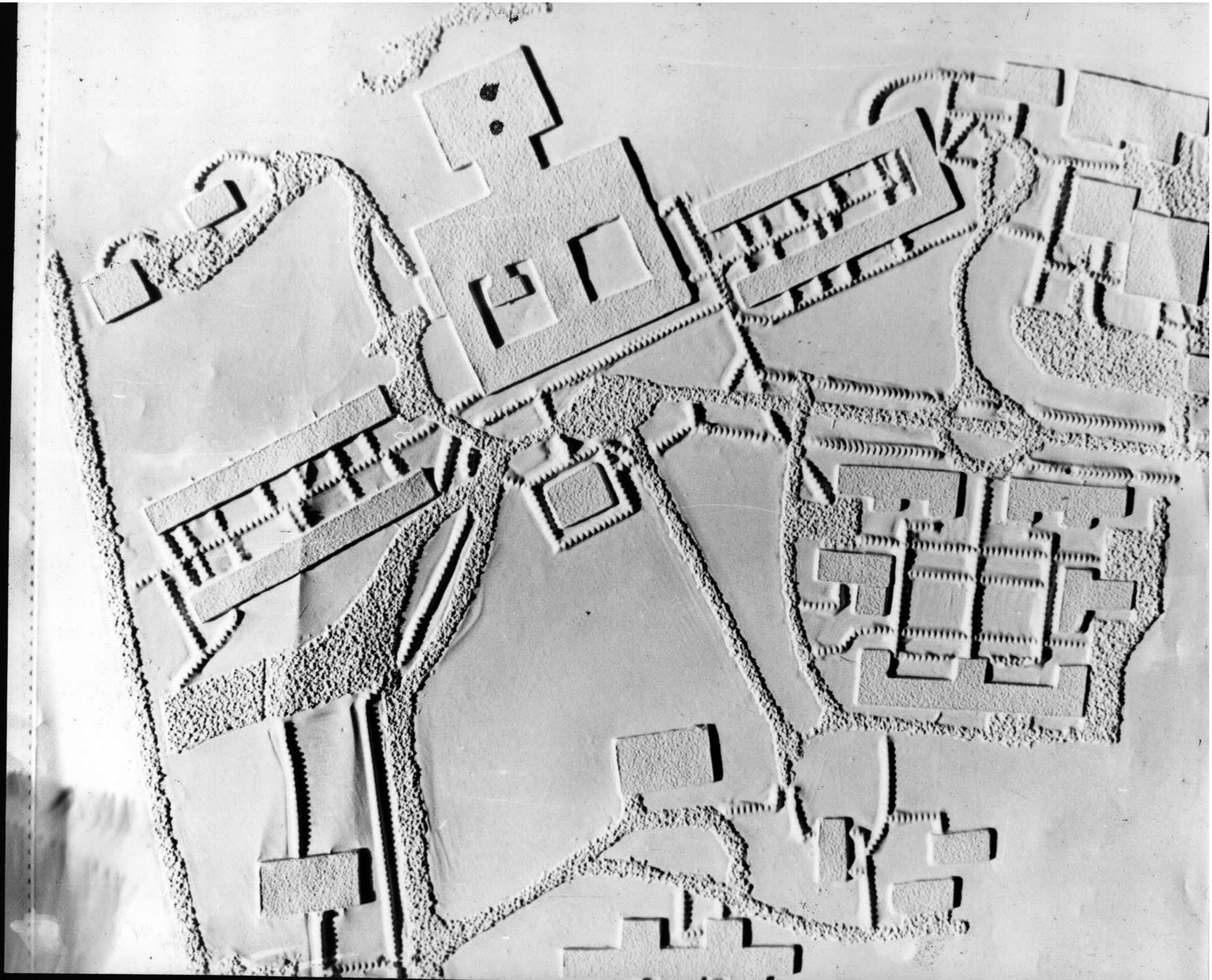
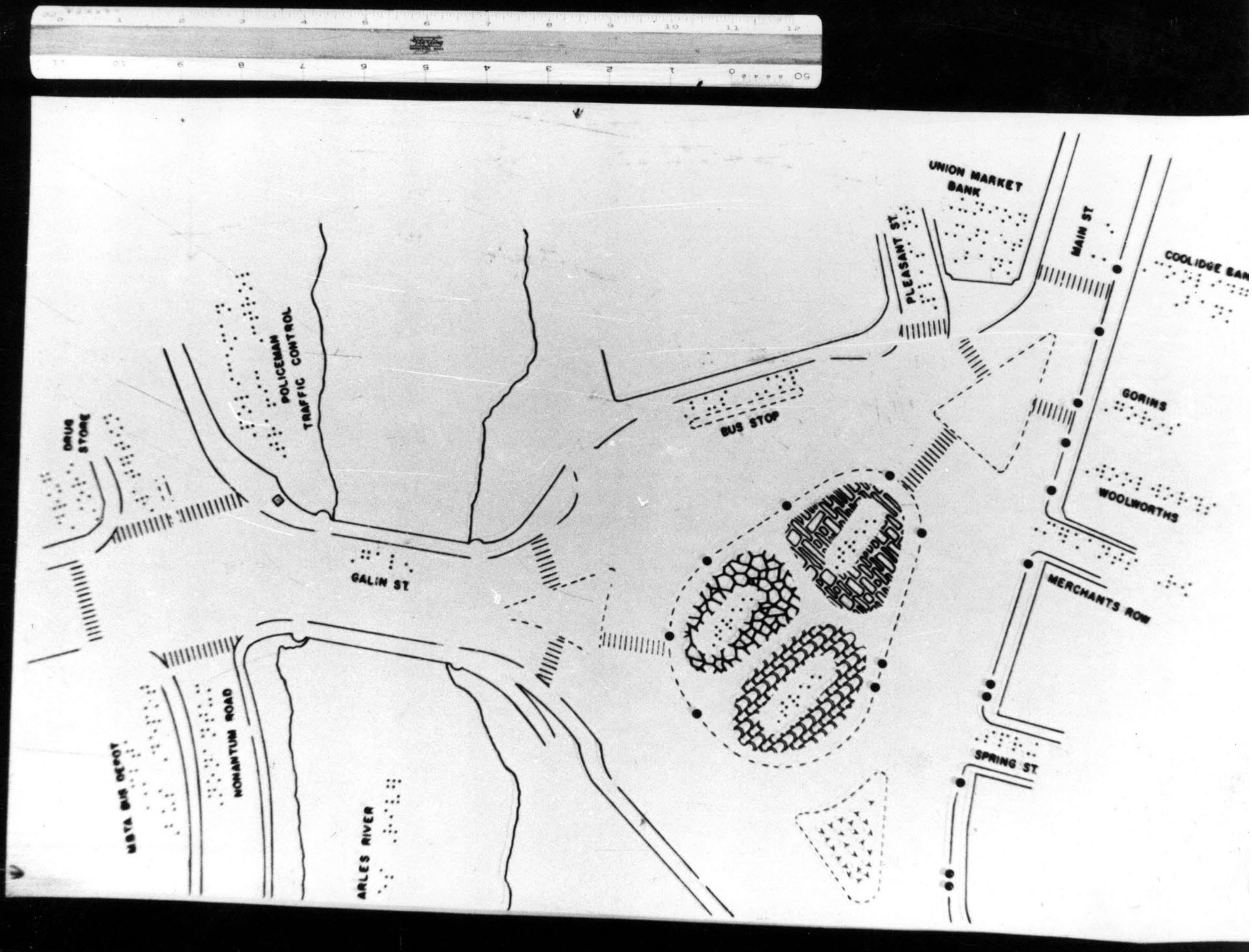


FIG 7



UNION MARKET BANK
PLEASANT ST.
MAIN ST
COOLIDGE BAN
POLICEMAN TRAFFIC CONTROL
DRUG STORE
BUS STOP
GORINS
WOOLWORTHS
GALIN ST.
MERCHANTS ROW
SPRING ST.
MBTA BUS DEPOT
NONANTUM ROAD
ARLES RIVER

FIG 8

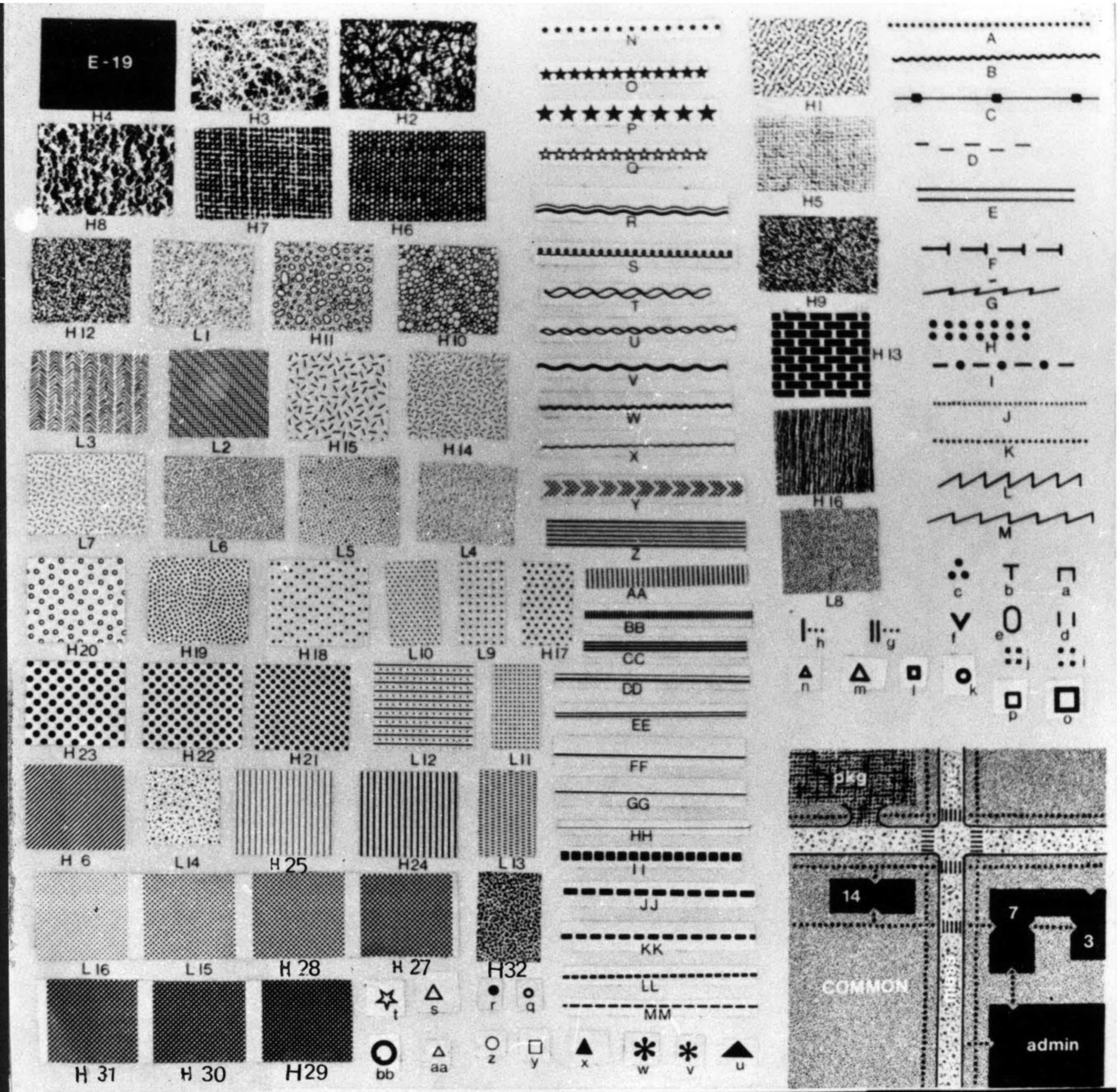

E-19
H4
H3
H2
H8
H7
H6
H12
L1
H11
H10
L3
L2
H15
H14
L7
L6
L5
L4
H20
H19
H18
L10
L9
H17
H23
H22
H21
L12
L11
H 6
L14
H25
H24
L13
L16
L15
H 28
H 27
H32
H 31
H 30
H29
N
O
P
Q
R
S
T
U
V
W
X
Y
Z
AA
BB
CC
DD
EE
FF
GG
HH
II
JJ
KK
LL
MM
H1
H5
H9
H13
H16
L8
A
B
C
D
E
F
G
H
I
J
K
L
M
pkg
14
7
3
COMMON
admin

FIG 9

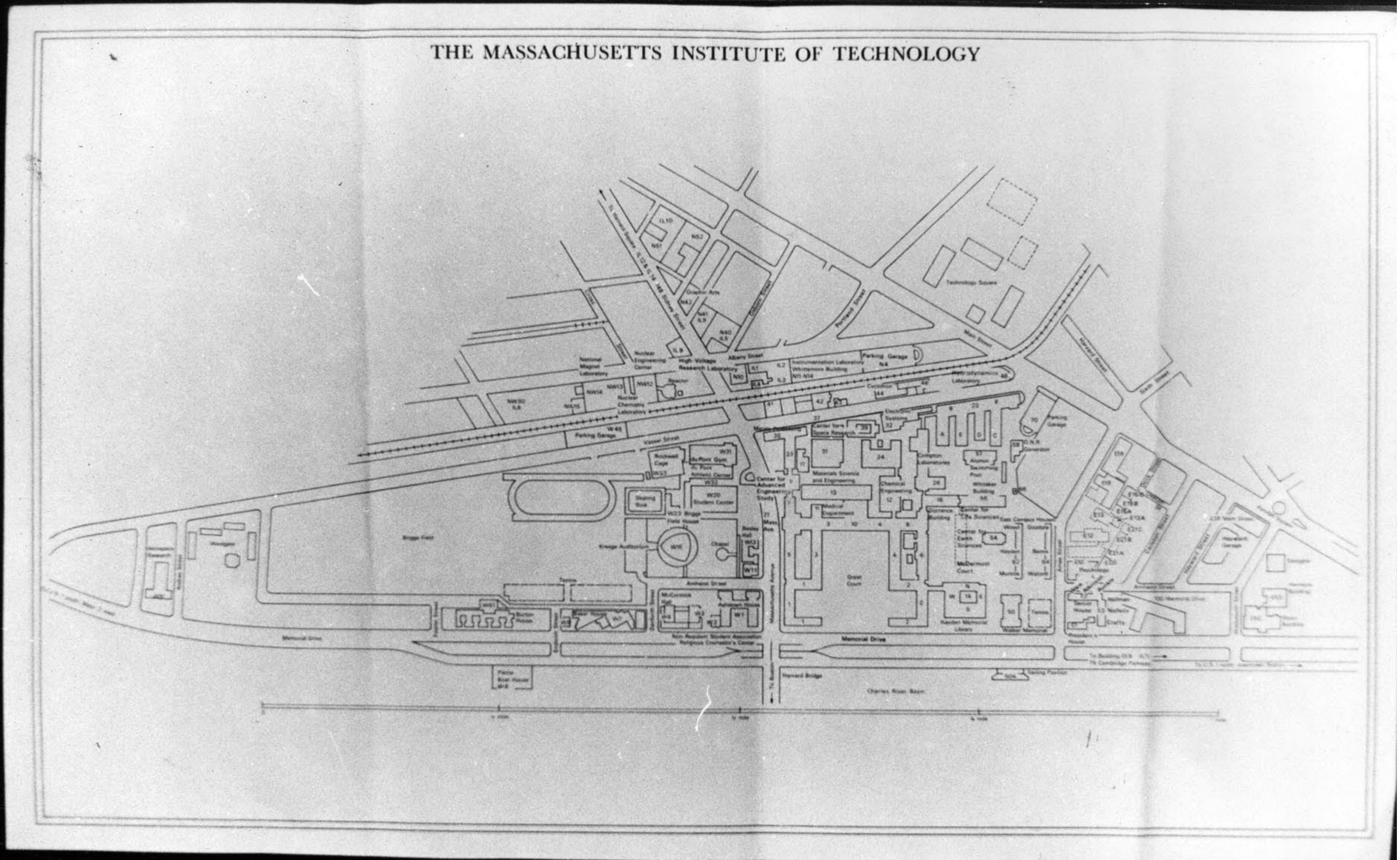


FIG 10

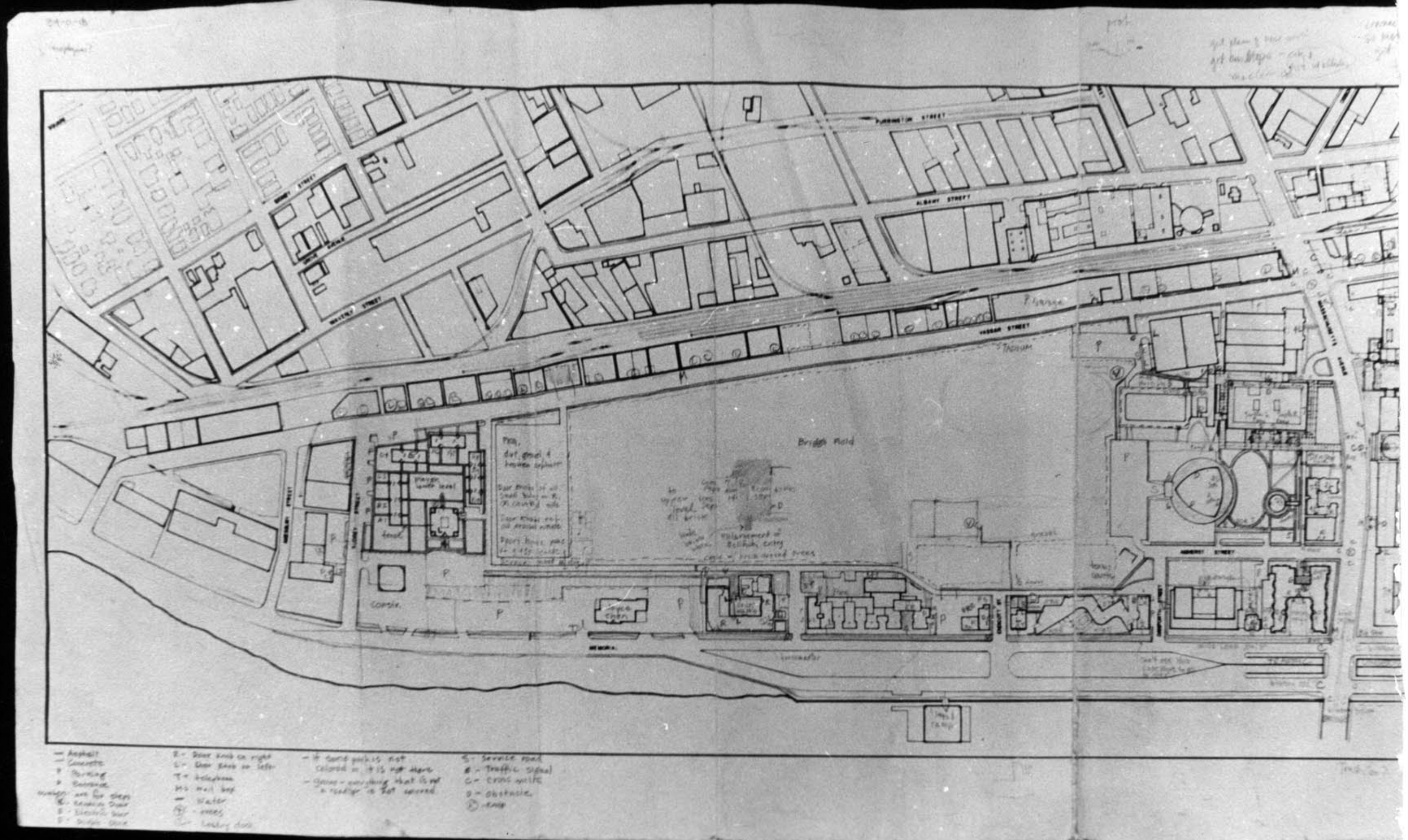


FIG II

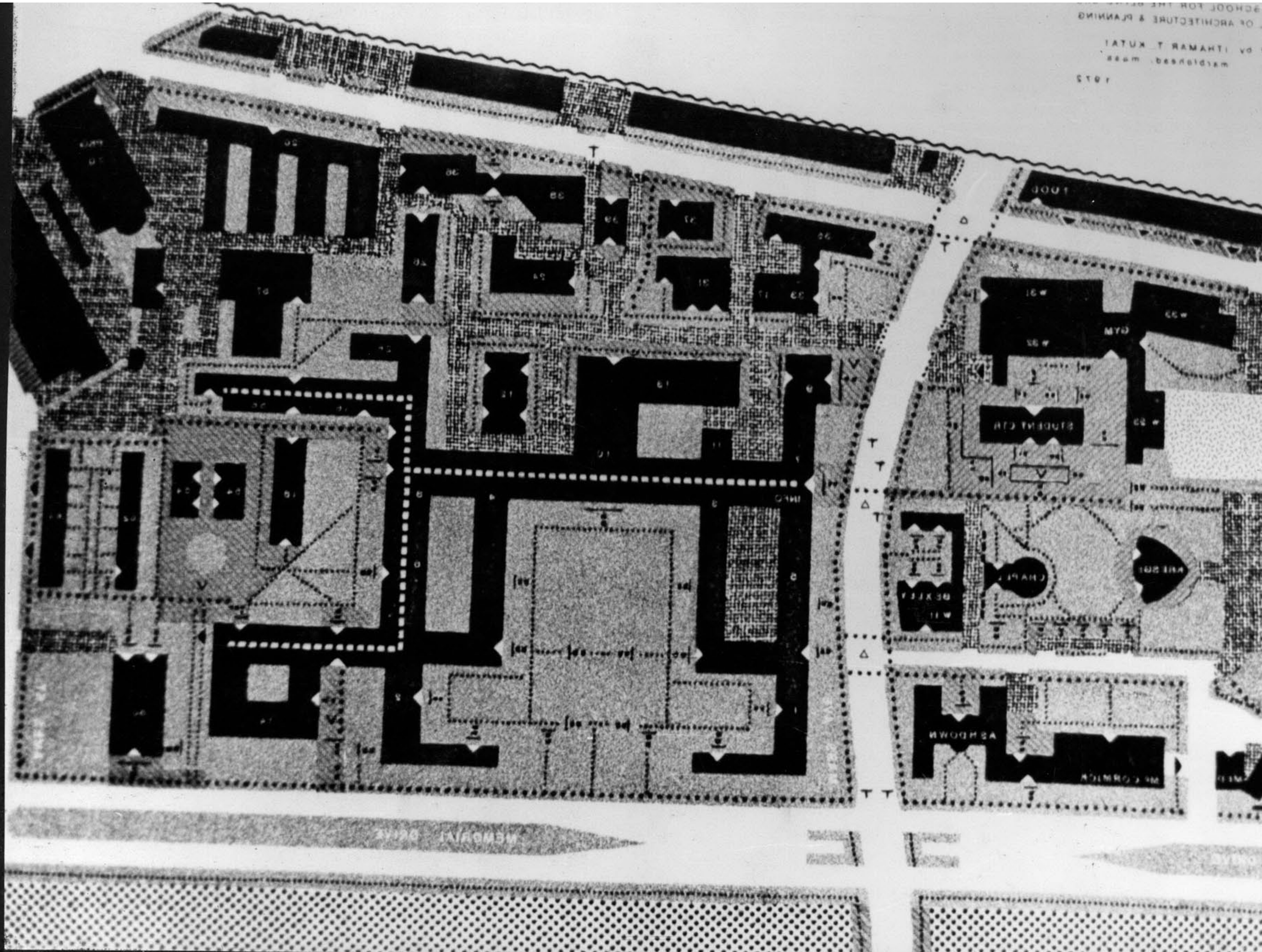
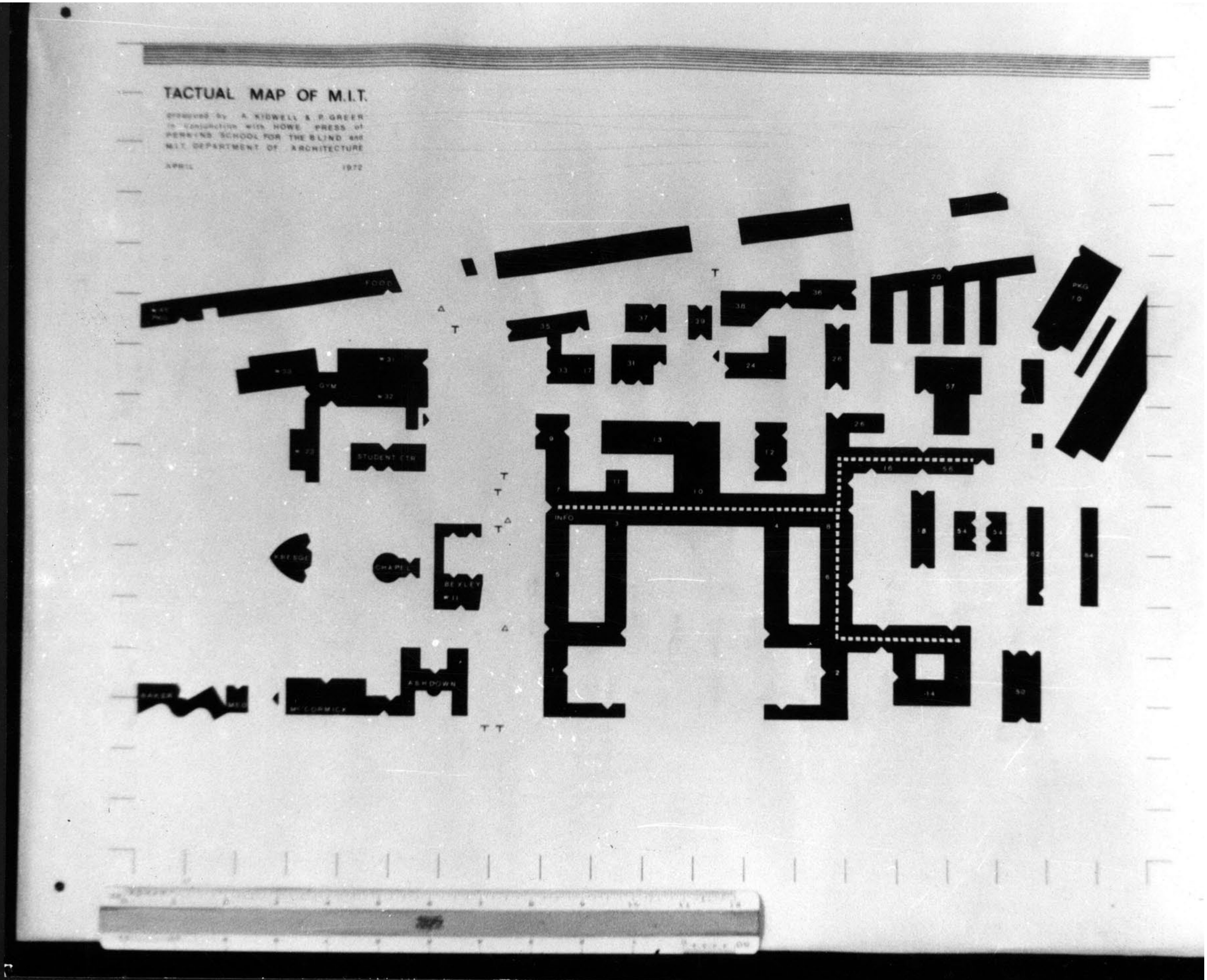


FIG 12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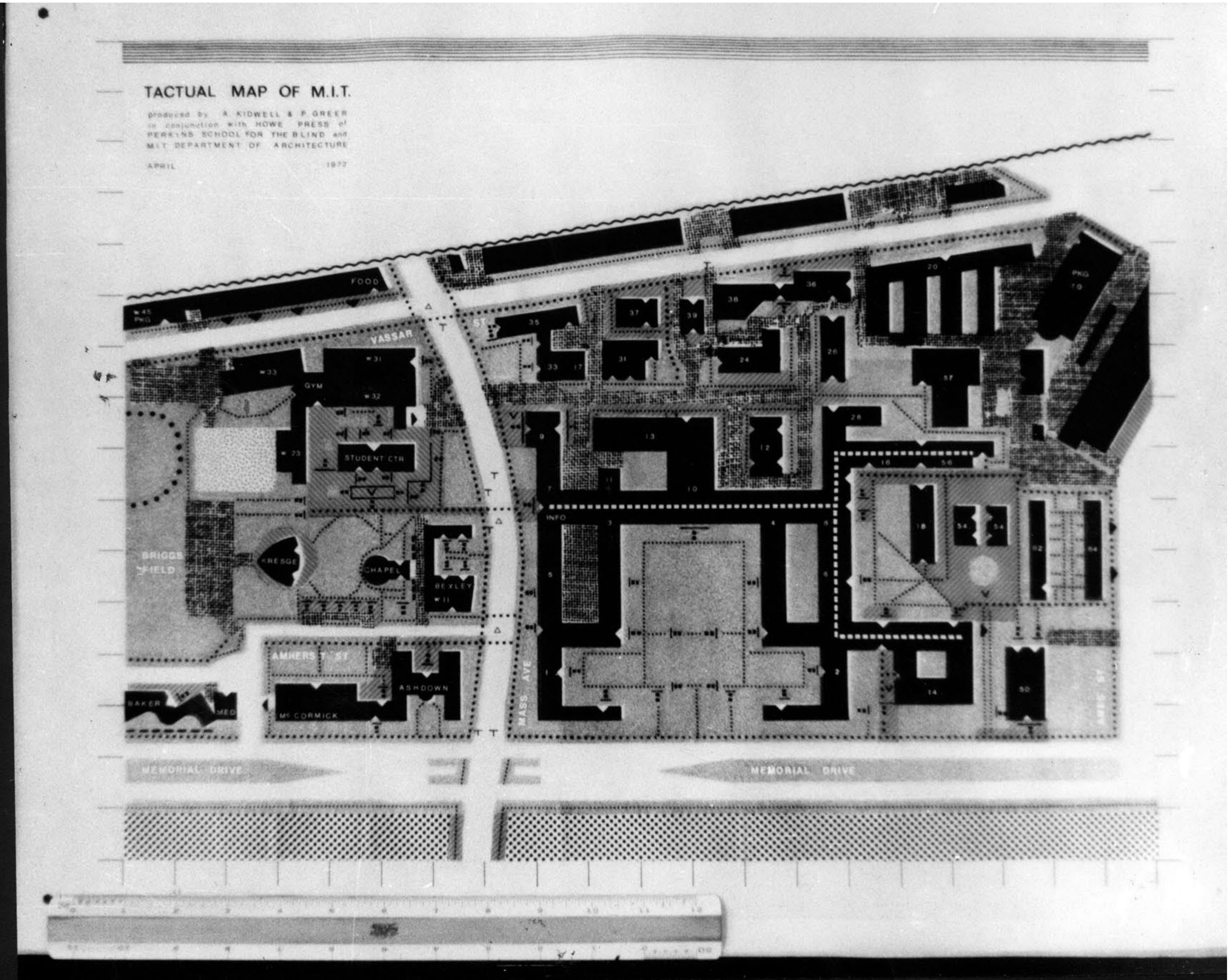
produced by A. KIDWELL & P. GREER
in conjunction with HOWE PRESS of
PERKINS SCHOOL FOR THE BLIND and
M.I.T. DEPARTMENT OF ARCHITECTURE
APRIL 1972
FOOD
GYM
STUDENT CTR
KRESGE
CHAPEL
BEXLEY
BAKER
McCORMICK
ASHDOWN
INFO

FIG 13-a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PERKINS SCHOOL FOR THE BLIND and
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APRIL 1977
FOOD
VASSAR ST
STUDENT CTR
GYM
KRESGE
CHAPEL
BEXLEY
BRIGGS FIELD
AMHERST ST
ASHDOWN
McCORMICK
BAKER
MASS AVE
INFO
MEMORIAL DRIVE
MEMORIAL DRIVE

FIG 13·b

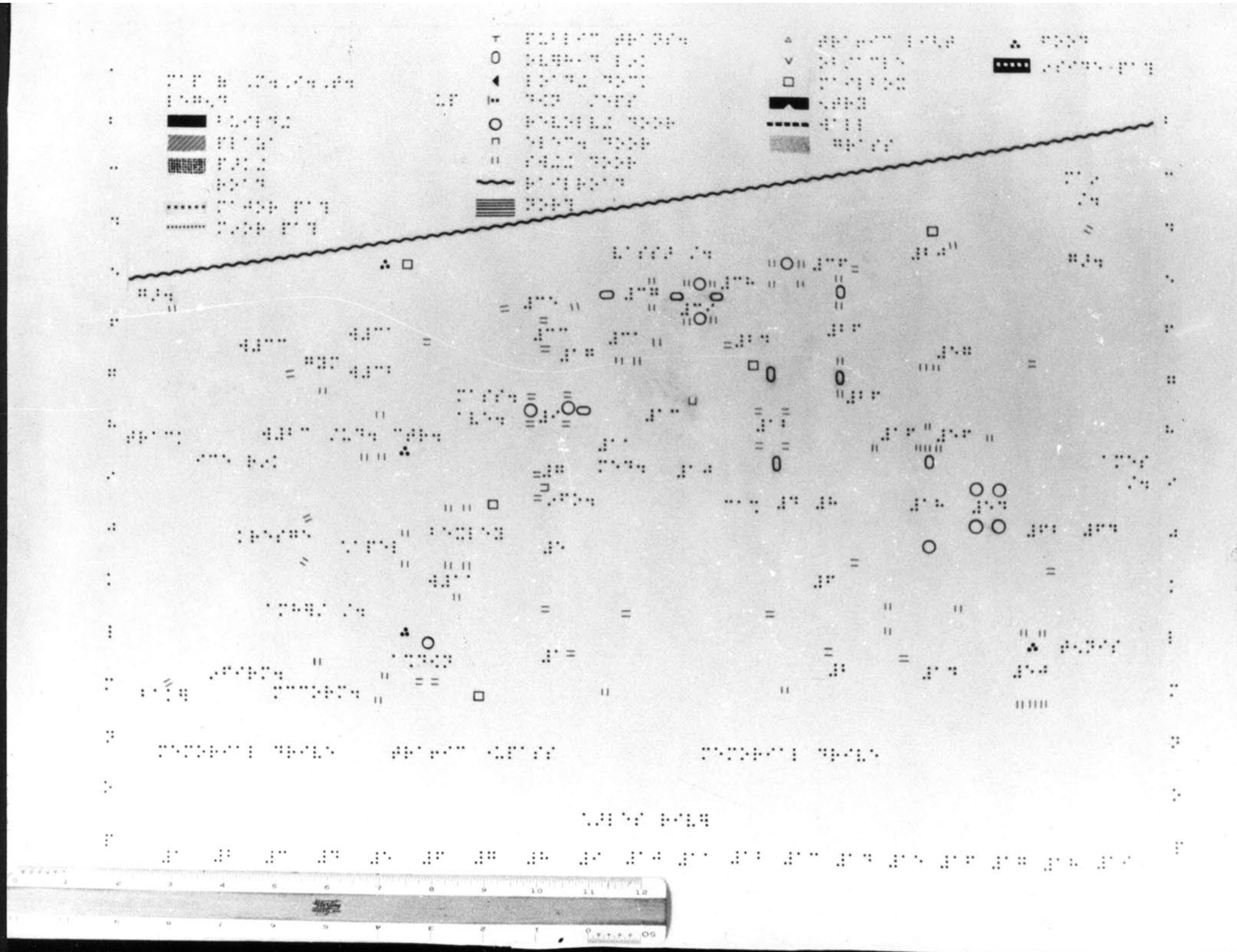

FIG 14

FIG 15

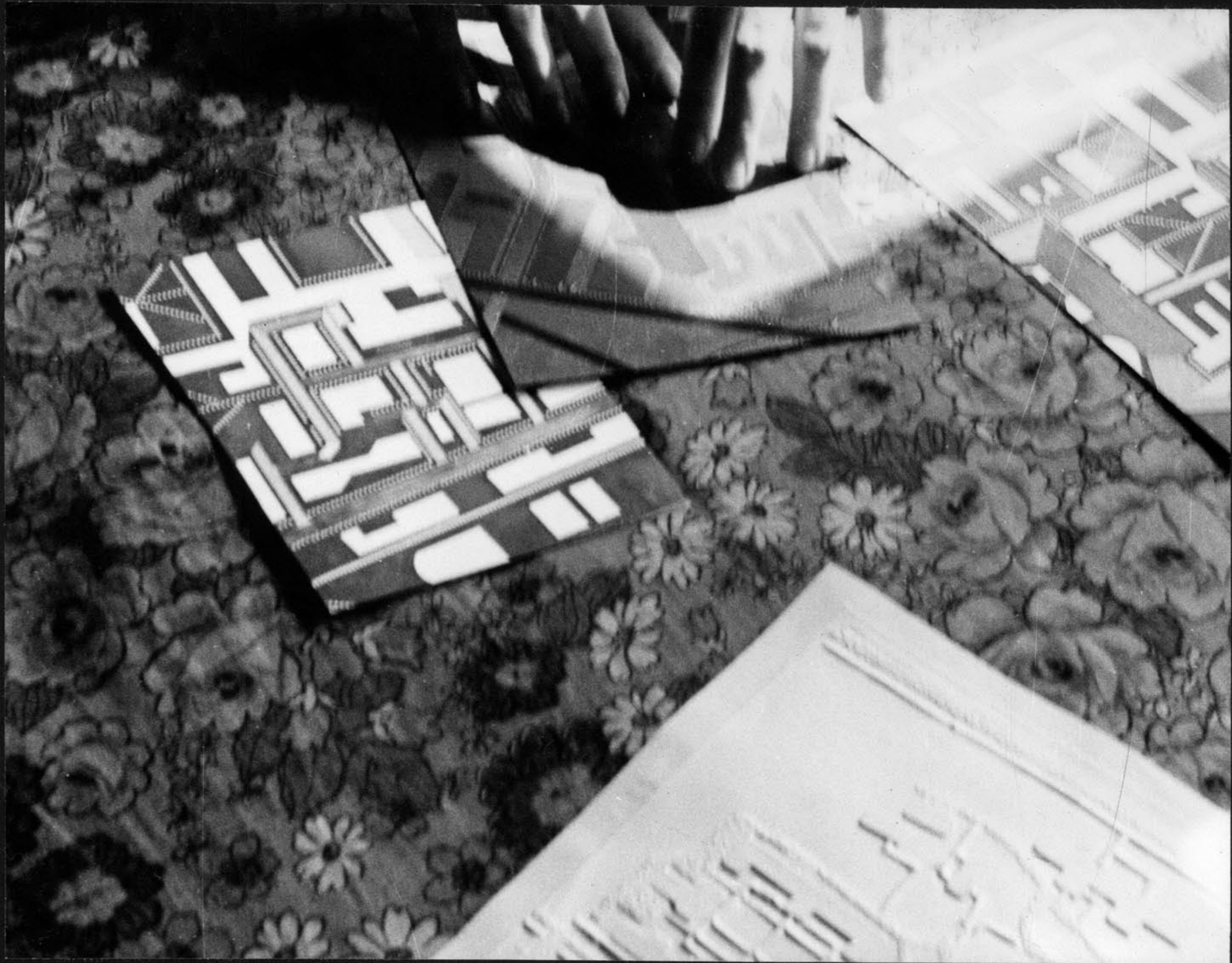

FIG 16

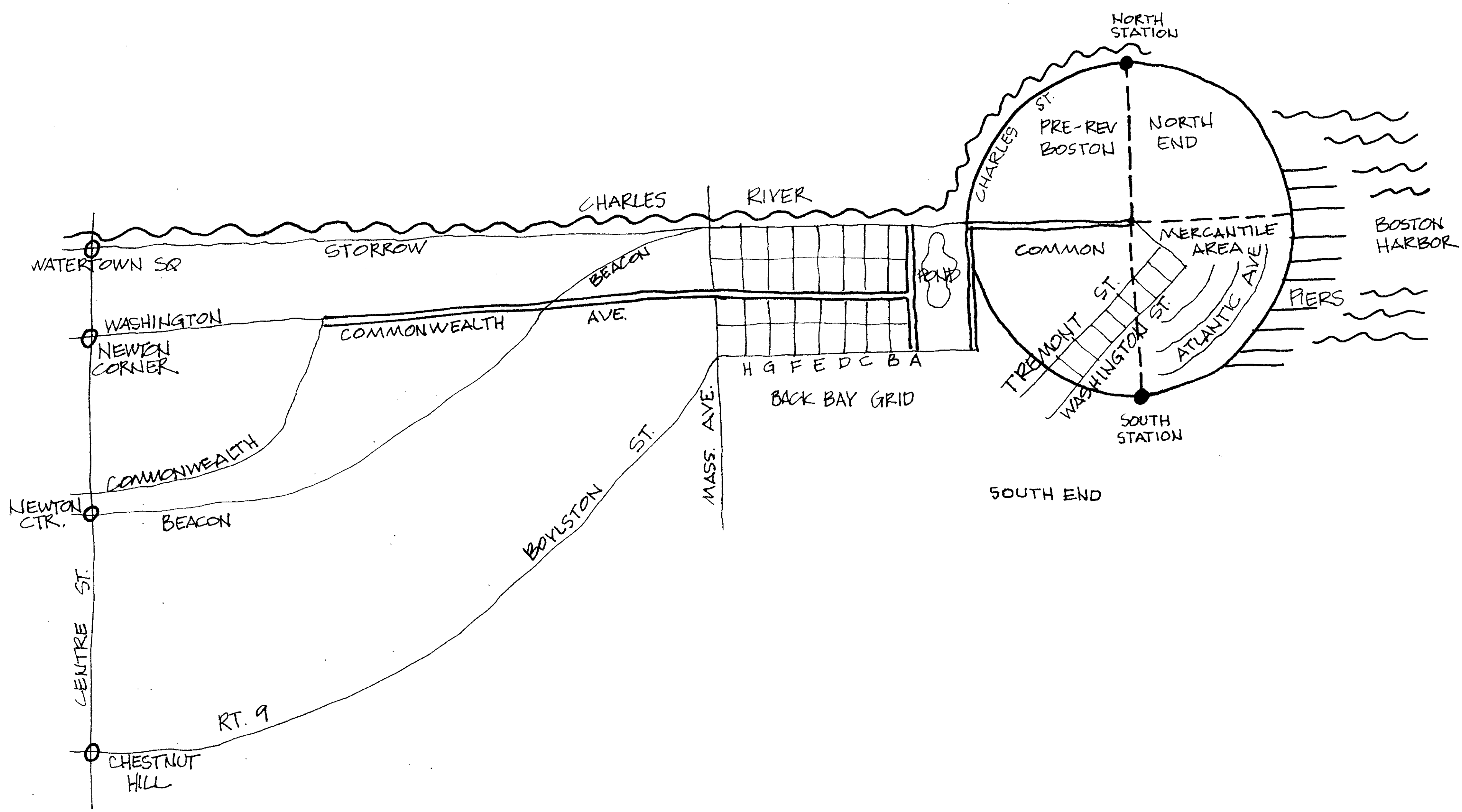
NORTH STATION
CHARLES ST.
PRE-REV BOSTON
NORTH END
CHARLES
RIVER
BOSTON HARBOR
WATERTOWN SQ
STORROW
BEACON
COMMON
MERCANTILE AREA
POND
WASHINGTON
NEWTON CORNER
COMMONWEALTH
AVE.
TREMONT ST.
WASHINGTON ST.
ATLANTIC AVE
PIERS
H G F E D C B A
BACK BAY GRID
SOUTH STATION
MASS. AVE.
BOYLSTON ST.
COMMONWEALTH
NEWTON CTR.
BEACON
SOUTH END
CENTRE ST.
RT. 9
CHESTNUT HILL

FIG 17