Preliminary Evaluation of the Bionic Instruments: Veterans Administration C-4 Laser Cane: A Final Report (1973)

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The members of the committee selected to undertake this project and prepare this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. Responsibility for the detailed aspects of this report rests with that committee.

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A PRELIMINARY EVALUATION OF

THE BIONIC INSTRUMENTS - VETERANS ADMINISTRATION

C-4 LASER CANE

A final report prepared by the Advisory Panel for the Evaluation of the Laser Cane, formed by the Subcommittee on Sensory Aids of the Committee on Prosthetics Research and Development, Division of Medical Sciences, National Research Council, National Academy of Sciences

September 1973

PREFACE

This report describes a preliminary evaluation study performed on the C-4 laser typhlocane designed and manufactured by Bionics Instruments, Inc., with funds provided by the Veterans Administration (V.A.). The study project was planned and executed by a multidisciplinary panel formed under the auspices of the Subcommittee on Sensory Aids, Committee on Prosthetics Research and Development (CPRD), National Academy of Sciences-National Research Council (NAS-NRC). Of the panel's seven original members four were drawn from the Orientation and Mobility (O&M) research staffs of two Veterans Administration Hospitals and three were members of CPRD or its Subcommittee on Sensory Aids. Two additional consultants joined the panel about halfway through the study.

The C-4 laser cane utilizes three gallium arsenide pulsed lasers, associated photocells and electronic components which provide three optical triangulation-ranging systems. One ranging system is responsible for detecting obstacles ahead of the man and is intended to permit relaxed walking without fear of collision. This sensor, referred to as the "forward channel," has a switch enabling the user to select a detection range of about either four feet or 12 to 14 feet. Any obstacle detected within the selected range will actuate a vibrating stimulator that contacts the index finger when the cane is carried in the usual "long cane" manner. A second system, the upper channel, points upward to detect overhanging branches, signs, casement windows and other above-the-waist hazards which appear from 18 to 24 inches in front of the cane tip. The third system projects downward, ahead of the cane tip to provide assurance of an extended level walking surface.

All three receivers (upper, forward and lower) operate a sound-emitting warning device which generates tones of different frequency; a low tone for the lower channel and a high tone for the upper channel. The audible warning for the forward channel may be switched off if so desired leaving only the tactile warning.

Mechanically, the laser cane is very similar to the conventional long cane, being as long although a little heavier. The laser cane is intended to perform all the functions of the long cane and, in addition, provide early warnings of obstacles through the agency of its added electronic components.

In an effort to avoid any misunderstanding about the objectives of this evaluation it should be made clear at the outset that the study makes no claim to comprehensiveness. It was not the intent of the project to determine the utility of the laser cane to the blind veteran population at large. The extremely small scale of the evaluation should clearly indicate that any inferences from our data relating to a general population may be invalid.

When the project began, there were only ten models of the C-4 laser cane available. The panel was therefore constrained to focus its investigation on only the most important questions which had emerged during the laser cane's development. These questions, posed by the staff of the Veterans Administration

and the developer, sought information about the value of the device to people who were equipped to take full advantage of its features, and other similar facts which might materially affect the direction that the development contract could take in the immediate future. Hence, in its scope, the study was concerned primarily with the technical performance of the laser cane as a device, the effect it had on the mobility of selected blind travelers, and their opinions as to the usefulness of the instrument.

The active phase of the evaluation plan took place during the 16 months from August 1971 to November 1972. The project used eight blind veterans who volunteered for a five-week course of training at a Veteran Administration Hospital. Following the training period, each volunteer returned to his own home with a laser cane and was subjected to a schedule of periodic questioning on the extent of his use of the laser cane and on his impressions of its performance and utility. In addition, after each man had acquired many months of experience with the device, he was observed as he negotiated a familiar and an unfamiliar route using the laser cane and the conventional long cane. The performance achieved with the long cane was taken as each man's norm against which his corresponding performance with the laser cane could be compared.

Two basic sources of data were utilized: objective behavioral measurements and subjective assessments. The latter were offered by the eight veterans, by the O&M researchers who assessed the volunteers' travel skills, and by independent groups of O&M specialists who, upon examining videotape recordings of the volunteers negotiating the familiar and unfamiliar routes, rated each of the performances.

There is a well-known maxim concerning evaluation technique which stresses the importance of gathering data in such a way that the measurements can be compared with data obtained under control conditions. Moreover, the maxim dictates that measurement procedures should be sufficiently well specified to allow their reproduction at a later date when a new or possibly improved device becomes available. In the preliminary evaluation of the C-4 laser cane special efforts were made to follow these principles. The control data were obtained from parallel observations of ordinary long-cane travel undertaken by the same eight subjects who used the laser cane. Also a considerable time was spent in documenting the measurement procedures to be used. Furthermore, with a view to the future, several technical improvements were noted at the end of the project for implementation if the procedures are used in a subsequent study. The sheer bulk of the descriptive material so collected has made necessary its separation from the main body of the report and its organization as a series of appendixes. Thus, those readers who need a ready access to the principal facts and findings will find such information in the main text. Those who may wish to learn more about the procedural details will find these data in the appropriate appendixes.

It should be noted that this study was not the first to have been carried out on the laser cane, although it was probably the largest. Prior studies

have been made by the Cincinnati Association for the Blind, teams at the Veterans Administration Hospitals at Hines and at Palo Alto, The Missouri School for the Blind, The Seeing Eye Inc., and Western Michigan University. Each institution based its conclusions on one cane. In cases where the procedures used have been similar, the results of these studies are generally in good agreement with the data reported here. In a number of other areas, however, where new methods or resources have been used which were unavailable to other workers, additional important data have been collected which will serve to give the most comprehensive account of the status of the laser cane available at the present time.

Patrick W. Nye
Panel Chairman
September 1973

ACKNOWLEDGMENTS

As with many projects of its kind, the evaluation program did not always proceed smoothly according to plan. However, it is a pleasure to note that when the panel members planned their occasional meetings at V.A. facilities events proceeded smoothly largely because the members could always rely on the availability of excellent facilities. For the hospitality, helpful consideration and full cooperation extended to us by Mr. Eugene Apple, Chief of the Western Blind Rehabilitation Center at Palo Alto, and Mr. John Malamazian, Chief of Central Rehabilitation Section for Visually Impaired and Blinded Veterans at Hines, the panel members wish to express their warm appreciation. Additional thanks are due to Mr. Howard Freiberger of the V.A. Prosthetic and Sensory Aids Service and to Mr. Malvern Benjamin of Bionic Instruments, both of whom provided valuable advice and information at various times throughout the program.

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Chapter 1.

PROJECT DESCRIPTION

INTRODUCTION

Although the adoption of basic principles of evaluation procedure should provide a common bond among all evaluation studies, in practice, each individual study conducted on the same device often emerges with its own special character and identity. This situation arises largely from the fact that the questions which are posed are seldom exactly the same and the study reported here is unlikely to be an exception. It is therefore appropriate to begin with an explicit statement, not only of the objectives of our study but also of the underlying philosophy.

OBJECTIVES

The broad objective of the study was to provide data concerning the technical performance of the laser cane, the extent to which the device enhanced the travel skills of good long-cane travelers and the value judgments that blind travelers made about the laser cane. It was also the intention that these data might assist in arriving at a decision as to whether the laser cane should be manufactured (to the design existing in 1971) in sufficient quantity to permit a full field evaluation, whether the design should be researched and refined still further, or whether the laser cane in anything like its 1971 design should be abandoned as inadequate. In formulating its evaluation plan the panel concluded that the issue could be resolved if as complete a set of answers as possible could be obtained to the following questions:

a) Relative to the conventional long cane, does the laser cane enable a subject to travel more effectively and/or more safely?

b) What kinds of information about the environment do the laser components of the cane provide?

c) Does the traveler value this information and, if so, how highly?

d) Should the information obtained by the laser-system be displayed in a different manner to increase user efficiency?

e) How should the training program be improved?

f) Does the availability of the laser cane increase the travel frequency of the user?

g) Is the laser cane technically reliable?

DESIGN PHILOSOPHY

Characteristically, in the evolution of the plan, consideration had to be given to such matters as cost and the availability of time and manpower. These problems, essentially imposed by practical constraints, sometimes forced the panel to decisions which led to perplexing difficulties. Most prominent among these was the decision to divide the work between the Palo Alto and Hines Hospitals. Also, in several other cases, owing to the absence of any pressing arguments favoring one side or the other, arbitrary decisions were made, not all of which were without unforeseen repercussions. The details of these problems as well as the project's accomplishments are fully discussed in this report. At this point, however, we propose to discuss four of the more important decisions that exemplify the underlying philosophy of our approach.

One of these decisions was to rely more on the informed opinion and judgment of trained mobility instructors than on objective physical measurement. To reduce the influence of observer bias, however, it was especially important to gather data from a large number of experts. The use of video-recording techniques as an aid in the analysis of different mobility performances by trained mobility instructors thus became an important part of our research plan.* Actually, at the outset it was not known whether recordings of sufficient quality could be obtained. In preliminary experimentation a substantial amount of time had to be spent in assembling suitable equipment and in developing methods of mobile recording which were adapted to a downtown urban environment.

Another decision revolved on the relationship of the laser mechanism to the long cane and the possible need to modify the so-called "long cane technique" to take advantage of the lasers. The question was, therefore, should the laser cane be regarded as being a long cane to which the laser system is attached or should it be treated as an entirely new composite instrument which might require an entirely new set of rules for its use? The panel decided that it should take what appeared to be the developer's view--that the device is primarily a long cane. Given this position an important immediate conclusion became apparent, namely, that in order to observe the full benefit provided by the laser system each of the experimental trainees must already possess good long-cane skills. This prerequisite was necessary as evidence

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*The analysis of a blind traveler's performance in terms of his ability to perform a number of discrete "critical tasks" was pioneered by J. A. Leonard[1] who, before his death, had also employed videotape recording to increase the number and reliability of sampled judgments. In the laser cane study these procedures, which are still in the developmental stage, saw more extensive and systematic usage than had been previously undertaken in this field. A detailed account of the methods used is given in Appendix 3.

that the trainees could absorb nonvisual (i.e., auditory and tactile) information and use it to control motor performance, and equally important that, having previously demonstrated mastery of the long cane, each man was more likely than a novice to be in a position to devote his attention to new sources of information.

A third decision concerned the personality and motivation of the subjects who were to be selected. To ensure that the scant amount of training time available would be used to maximum efficiency, it was decided that only highly motivated people would be invited to volunteer. Such men were easy to find because the V.A. hospitals maintain files on all blinded veterans with their training histories on record. However, any serious attempt to investigate the important relationship between psychological measures and mobility performance could not be made because of the small number of trainees and their greater-than-average mobility.

SUBJECT SELECTION

With the intent of stimulating motivation, a fourth decision made by the panel was to guarantee that each trainee could retain a laser cane for as long as he felt that it was of use to him. Morale, in fact, was high throughout the entire program, and at the time that this report was prepared (September 1973) only one trainee* had surrendered his laser cane. He did this several months after completion of the evaluation program on the grounds that he felt that he was not making sufficient use of it.

From the foregoing discussion it may be apparent that underlying many of the decisions was a deliberate effort to avoid introducing any conditions which might be construed as representing a bias against the laser cane. Thus, on the basis of these decisions, a set of trainee qualifications was drawn up as follows:

1. A male veteran who has received his O&M training at a V. A. Center and graduated in an above average category.

2. No useful form vision.

3. Good health and good hearing.

4. Right handedness.

5. Good motivation and the need and desire to travel frequently.

6. Willingness to spend an entire month at a V. A. Center while receiving training and to cooperate in the follow-up program.

7. Residence in the vicinity of one or the other of the two participating V. A. Centers.

* Subject P3 returned his cane in the Spring of 1973.

The selection of the eight volunteers (subjects P1, P2, P3 and P4 at Palo Alto and Subjects H1, H2, H3 and H4 at Hines) proved to be difficult, primarily because most of the veterans having the high qualifications demanded from potential trainees were already employed or fully occupied and unable to devote an entire month to the training program. To meet the required quota, the area of search was increased and eight men were eventually found who either fully met or very closely approached the initial criteria. During the course of the program, however, subject H2 recovered some useful form vision and the health of subject P3 deteriorated and may have interfered with his video-recorded trials over familiar and unfamiliar routes. Table 1 provides background information on the eight subjects extracted from V. A. records. The names and addresses have been withheld.

TABLE 1

BACKGROUND INFORMATION ON C-4 LASER CANE SUBJECTS

Subject H1

BIRTH DATE:	March 11, 1950
HEIGHT & WEIGHT:	5' 11", 170 lbs
DATE ADMITTED TO BRS FOR O/M REHAB TRNG.	September 26, 1970
DATE DISCHARGED:	March 4, 1971
DIAGNOSIS:	Multiple lacerations and injuries of face, eyes, shoulder and hands, sustained in combat in South Viet Nam. Both eyes enucleated. Subject has two plastic eyes.
ONSET OF BLINDNESS:	Subject injured April 20, 1970, by booby trap hanging from a tree which struck him in the head while he was riding in a military vehicle, resulting in blindness and the enucleation of both eyes.
HEALTH:	Subject in very good health.
MARITAL STATUS:	Married but no children.
EDUCATION:	Four years of high school but did not get a diploma. Completed GED Tests at the Rehabilitation Center and got Certificate (GED High School Equivalency Diploma).
MILITARY:	Army. Attained rank of Sp-4.
RESIDENCY:	Large metropolitan city in the midwest.
ADDITIONAL INFORMATION:	
1. Travel Habits	Subject travels to and from work using public transportation. The trip involves using buses and subway trains.
2. Changes in Background	Subject took course and qualified as a dark-room technician. A son was born to subject and his wife. He is presently employed as a dark-room technician in a hospital in the same metropolitan area in which he lives.
3. Psychological Test Result	WAIS IQ Average

TABLE 1 (cont'd)

BACKGROUND INFORMATION ON C-4 LASER CANE SUBJECTS

Subject H2

BIRTH DATE:	February 19, 1949
HEIGHT & WEIGHT	6' 1 1/2", 175 lbs.
DATE ADMITTED TO BRS FOR O/M REHAB TRNG:	November 6, 1970
DATE DISCHARGED:	April 28, 1971
DIAGNOSIS:	1. Penetrating and lacerating injuries of face and trunk as a result of combat duty in South Viet Nam. 2. Loss of vision, right eye, eye phthisical, light perception, left eye due to #1, resulting in blindness. Has a prosthetic right eye. 3. Partial arthrodesis and deformity of right little finger, status post-op.
ONSET OF BLINDNESS:	Subject was injured as the result of a mine explosion in South Viet Nam on September 16, 1970.
HEALTH:	Subject in good health.
MARITAL STATUS:	Single.
EDUCATION:	Completed the 10th grade but during his stay at the Rehabilitation Center, subject completed his GED Tests and got his GED High School Equivalency Diploma. He is now attending college.
OCCUPATION:	Musician. Played sax in a band for about eight years.
MILITARY:	Army. Inducted September 4, 1968, and discharged December 16, 1970. Attained rank of Sgt. E-5.
RESIDENCY:	Large metropolitan area in the midwest.

ADDITIONAL INFORMATION:

1. Travel Habits	Subject uses public transportation to go to college classes.
2. Changes in Background	Subject underwent surgical procedures which resulted in the restoration of some useful residual vision. He married in 1972. Subject and wife moved from an apartment and bought a trailer in a more rural area. However, he still lives in same general metropolitan area. His wife is pregnant and the baby will arrive in early 1973.
3. Psychological Test Result	WAIS IQ Bright normal.

TABLE 1 (cont'd)

BACKGROUND INFORMATION ON C-4 LASER CANE SUBJECTS

Subject H3

BIRTH DATE:	December 11, 1941
HEIGHT & WEIGHT:	5' 11 3/4", 195 lbs.
DATE ADMITTED TO BRS FOR O/M REHAB TRNG:	July 31, 1968
DATE DISCHARGED:	November 20, 1968
DIAGNOSIS:	Injuries of head and eye, and flesh wounds of trunk. Loss of right eye and loss of vision of left eye, resulting in bilateral blindness.
ONSET OF BLINDNESS:	Subject was injured as the result of a mine explosion in South Viet Nam on December 4, 1967.
HEALTH:	Subject in very good health.
MARITAL STATUS:	Subject is married and has two children.
EDUCATION:	Subject received a B.S. in Biological Sciences prior to entering the Service. Currently doing graduate work in the Social Sciences which involves field work.
OCCUPATION:	Worked for a protection and security firm after discharge from the Rehabilitation Center.
MILITARY:	Officer in the Marine Corps.
RESIDENCY:	Large metropolitan city in the midwest.

ADDITIONAL INFORMATION:

1. Travel Habits	Subject uses public transportation to go to college classes and to place of employment where he is doing his field work.
2. Changes in Background	Subject now working for a different agency in doing his field work.
3. Psychological Test Result	WAIS IQ Superior.

TABLE 1 (cont'd)

BACKGROUND INFORMATION ON C-4 LASER CANE SUBJECTS

Subject H4

BIRTH DATE:	February 3, 1929
HEIGHT & WEIGHT:	5' 2", 138 lbs.
DATE ADMITTED TO BRS FOR O/M REHAB TRNG.	February 9, 1952
DATE DISCHARGED:	September 11, 1952
DIAGNOSIS:	Bilateral blindness, both eyes enucleated. Subject has two plastic eyes.
ONSET OF BLINDNESS:	Subject was injured October 16, 1951, by a mortar shell in North Korea.
HEALTH:	Subject in very good health.
MARITAL STATUS:	Subject is married and has two children.
EDUCATION:	College degree in Social Work.
OCCUPATION:	Dark-room technician.
MILITARY:	Subject was a rifleman in the Army.
RESIDENCY:	Large metropolitan city in the midwest.

ADDITIONAL INFORMATION:

1. Travel Habits	Subject uses public transportation to go across town to and from work. He also does considerable traveling in going shopping with his children and taking care of his personal and business needs.
2. Changes in Background	No significant changes since subject completed the training course.
3. Psychological Test Result	WAIS IQ Bright normal

TABLE 1 (cont'd)

BACKGROUND INFORMATION ON C-4 LASER CANE SUBJECTS

Subject P1

BIRTH DATE:	July 10, 1947
HEIGHT & WEIGHT:	6' 4", 180 lbs.
DATE ADMITTED TO BRS FOR O/M REHAB TRNG:	August 8, 1968
DATE DISCHARGED:	November 13, 1968
DIAGNOSIS:	Facial and eye injuries causing total blindness.
ONSET OF BLINDNESS:	Subject's injuries caused by grenade explosion sustained in combat in South Viet Nam on February 9, 1968.
HEALTH:	Good
MARITAL STATUS:	Married
EDUCATION:	College student at the time of training and follow-up program.
OCCUPATION:	Student
MILITARY:	Army
RESIDENCY:	Small western city

ADDITIONAL INFORMATION:

1. Travel Habits	Travels daily to the campus several blocks away and around the campus to his various classes.
2. Changes in Background	Immediately following the training he transferred to another college in a different state. He got married on June 12, 1972, which was one week prior to the final home evaluation.
3. Psychological Test Results	WAIS IQ Very superior.

TABLE 1 (cont'd)

BACKGROUND INFORMATION ON C-4 LASER CANE SUBJECTS

Subject P2

BIRTH DATE	February 2, 1942.
HEIGHT & WEIGHT:	5' 6", 145 lbs.
DATE ADMITTED TO BRS FOR O/M REHAB TRNG:	June 30, 1971 Student had prior training at Hines V. A. in 1963 and had entered Western Blind Rehab. for a refresher program.
DATE DISCHARGED:	September 8, 1971
DIAGNOSIS:	Face and eye injuries.
ONSET OF BLINDNESS:	Auto accident in 1963. Subject was a passenger in a car which ran off the road.
HEALTH:	Good. Walks with a noticeable limp in his right leg; however, this did not impair his travel during lessons.
MARITAL STATUS:	Married
EDUCATION:	Two years of college
OCCUPATION:	Unemployed
MILITARY:	Air Force
RESIDENCY:	Small western city

ADDITIONAL INFORMATION:

1. Travel Habits	He lives in a residential area that is six blocks from the downtown business area and travels several times a week to the business area using either a cane or a dog guide.
2. Changes in Background	He was a student when he was trained with the laser cane and graduated in June of 1972 just prior to the final evaluation. Presently he is seeking employment.
3. Psychological Test Results	WAIS IQ Superior.

TABLE 1 (cont'd)

BACKGROUND INFORMATION ON C-4 LASER CANE SUBJECTS

Subject P3

BIRTH DATE:	June 29, 1945
HEIGHT & WEIGHT:	6' 3", 235 lbs.
DATE ADMITTED TO BRS FOR O/M REHAB TRNG:	July 26, 1971 In 1969 - Student had prior training at West Haven, V. A.
DATE DISCHARGED:	August 31, 1971
DIAGNOSIS:	Trauma
ONSET OF BLINDNESS:	Subject was injured in Spring 1968 by an explosion while engaged in combat in South Viet Nam.
HEALTH:	Good during training. Following training some recurrence of seizures secondary to brain trauma. At the final evaluation the seizures were being better controlled by tranquilizers.
MARITAL STATUS:	Married
EDUCATION:	Two years of college.
OCCUPATION:	Student
MILITARY:	Marine Corps
RESIDENCY:	East coast city

ADDITIONAL INFORMATION:

1. Travel Habits	Travels 5-6 hours a week on a college campus. Most of his travel is confined to the campus.
2. Changes in Background	Moved from Palo Alto, Cal., to East Haven, Conn., in April of 1972. Did not return to school until the Fall of 1972 and did little traveling as he did not live within traveling distance of destinations he had need of getting to.
3. Psychological Test Results	WAIS IQ Very superior.

TABLE 1 (cont'd)

BACKGROUND INFORMATION ON C-4 LASER CANE SUBJECTS

Subject P4

BIRTH DATE:	March 3, 1925
HEIGHT & WEIGHT:	5' 7", 172 lbs.
DATE ADMITTED TO BRS FOR O/M REHAB TRNG:	Prior instruction at Western Blind Rehabilitation in 1969. Prior instruction at Hines V. A. in 1950. Prior instruction at Perkins Institute in 1949.
DATE DISCHARGED:	August 30, 1972
DIAGNOSIS:	Occular damage.
ONSET OF BLINDNESS:	Subject was injured by an explosion which occurred while he was handling cargo in Port Chicago, 1944.
MARITAL STATUS:	Married
EDUCATION:	Presently enrolled in college.
OCCUPATION:	Student
MILITARY:	Navy
RESIDENCY:	Large west coast city

ADDITIONAL INFORMATION:

1. Travel Habits	Travels to college and around the campus. The trip to school involves taking three buses. Occasionally travels to a nearby hamburger stand.
2. Changes in Background	Upon completion of the laser-cane training program he moved to a new home.
3. Psychological Test Results	WAIS IQ Very superior.

Chapter 2.

PROJECT PLAN AND TIMETABLE

INTRODUCTION

The complete program consisted of two parts--the training phase, lasting for one month, and the follow-up phase which extended over a period of one year. During the training program, effort was focused primarily on the task of acquainting each student with the characteristics of the laser cane under a variety of conditions. Some performance data were also gathered at this time but the main purpose of this data-collecting activity was that of a pilot run; to allow the research staff to gain experience in human performance measurements; and to explore and improve procedures which were extensively used in the second phase of the program. Additional secondary goals were to obtain some objective data which could reflect the functioning of the laser canes, to assess the subjects' ability to learn particular tasks and to gain some insight into the appropriateness of the teaching format. A description of the training procedures and the results of the preliminary measurements are given in Appendixes 1 and 2. The contents of these appendixes indicate that the level of effort involved was not small and unimportant. Nevertheless, the data obtained at this very early stage of the project have been set aside in favor of the more important data derived from the follow-up study. Thus this latter stage constitutes the major source of data on which the conclusions of this report have been based almost exclusively.

Frequent breakdowns were among the most disruptive and irksome problems that both the subjects and the research staff had to contend with during the program. In the first four months of the follow-up phase, a total of 38 breakdowns occurred. Twenty-one failures were caused by accidental damage, 11 were due to faults in electronic components, and 6 were caused by loose wires and misalignments. The reliability of the laser canes did show some improvement during the later months of the program, however. By March 1972 the failure rate had dropped to 4 per month and by August 1972, the rate fell still further to a little less than 2 per month.

The high failure rate had repercussions beyond the obvious inconvenience of often having less than the required eight canes in service. The loss of confidence that grew from the need to return canes sometimes led subjects to suspect failures when in fact none had occurred. Thus on a few occasions, canes were returned to the manufacturer and subsequently were found to be in normal working order. These experiences, in addition to remarks made by the subjects, clearly indicated to the evaluators that a generally prevalent low level of confidence in the laser cane must inevitably have taken a toll on the mobility performances that the subjects were able to achieve.

Another factor which contributed to the air of uncertainty surrounding

the laser canes was their variability. Each cane appeared to have its idiosyncrasies. Hence, when a cane in process of repair was replaced by a spare, the subject had to spend time becoming accustomed to its special characteristics. Once again this may have detracted from the subjects' performances.

TRAINING PROGRAM

Table 2 shows the training timetable. The course began with an evaluation of each subject's long cane performance. All subjects were found to perform at levels below those that they had reached when they were originally discharged from their respective centers. However, a majority of the trainees were unaware of their errors in performing certain cane skills and had to be given a short refresher course.*

The remainder of the instruction consisted of a sequence of encounters in specially contrived laboratory environments followed by a series of journeys in residential and business settings. The laboratory training opened with a demonstration of each of the laser cane's three channels detecting hazards at head height, waist height, and foot level. These introductory lessons were followed by three formal test procedures (tests of Detection, Avoidance and Navigation, i.e., obstacle avoidance) which, although designed primarily for measurement, were found to be excellent training tools as well. Descriptions of these tests are given in Appendix 1. The journeys through normal streets were graduated in increasing difficulty and culminated in runs through crowded downtown districts. Details of representative routes are given in Appendix 2.

Instructors were aided by an FM transmitter attached to each laser cane to signal the output of the cane. They were thus able to observe the signals that the trainee was receiving as well as his response and were able to advise on whether the actions taken were appropriate.

The training program was conducted during the month of August and the first week of September 1971. At the end of that period the trainees returned to their homes and commenced a nine-month term during which frequent communication was established between them and the instructional staff.

FOLLOW-UP TIMETABLE

Table 3 shows the timetable of the follow up phase of the study in relation to the training program. The major features of the follow-up phase included repeated

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*For example, some subjects were not maintaining a correct (i.e., safe) arc width (probably because proprioceptive feedback is characteristically imprecise). Such a deterioration in performance could be offset by periodic retraining and there is good reason to believe that the rehabilitation agencies should be directing more attention to this problem.

"TIMETABLE OF INITIAL TRAINING PROGRAM" TABLE 2

LASER CANE EVALUATION

MONTH: AUGUST 1 — SEPTEMBER 3, 1971

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
[1] student arrival at blind centers	[2] orientation to center and program	[3] long cane and travel performance evaluation run one	[4] same as Tuesday run two	[5] general expl. of laser cane lab middle channel	[6] laser cane lab upper channel	[7] day off
[8] day off verbal WAIS test (psychological) given this week to students	[9] Laser Cane lab down channel	[10] lab all channels detection test	[11] lab all channels avoidance test	[12] obstacle test laser runs	[13] laser runs channel use rec.	[14] day off
[15] Starting the administration of the Rotter tests to the students	[16] laser runs	[17] laser runs	[18] laser runs	[19] laser runs channel use rec.	[20] laser runs obstacle test	[21] day off
[22] day off	[23] run one test long and laser cane (peer group rating	[24] run two test long and laser cane and subtask rating	[25] run two test long and laser cane by eval. team)	[26] extra testing time or for runs channel use rec.	[27] time spent for filming students on runs	[28] day off
[29] day off	[30] extra time (used for catch up work) or for extra runs	[31] extra time (used for catch up work) or for extra runs	[1] extra time (used for catch up work) or for extra runs	[2] group meeting and final comments	[3] student departure date	[4]

V A FORM JUN 1953 **7054** EXISTING STOCKS OF VA FORM 6-7054 FEB 1953, WILL BE USED. **PROGRAM PLANNER** 448190 *Write days of month in the brackets*

RUN A (PAT... AVE...
DAVIS AND ...

BLOCK 1
EAST

BLOCK 2
EAST

BLOCK 3
EAST

BLOCK 4
EAST

BLOCK 5
EAST

BLOCK 6
EAST

BLOCK 7
EAST

BLOCK 8
EAST

TABLE 3

"TIMETABLE OF EVALUATION PROGRAM"

PERIOD	INSTRUCTIONS TO TRAINEES
August 1 September 3	Training programs at the VA facilities at Hines, Illinois and Palo Alto, California.
CHRONOMETRIC DEVICE fitted in last week of training	
September October (1 1/2 months)	Trainees encouraged to use laser cane exclusively. Telephone contact will be made during 2nd week at home (T1)
FIRST VISIT by O&M specialists (V1) to check timer and other details	
October November (1 1/2 months)	Encourage trainees to make exclusive use of the laser cane.
TELEPHONE INTERVIEWS with trainees who provide subjective reports (T2)	
December March (4 months	Trainees are asked to use the long cane and laser cane an equal amount.
SECOND TELEPHONE INTERVIEWS (T3)	
April May (2 months)	Trainees should use the cane of their choice.
SECOND VISIT by O&M specialists (V2)	

KEY: The symbols T1, T2, T3 and V1, V2 refer to a series of telephone calls and visits made by the O&M research staff. During these contacts the volunteer laser-cane users were asked a number of prearranged questions. A summary of the answers to these questions is given in Chapter 6.

BLOCK 1
WEST

BLOCK 2
WEST

BLOCK 3
WEST

BLOCK 4
SOUTH

BLOCK 5
SOUTH

BLOCK 6
EAST

BLOCK 7
EAST

BLOCK 8
EAST

telephone interviews with each trainee and the assignment of trial runs over familiar and unfamiliar routes (6-8 blocks in length) using the laser cane and the long cane in turn. During the telephone interviews, portions of the questionnaire included as Appendix 6 were administered together with instructions on ways of apportioning time between use of the long cane and the laser cane. Each trainee made four types of runs in an order specified by the latin squares for each center shown in Table 4, and while these runs were in progress videotape recordings were made primarily from a viewpoint behind the traveler. These tapes carried a sound track on which was recorded the output signals of the laser cane, and the ambient traffic noise. In addition, a commentary on the performance of the traveler was made by an O&M trained member of the evaluation staff on a separate tape recorder. The information from the video-and audio tapes constituted the data from which the staff later compiled the "Subtask Checklist" which is shown in full in Appendix 3.

It should be noted that, owing to the numerous breakdowns experienced with the laser canes, the planned timetable shown in Table 3 could not be followed by most of the subjects. As a practical matter, the subjects were actually instructed to use their laser cane whenever it was available and this stratagem allowed each volunteer to eventually accumulate the number of hours of experience called for in the original plan.

To complete the analysis of the videotaped performances, sixteen independent O&M specialists were asked to view a selected number of tapes and to rate various aspects of the subjects' travel behavior on a seven-point scale. Each specialist viewed 4 tapes--one of each type of run, the order of the sequence being varied (see Chapter 5), and recorded his scores in response to the list of questions which made up the "Task Rating Form" (see Appendix 4 and Chapter 3).

A subsequent assessment of the efficiency of the Task Rating Form used in conjunction with video recordings was made by sampling the opinions of the 16 O&M specialists. The replies showed that, although several improvements were possible, the procedures were thought, on the whole, to provide enough information to obtain an accurate assessment of a person's mobility skill. A copy of the questionnaire and an analysis of the replies are given in Appendix 5.

As indicated in Table 3, a chronometric device was fitted to all canes at the end of the training period. This was done in an effort to gauge the amount of use each laser cane received during the follow-up program. However, contrary to usual practice, each subject was told that a timer--the Curtis elapse-time indicator--had been fitted to his cane.* The vibration specification of the Curtis timers is said to exceed 20g at 2,000 Hz and the shock

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*The subjects were given this information primarily to avoid the risk of appearing to breach the trust which, in the interests of full cooperation, was maintained between the volunteer subjects and the O&M staff through an open information policy. It should be understood in this context that many of the subjects indicated that they did not relish having their performances examined, criticized and videotaped, and several indicated that they sometimes felt self-conscious when using the laser cane in public.

BLOCK 1
NORTH

BLOCK 2
NORTH

BLOCK 3
NORTH

BLOCK 4
WEST

BLOCK 5
SOUTH

BLOCK 6
SOUTH

[illegible]

BLOCK 8
EAST

TABLE 4

ORDER OF ASSIGNMENTS FOR SUBJECTS MAKING VIDEOTAPED RUNS

SUBJECT	FIRST RUN	SECOND RUN	THIRD RUN	FOURTH RUN
H1	Laser F	Laser UNF	Long F	Long UNF
H2	Long UNF	Long F	Laser UNF	Laser F
H3	Long F	Laser F	Long UNF	Laser UNF
H4	Laser UNF	Long UNF	Laser F	Long F
P1	Laser F	Long F	Laser UNF	Long UNF
P2	Long UNF	Laser UNF	Long F	Laser F
P3	Long F	Long UNF	Laser F	Laser UNF
P4	Laser UNF	Laser F	Long UNF	Long F

KEY: F - Familiar route. UNF - Unfamiliar route.

criterion to exceed MIL-STD-202, Method 205. However, while in normal use or while in air transit for repair, many canes received shocks sufficient to break the timer filaments and hence the time-in-use information was lost. Of the remaining seemingly intact units, the readings showed such wide variation that they had to be rejected as unreliable.

Chapter 3.

GENERAL DESCRIPTION OF METHODS

INTRODUCTION

Three distinct measuring procedures were used; one employed a specially designed document termed the "Subtask Check List" while the remaining two procedures were designed to gauge some of the more subjective features associated with mobility using a laser cane. These latter methods utilized a "Task Rating Form" and a "Questionnaire."

THE SUBTASK CHECKLIST

The primary vehicle for objective measurement was the Subtask Checklist (given in Appendix 3) which endeavored to record for analysis a number of the critical events which can occur during travel. Such events included body and/or cane contacts with obstacles, stops, hesitations and orientation errors, etc. These data were tabulated from the videotape and audio recordings, on a block-by-block basis, by O&M staff members who reviewed each traveler's videotaped journey using the long cane and the laser cane. An important prerequisite to the making and interpretation of such counts was the attempt to formulate clear and concise definitions of each of the critical events. For example, a "stop" was defined as "any situation where the traveler comes to a full and complete standstill. The only exception to this will be stops at curbs or alleyways." A full list of definitions is also given in Appendix 3.

In addition to the critical event counts, the Subtask Checklist provided space for recording the total travel time, the traffic conditions (whether heavy, medium or light) and the prevailing weather.

The data which were gathered on the eight subjects has been summarized in Table 5. Run A represents a laser cane run over a route familiar to the traveler. Run B represents a journey over a familiar route using the long cane. Run C represents a laser cane journey over an unfamiliar route and Run D is a long cane run--also over an unfamiliar route. Therefore in reading Table 5 for comparisons of laser cane and long cane performances one should look at A versus B, C versus D and perhaps A and C versus B and D.

THE TASK RATING FORM

The rating procedure was based on a document termed the Task Rating Form (reproduced in Appendix 4). This document posed two classes of questions to the O&M specialists who viewed the video recordings. Class 1 questions focused on specific components of a mobility performance. For example, these questions were concerned with assessing curb detection, obstacle avoidance and other similarly discrete skills. Class 2 questions were concerned with more global features and required an assessment of the safety of a traveler's

BLOCK 1
NORTH

BLOCK 2
NORTH

BLOCK 3
NORTH

BLOCK 4
NORTH

BLOCK 5
SOUTH

BLOCK 6
SOUTH

BLOCK 7
NORTH

BLOCK 8
NORTH

TABLE 5

Subjects		CONTINUITY OF TRAVEL: Hesitations: Block	Hesitations: Street	Stops: Block	Stops: Street	ATTEMPTED CIRCUMVENTION WITHOUT CONTACT: Block: Obstacle	Block: Pedestrian	Street: Obstacle	Street: Pedestrian
1H	Run A	23	2	10	0	26	3	0	0
	" B	22	0	11	0	0	0	0	0
	" C	26	0	15	1	16	6	0	0
	" D	18	0	11	0	6	0	0	0
2H	Run A	0	0	0	0	6	1	0	0
	" B	0	0	0	3	0	0	0	0
	" C	2	0	0	0	3	1	0	0
	" D	0	0	3	1	0	0	0	0
3H	Run A	19	1	15	0	16	0	0	0
	" B	20	2	8	0	0	0	0	0
	" C	15	1	5	3	25	5	2	0
	" D	9	0	4	0	11	0	0	0
4H	Run A	19	2	14	1	26	9	0	1
	" B	11	1	4	2	6	2	0	0
	" C	24	2	23	1	18	5	0	0
	" D	23	1	13	0	1	3	0	0
1P	Run A	58	4	14	2	20	0	1	0
	" B	30	6	11	7	0	0	0	0
	" C	60	6	31	2	27	1	1	0
	" D	39	8	26	5	0	0	0	0
2P	Run A	39	4	10	1	20	1	0	0
	" B	30	4	6	6	0	0	0	0
	" C	47	4	11	2	15	2	1	0
	" D	61	4	21	3	1	0	0	0
3P	Run A	30	3	7	0	6	1	0	0
	" B	17	1	24	1	0	0	0	0
	" C	47	1	19	0	6	1	0	0
	" D	33	1	35	2	0	0	0	0
4P	Run A	41	1	17	2	6	0	0	0
	" B	22	1	15	0	0	0	0	0
	" C	38	3	24	2	3	0	0	0
	" D	20	5	8	2	0	0	0	0

TABLE 5 (cont'd)

Subjects			ATTEMPTED CIRCUMVENTION WITH CONTACT — BLOCK						Street						CONTACT WITHOUT ATTEMPTED CIRCUMVENTION — Block					
			Cane Contact Obstacle	Cane Contact Pedestrian	Body Contact Obstacle	Body Contact Pedestrian	Both Obstacle	Both Pedestrian	Cane Contact Obstacle	Cane Contact Pedestrian	Body Contact Obstacle	Body Contact Pedestrian	Both Obstacle	Both Pedestrian	Cane Contact Obstacle	Cane Contact Pedestrian	Body Contact Obstacle	Body Pedestrian	Both Obstacle	Both Pedestrian
1H	Run	A	1	0	1	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
	"	B	3	0	0	0	0	0	0	0	0	0	0	0	11	2	5	0	1	0
	"	C	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	"	D	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	0	0	0
2H	Run	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	"	B	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
	"	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	"	D	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0
3H	Run	A	3	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
	"	B	0	0	0	0	0	0	0	0	0	0	0	0	19	0	1	0	1	0
	"	C	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	"	D	0	0	0	0	0	0	0	0	0	0	0	0	5	0	3	0	1	0
4H	Run	A	7	0	4	0	2	0	0	0	0	0	0	0	1	0	2	0	2	0
	"	B	0	0	0	0	0	0	1	0	0	0	0	0	8	0	12	0	7	0
	"	C	2	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0
	"	D	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	0	0
1P	Run	A	1	1	1	0	0	0	0	0	0	0	0	0	15	0	6	0	1	0
	"	B	0	0	0	0	0	0	0	0	0	0	0	0	19	2	12	0	1	0
	"	C	1	0	0	0	1	0	0	0	0	0	0	0	6	0	1	0	5	0
	"	D	0	0	0	0	0	0	0	0	0	0	0	0	15	1	1	0	3	0
2P	Run	A	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	"	B	0	0	0	0	0	0	0	0	0	0	0	0	8	0	2	0	0	0
	"	C	2	0	6	0	2	0	0	0	0	0	0	0	3	0	1	0	0	0
	"	D	0	0	0	0	0	0	0	0	0	0	0	0	6	0	2	0	9	0
3P	Run	A	4	0	1	0	0	0	0	0	0	0	0	0	11	0	1	0	1	0
	"	B	0	0	0	0	0	0	0	0	0	0	0	0	24	1	4	1	0	0
	"	C	3	0	1	0	0	0	0	0	0	0	0	0	22	0	0	0	1	0
	"	D	0	0	0	0	0	0	0	0	0	0	0	0	29	0	3	0	2	0
4P	Run	A	2	0	2	0	0	0	0	0	0	0	0	0	15	0	3	0	0	0
	"	B	0	0	0	0	0	0	0	0	0	0	0	0	18	1	8	0	0	0
	"	C	0	0	0	0	0	0	0	0	2	0	0	0	18	0	7	0	1	0
	"	D	0	0	0	0	0	0	0	0	0	0	0	0	6	0	4	0	0	0

TABLE 5 (cont'd)

Subjects		CONTACT WITHOUT ATTEMPTED CIRCUMVENTION (Street)						ORIENTATION PROBLEM		RECOVERS FROM ORIENT.PR.		ASSISTANCE GIVEN		DEVIATION FROM ROUTE		DETECTS DOWN CURBS	
		Cane Contact Obstacle	Cane Contact Pedestrian	Body Contact Obstacle	Body Contact Pedestrian	Both Obstacle	Both Pedestrian	Blocks	Streets	Blocks	Streets	Blocks	Streets	Blocks	Streets	Yes	No
1H	Run A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
	" B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
	" C	0	0	0	0	0	0	3	0	3	0	0	0	0	1	6	0
	" D	0	0	0	0	0	0	1	1	0	0	1	0	2	1	8	0
2H	Run A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
	" B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1
	" C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
	" D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2
3H	Run A	0	0	0	0	0	0	2	0	1	0	1	0	1	0	6	0
	" B	0	0	0	0	0	0	2	0	1	0	1	0	2	0	6	0
	" C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2
	" D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0
4H	Run A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
	" B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
	" C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4
	" D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1
1P	Run A	0	0	0	0	0	0	1	0	0	0	0	0	0	0	6	0
	" B	7	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0
	" C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
	" D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
2P	Run A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
	" B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
	" C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
	" D	0	0	0	0	0	0	2	0	2	0	0	0	0	0	6	0
3P	Run A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
	" B	3	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0
	" C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
	" D	5	0	1	0	0	0	2	1	1	1	1	0	1	0	4	1
4P	Run A	0	0	0	0	0	1	1	0	1	0	0	0	0	0	7	0
	" B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
	" C	0	0	0	0	0	0	1	0	0	0	1	0	1	0	6	1
	" D	2	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0

TABLE 5 (cont'd)

Subjects		PROGRESS ALIGN-MENT		START AT APP. TIME		VEERS ON STREET CROSSING			NEEDS ASST.ON CROSSING		CANE CONTACT WITH GUIDELINE		VEERS OFF TRAVEL PATH		TRAVEL TIME
		Yes	No	Yes	No	Towards Street	Away from Street	No	Yes	No	Towards Street	Away from Street	Towards Street	Away from Street	
1H	Run A	5	1	5	1	0	3	3	0	6	69	18	0	5	20
	" B	5	1	6	0	1	2	3	0	6	25	61	1	4	26*
	" C	6	0	6	0	0	1	5	0	6	27	27	2	0	25
	" D	6	0	6	0	0	1	5	0	6	25	47	2	2	23
2H	Run A	6	0	6	0	0	0	6	0	6	1	4	0	0	9
	" B	6	0	4	2	0	0	6	0	6	6	8	0	0	10
	" C	6	0	6	0	0	0	6	0	6	5	2	0	0	13
	" D	6	0	6	0	0	0	6	0	6	7	8	0	0	12
3H	Run A	5	1	6	0	0	3	3	0	6	31	47	0	4	20
	" B	6	0	6	0	1	1	4	0	6	30	46	3	1	22
	" C	3	3	6	0	1	1	4	0	6	19	61	2	2	20
	" D	3	3	6	0	2	2	2	0	6	23	82	1	4	18
4H	Run A	5	1	6	0	0	2	4	0	6	2	23	0	0	15
	" B	6	0	6	0	0	2	4	0	6	0	59	0	0	13
	" C	5	1	6	0	0	3	3	0	6	0	37	0	1	18
	" D	4	2	6	0	1	3	2	0	6	1	76	0	4	17
1P	Run A	6	0	6	0	0	3	3	0	6	35	61	1	2	25
	" B	6	0	5	1	0	1	5	0	6	40	78	0	1	19
	" C	6	0	5	1	1	2	3	0	6	68	63	3	3	23
	" D	5	1	6	0	0	2	4	0	6	46	84	1	1	20
2P	Run A	7	0	5	2	0	2	4	0	7	30	26	0	1	25
	" B	7	0	7	0	0	3	3	0	7	62	33	0	0	24
	" C	6	0	6	0	0	1	5	0	6	39	59	2	2	23
	" D	6	0	6	0	0	0	6	0	6	40	81	2	3	27
3P	Run A	3	2	6	0	0	3	2	0	5	19	28	0	3	23
	" B	5	0	4	1	0	3	2	0	4	120	43	3	2	23
	" C	4	2	6	0	0	3	3	0	6	38	94	1	0	26
	" D	5	0	4	0	0	4	0	0	4	25	124	0	2	32
4P	Run A	5	2	7	0	0	4	3	0	7	17	167	0	1	22
	" B	5	2	6	0	0	3	4	0	7	39	180	1	1	20
	" C	3	4	7	0	0	5	2	0	7	39	92	0	2	27
	" D	1	6	6	1	0	6	1	0	7	23	199	0	2	19

*Progress halted by playing children

performance and the confidence he exhibited. A total of 18 questions was included in the form, and associated with each question was a seven-point scale--7 representing an excellent performance and 2 an average performance. The prominence given to the above-average region of the scale reflected the initial selection criteria which specified that the subjects should be accomplished long-cane travelers of above-average ability.

Prior to using the Task Rating Form, each of the 16 raters was provided with a page of instructions. However, owing to time limitations, the raters did not have the opportunity to practice and gain experience in completing the form. In fact it became increasingly apparent as the project developed that, although the questions posed in the form related to factors which O&M instructors consider daily, the idea of examining each factor independently and relating it to an abstract level called the "average performance" was novel to most of the instructors. Thus the results shown in Table 6 contain some erratic entries which must presumably have been caused by inexperience. The data also contain two other sources of error which make the long cane and laser cane performances difficult to compare directly. These are, first, an apparent element of partisanship (revealed by analysis of the rating data, see Chapter 5) which tended to bias the raters' assessments towards those subjects who had received training from their centers, and second, an obvious and striking difference in the standard of "average performance" at the Hines and Palo Alto Centers. This latter effect has been brought out clearly in Table 6 by tabulating the rating given in each category by raters at Palo Alto side by side with the scores given by their opposite numbers at Hines.

THE QUESTIONNAIRE

The second subjective procedure was based upon a questionnaire which sought observations from the subjects which could lead to improvements in the design of the cane and also personal opinions which could reveal the value that each might place on his ownership of a laser cane. A complete list of the forty questions is given in Appendix 6 and a summary of the replies is given in Chapter 6 of this report. This same chapter includes lists of the suggested modifications which the subjects thought might lead to improvements in the performance of the laser cane.

Prompted by the high rate at which the laser cane developed faults during use, three so-called "bonus questions" were asked at the end of the study. These questions attempted to gauge the tolerance of the subjects to laser-cane failures, the annual cost they might be prepared to pay for maintenance and the delay they would be prepared to accept while the device was being repaired. With a warning to take some caution in making generalizations from these figures (particularly in the absence of information about each man's financial and domestic responsibilities), the replies to the bonus questions have been included in Appendix 6.

TABLE 6

HINES & PALO ALTO RATER SCORES OF VIDEOTAPES

	SUBJECT H1				SUBJECT H2			
ORDER OF RUNS	3	1	4	2	2	4	1	3
RUN	LONG F	LASER F	LONG UNF	LASER UNF	LONG F	LASER F	LONG UNF	LASER UNF
H - Hines P - P.A. RATERS	H-5 P-6	H-1 P-1	H-3 P-8	H-7 P-3	H-8 P-4	H-4 P-7	H-2 P-2	H-6 P-1
RATING QUESTION								
1	5 - 3	5 - 5	5 - 5	2 - 6	5 - 7	7 - 7	5 - 7	7 - 7
2	6 - 6	6 - 6	6 - 6	6 - 6	7 - 7	7 - 7	6 - 6	6 - 6
3	5 - 5	4 - 3	6 - 6	2 - 7	5 - 6	7 - 7	6 - 7	6 - 7
4	5 - 6	4 - 5	6 - 6	5 - 6	7 - 7	7 - 7	6 - 7	6 - 6
5	6 - 5	5 - 5	5 - 6	1 - 7	5 - 7	7 - 7	6 - 7	6 - 6
6	5 - 4	6 - 5	6 - 5	4 - 5	7 - 7	7 - 7	6 - 7	6 - 7
7	5 - 4	5 - 4	6 - 5	6 - 5	4 - 7	7 - 6	5 - 7	6 - 6
8	4 - 5	4 - 4	5 - 5	7 - 6	5 - 7	7 - 6	5 - 7	7 - 6
9	3 - 4	7 - 5	5 - 6	2 - 7	2 - 7	7 - 5	5 - 6	7 - 6
10	4 - 4	6 - 5	6 - 6	7 - 7	2 - 7	7 - 6	6 - 7	7 - 7
11	6 - 5	7 - 6	6 - 6	3 - 5	7 - 7	7 - 7	7 - 7	7 - 6
12	6 - 6	6 - 5	6 - 5	5 - 5	7 - 7	7 - 7	6 - 7	7 - 6
13	6 - 6	4 - 4	6 - 7	5 - 7	4 - 7	7 - 7	6 - 7	6 - 6
14	6 - 5	5 - 5	5 - 6	1 - 5	4 - 7	7 - 7	6 - 7	6 - 6
15	5 - 5	3 - 4	6 - 7	6 - 7	2 - 7	7 - 7	6 - 7	6 - 6
16	5 - 5	4 - 5	6 - 6	6 - 6	3 - 7	7 - 7	6 - 7	6 - 6
17	5 - 5	5 - 5	6 - 5	3 - 6	3 - 7	7 - 7	6 - 7	6 - 6
18	6 - 4	5 - 6	6 - 3	6 - 4	4 - 7	7 - 6	7 - 3	6 - 7

NB. The symbols H-1, H-2....H-8 and P-1, P-2....P-8 refer to the raters based at the Hines and Palo Alto VA Centers and should not be confused with the cane travelers indicated by the symbols H1, H2, P1, P2, etc.

TABLE 6 (cont'd)

HINES & PALO ALTO RATER SCORES OF VIDEOTAPES

	SUBJECT H3				SUBJECT H4			
ORDER OF RUNS	1	2	3	4	4	3	2	1
RUN	LONG F	LASER F	LONG UNF	LASER UNF	LONG F	LASER F	LONG UNF	LASER UNF
H - Hines P - P.A. RATERS	H-3 P-3	H-2 P-8	H-7 P-5	H-5 P-6	H-6 P-5	H-8 P-2	H-1 P-7	H-4 P-4
RATING QUESTION								
1	4 - 5	3 - 4	7 - 5	6 - 3	3 - 7	5 - 6	6 - 7	7 - 6
2	5 - 6	4 - 6	7 - 7	6 - 3	3 - 7	7 - 7	5 - 6	5 - 5
3	5 - 5	3 - 5	6 - 5	5 - 3	2 - 5	7 - 7	4 - 6	6 - 6
4	5 - 5	2 - 3	7 - 5	5 - 3	3 - 6	7 - 7	5 - 7	7 - 6
5	3 - 6	4 - 5	2 - 6	6 - 4	4 - 6	5 - 7	4 - 7	6 - 5
6	4 - 6	2 - 5	2 - 6	6 - 6	4 - 5	7 - 7	4 - 7	7 - 6
7	5 - 6	4 - 4	6 - 6	6 - 5	3 - 6	3 - 7	6 - 7	6 - 5
8	5 - 6	5 - 4	1 - 6	7 - 5	4 - 6	5 - 7	6 - 7	7 - 7
9	4 - 6	3 - 4	7 - 5	6 - 5	2 - 6	6 - 5	5 - 7	7 - 7
10	4 - 5	2 - 6	7 - 6	6 - 5	4 - 4	6 - 7	7 - 7	7 - 7
11	1 - 5	5 - 3	7 - 7	6 - 6	4 - 6	7 - 7	6 - 7	7 - 7
12	2 - 5	4 - 4	5 - 5	7 - 5	4 - 6	7 - 7	5 - 7	6 - 7
13	2 - 5	3 - 3	7 - 5	6 - 4	4 - 6	7 - 6	6 - 7	6 - 6
14	2 - 5	4 - 4	7 - 6	5 - 4	4 - 6	7 - 7	6 - 7	7 - 6
15	2 - 6	4 - 6	3 - 6	6 - 4	4 - 7	5 - 7	6 - 7	7 - 7
16	2 - 5	5 - 4	6 - 6	6 - 5	4 - 6	5 - 6	6 - 7	6 - 6
17	2 - 5	3 - 4	5 - 6	6 - 4	4 - 6	5 - 7	5 - 7	6 - 6
18	6 - 6	4 - 5	5 - 6	6 - 6	6 - 6	5 - 7	5 - 7	5 - 7

TABLE 6 (cont'd)

HINES & PALO ALTO RATER SCORES OF VIDEOTAPES

	SUBJECT P1				SUBJECT P2			
ORDER OF RUNS	2	1	4	3	3	4	1	2
RUN	LONG F	LASER F	LONG UNF	LASER UNF	LONG F	LASER F	LONG UNF	LASER UNF
H - Hines P - P.A. RATERS	H-4 P-2	H-5 P-5	H-8 P-3	H-1 P-7	H-1 P-8	H-7 P-4	H-6 P-6	H-3 P-5
RATING QUESTION								
1	7 - 7	4 - 6	2 - 6	6 - 7	6 - 4	3 - 6	5 - 5	6 - 7
2	7 - 7	6 - 6	3 - 6	6 - 7	6 - 6	1 - 7	6 - 6	7 - 7
3	7 - 6	5 - 5	3 - 7	3 - 7	7 - 5	2 - 6	6 - 6	6 - 6
4	7 - 7	5 - 7	7 - 7	4 - 7	7 - 4	5 - 7	4 - 4	7 - 6
5	7 - 7	5 - 6	2 - 7	5 - 7	7 - 5	1 - 6	6 - 5	6 - 6
6	7 - 7	6 - 7	2	4 - 7	7 - 6	6 - 7	5 - 5	7 - 6
7	7 - 7	5 - 7	4 - 7	6 - 7	5 - 4	2 - 7	5 - 5	6 - 7
8	7 - 7	3 - 6	2 - 5	6 - 7	6 - 6	1 - 7	4 - 5	7 - 6
9	7 - 6	4 - 6	2	5 - 6	5 - 5	1 - 7	4 - 5	6 - 5
10	7 - 6	6 - 7	2 - 6	6 - 7	6 - 6	2 - 7	3 - 4	6 - 6
11	7 - 7	6 - 6	7 - 7	7 - 7	7 - 6	7 - 7	4 - 6	7 - 6
12	7 - 7	5 - 6	7 - 7	6 - 7	7 - 5	7 - 7	5 - 6	7 - 6
13	7 - 7	6 - 7	4 - 7	6 - 7	7 - 6	7 - 7	5 - 6	7 - 6
14	7 - 7	5 - 7	4 - 7	6 - 7	7 - 5	6 - 7	5 - 4	7 - 6
15	7 - 7	6 - 6	2 - 6	3 - 7	7 - 6	3 - 7	4 - 5	7 - 6
16	7 - 7	6 - 7	3 - 7	6 - 7	7 - 5	6 - 7	5 - 5	6 - 6
17	7 - 7	5 - 6	3 - 6	5 - 7	7 - 5	5 - 7	5 - 5	6 - 7
18	7 - 7	5 - 7	4 - 6	5 - 7	6 - 4	6 - 6	6 - 6	6 - 7

TABLE 6 (cont'd)

HINES & PALO ALTO RATER SCORES OF VIDEOTAPES

	SUBJECT P3				SUBJECT P4			
ORDER OF RUNS	1	3	2	4	4	2	3	4
RUN	LONG F	LASER F	LONG UNF	LASER UNF	LONG F	LASER F	LONG UNF	LASER UNF
H - Hines P - P.A. RATERS	H-7 P-7	H-3 P-3	H-5 p-1	H-2 P-2	H-2 P-1	H-6 P-6	H-4 P-4	H-8 P-8
RATING QUESTION								
1	1 - 7	2 - 5	5 - 3	3 - 7	4 - 5	4 - 7	7 - 7	1 - 6
2	2 - 7	2 - 7	6 - 4	4 - 7	5 - 6	4 - 6	7 - 7	5 - 4
3	1 - 5	1 - 4	4 - 1	3 - 7	4 - 5	3 - 6	5 - 5	2 - 4
4	1 - 6	2 - 5	3 - 1	4 - 7	4 - 5	4 - 6	5 - 7	4 - 4
5	1 - 6	2 - 6	6 - 2	3 - 7	6 - 6	4 - 6	6 - 7	4 - 5
6	1 - 5	3 - 2	6 - 2	4 - 7	6 - 6	5 - 6	7 - 7	3 - 5
7	1 - 6	2 - 5	4 - 3	3 - 6	3 - 6	4 - 6	5 - 7	2 - 6
8	2 - 6	2 - 6	6 - 5	2 - 7	3 - 7	4 - 6	4 - 7	4 - 6
9	1 - 6	2 - 5	5 - 4	3 - 6	3 - 6	5 - 6	6 - 7	2 - 4
10	1 - 4	1 - 5	6 - 5	4 - 7	5 - 6	5 - 6	6 - 7	2 - 4
11	1 - 6	1 - 6	1 - 1	5 - 7	7 - 7	4 - 6	7 - 7	2 - 3
12	1 - 6	2 - 5	5 - 2	5 - 7	5 - 6	4 - 6	7 - 7	2 - 4
13	1 - 6	2 - 6	5 - 2	3 - 7	5 - 7	5 - 6	7 - 7	3 - 7
14	2 - 6	2 - 5	4 - 1	5 - 7	5 - 6	4 - 6	6 - 7	3 - 5
15	1 - 7	2 - 6	5 - 1	5 - 7	4 - 5	5 - 6	4 - 7	2 - 6
16	1 - 6	2 - 5	4 - 2	4 - 7	4 - 6	5 - 6	5 - 7	3 - 5
17	1 - 6	2 - 5	4 - 1	4 - 6	5 - 6	4 - 6	6 - 7	2 - 4
18	5 - 6	6 - 6	6 - 6	4 - 7	5 - 6	6 - 6	5 - 7	4 - 5

Chapter 4.

ANALYSIS OF SUBTASK CHECKLIST DATA

INTRODUCTION

The data derived from the Subtask Checklists are contained in Table 5. At first glance they reveal a preponderance of zero entries which are brought about in part by the fine breakdown of tasks and contingencies and also, in some degree, by the skill of the travelers. Nevertheless, the fact that the subjects performed so well with either cane provides scant encouragement to the statistician because there remain relatively few columns which contain a sufficient number of entries to analyze.

PROBLEMS OF ANALYSIS

Before formally analyzing any data, an important consideration to be borne in mind is that each occasion on which a subject was tested, either with the long cane or the laser cane, was an essentially different experiment. As far as the objective measures are concerned, this makes the data not directly internally comparable, i.e., the measures as given are, generally, dependent on the particular environment and conditions under which each excursion was made. One subject, for example, encountered children playing during one of his trials. Trials do vary as to the density of pedestrians, traffic and unforeseen incidents--even for a single traveler. Each subject therefore had to cope with a different environment entirely, although the O&M specialists who conducted the trials tried to make every journey as similar in character as possible.

Thus we must reluctantly conclude that only measures which can be normalized (i.e., made more or less independent of the circumstances and environment of the trials), can be usefully analyzed by a formal statistical procedure. For example, a circumvention can only be attempted if an opportunity exists and subject opportunities may be more frequent on some occasions than on others. However, the frequency of such opportunities is reflected in the total number under heading of "attempted circumvention with and without contact" plus "contact without attempted circumvention". Another example is that of "orientation problems," which do not necessarily occur, but the ratio of recoveries to problems might have been useful had there not been so few problems at all.

The possibility of using a ratio for variables under the headings "proper alignment," "start at appropriate time," "veers on street crossings," "need assistance on crossing," for example, occurs to one. In the first two cases, one is deterred by the plentiful number of zeros. In the last case, performance was uniformly excellent. However, in the case of veers we used "number of no veers," (this section deals with street-crossing veers) since, except for subjects P3 and P4, the total number of opportunities was always 6 (no doubt it would have been better to normalize the data for subjects P3

and P4 to equivalent "no veers" on 6 performances; but the influence of such a procedure on the conclusions would have been only slight).

It is apparent from the data that the amount of "cane contact with guideline" depends too much on an individual's cane technique and the prevailing traffic to make an analysis across subjects possible. Subject H2 was clearly benefited by his partial recovery of sight, while subject P3 was not feeling well. Questions left unanswered include the reason for the heavy veering tendency of subjects H4 and P4. "Veers off travel path" and "continuity of travel" exhibit the same trends and it is unfortunate that no suitable normalizer was recorded.

ANALYSIS

The videotaped performances of the 8 subjects were obtained under four sets of conditions labeled A-D and referred to here as "treatments."

A. Laser cane in familiar environment.

B. Long cane in familiar environment.

C. Laser cane in unfamiliar environment.

D. Long cane in unfamiliar environment.

The following variables were analyzed:

(i) "Attempted circumventions (of obstacles and pedestrians) with and without contact" on blocks only, in the form

$$\log\{\frac{\text{no. without} + 0.5}{\text{no. with} + 0.5}\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

(0.5 is added to avoid division by zero. The log transform is used with the objective of improving the shape of the distribution by avoiding a long right tail.)

(ii) "Contacts avoided and contacts made" (of all types) in the form

$$\log\{\frac{\text{contacts avoided} + 0.5}{\text{all contacts} + 0.5}\} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In both (i) and (ii), the value of the variable increases as performance improves.

(iii) Number of "no veers" on street crossing.

The results are summarized in Table 7. The analysis assumes the model described in Chapter 5 but without the rater effects or interactions which are considered there. "Treatments" refer to the combination of cane (whether laser-cane or long-cane) and the familiarity of the run (i.e., whether it was made over a familiar route or unfamiliar route). The last column (a) gives (conservatively) the level of significance reached.

TABLE 7

Attempted circumventions with and without contact (log transformed, see (1))

Source	df	Mean Square	F	α
Subject locations	1	1.720	4.86	0.1
Subjects	6	0.354	3.46	0.05
Order of runs	3	0.271	2.65	0.1
Treatment type	3	1.069	10.46	0.005
Locations X order	3	0.295	2.88	0.1
Locations X treatment	3	0.145	1.41	
Error	12	0.102		

$R^2 = 0.882$

Treatment contrasts:

Laser - Long $t_{12} = 4.75$ (significance level $p = 0.001$)

Unfamiliar - Familiar $t_{12} = 1.84$ (significance level $p = 0.10$)

Location effect (Hines) = 0.23

TABLE 7 (cont'd)

Contacts avoided and contacts made (log transformed, see (2))

Source	df	Mean Square	F	α
Subject locations	1	6.723	16.66	0.01
Subjects	6	0.404	4.22	0.025
Order of runs	3	0.424	4.44	0.03
Treatment type	3	5.771	60.35	0.001
Locations X order	3	0.125	1.31	
Locations X treatment	3	0.236	2.48	0.1
Error	12	0.096		

$R^2 = 0.962$

Treatment contrasts:

Laser - Long $t_{12} = 12.48$ (significance level $p = 0.001$)

Unfamiliar - Familiar $t_{12} = 3.70$ (significance level $p = 0.005$)

Location effect (Hines) = 0.21

TABLE 7 (cont'd)

Number of "no veers" on street crossing

Source	df	Mean Square	F	α
Subject locations	6	8.00	1.25	
Subjects	1	6.417	5.31	0.01
Order of Runs	3	2.083	1.72	
Treatment type	3	0.75	0.62	
Locations X order	3	0.25	0.21	
Locations X treatment	3	0.833	0.69	
Error	12	1.271		

$R^2 = 0.793$

CONCLUSIONS

Variables (i) and (ii) are obviously dependent on one another, and therefore their indications are similar. We note that:

(a) Hines-trained subjects appear to avoid contact more successfully than Palo Alto-trained subjects (this may, of course, be an observer-induced effect).

(b) Subjects vary considerably in their ability to avoid contact.

(c) Experience in the experimental situation (order of runs) has some bearing on avoidance.

(d) The type of cane and type of environment are very important. Performance improves with the laser cane and when in an unfamiliar environment.

Variable (iii) shows no significant effect of any interest--we expect that subjects are significantly different from each other.

The following general conclusion can be drawn from an inspection of the data.

If one looks at the "attempted circumvention without contact" columns--in particular the "block-obstacle" column--it is obvious that all subjects avoid obstacles better when they attempt to do so with the laser cane (compare Run A with Run B, and Run C with Run D). From the sparseness of non-zero data under "attempted circumvention with contact," it appears that the subjects rarely attempted a circumvention without accomplishing it. Only subject H1 ever attempted a circumvention with the long cane in which he did not avoid contact, and no subject from Palo Alto ever attempted a circumvention with the long cane at all.

Now consider the data on "continuity of travel." If one uses the "Hesitations-block" column to form ratios of the number of hesitations with the laser cane to the number of hesitations with the long cane in either familiar or unfamiliar terrain, we find that only two of the resulting 16 ratios are less than 1 (note that we add 1 to all entries to avoid division by zero, forming the ratios (Run A + 1)/(Run B + 1) and (Run C + 1)/(Run D + 1) The chance of this occuring at random (if one assumes no differences between canes) is less than 0.004. On the other hand, the same procedure applied to the "Stops-block" column yields 5 ratios less than 1, which should not be regarded as surprising. Evidently more hesitations occur when the laser cane is used than when the long cane is used but not necessarily more stops. One also notices that the Hines-trained subjects appear to hesitate less often than the Palo Alto subjects, even when the scores of Subject H2 are ignored. However, the Hines subjects do not stop much less frequently. Their average rate is similar to the Palo Alto group, although the Palo Alto subjects show some high scores which increase the variability of their data.

Repeating this procedure for "Cane contact with guideline", it seems that the laser cane is not better than the long cane in avoiding contact with the guideline toward the street, but it seems to be better away from the street (1 ratio out of 16 greater than 1). With "veers off travel path", a delicate situation emerges: 8 of the "towards" ratios and 5 of the "away" ratios are 1.00. When these entries are removed from the data, the laser cane performance does not appear to be different from the long cane performance as far as veers are concerned; but we note the number of veers is in most cases extremely low.

Chapter 5.

ANALYSIS OF TASK RATING DATA

INTRODUCTION

This chapter analyzes the data contained in Table 6 which were compiled from the Task Rating Forms completed by 16 mobility specialists.

The gathering of these data from the videotaped recordings of 32 journeys was adopted in an effort to reduce the effects of observer bias. However, only one attempt could be made to videotape each particular journey (or treatment) and, as has been pointed out before, this did not make allowance for "bad days." Additional factors which may have influenced day-to-day performance were learning effects and a progressive lessening of camera consciousness and associated tension. To avoid the bias these trends might introduce, it was therefore decided to vary the order of the treatments according to a Latin Square design for each set of subjects from each training center.

In deciding the number of raters to be used, the relevant considerations were:

(i) limitations on the number of mobility specialists available at each location, and

(ii) the fact that if each rater were to view all 32 tapes, he would have to spend 16 hours of his time. Not only would this have been an imposition, but it is questionable that consistent standards could have been maintained for so long. Thus raters were only asked to view a limited number of tapes.

It was decided that eight raters could be found at each location and that it was reasonable to ask each to view four tapes. Thus each videotape could be viewed twice. It was intended that each rater would see two subjects from each center, one performance under each of the four treatments, and one performance at each possible time (order in sequence of runs). Also each performance would be seen by a rater from each center. The resulting design is given in Table 8.*

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*It will be seen that the objective of having each rater view one performance at each possible time was not realized, owing to an error in copying, so that H-1 saw two 3rd runs and no 4th run and H-2 saw two 4th runs and no 3rd run. The effect of this error was judged to be unimportant.

The order of presentation of tapes to the raters was also considered. A situation in which the treatments are presented in the same order, or the times presented in the same order, should be avoided. A scheme for the order of presentation was drawn up where each treatment was presented equally often in each position of the order of presentation, and the times were mixed up, if not balanced, in a pseudo-random manner.

THE MODEL

The resulting design is an extremely complex incomplete design and a rigorous statistical analysis of a full model which accounted for all factors: subjects, subject locations (i.e., training centers, Hines and Palo Alto), treatments, times (order of runs), raters, rater locations and rater-viewing order, along with the appropriate interactions, would be impossible. We adopted the following simplified model:

Y_{ijktr} = the observation on the jth subject from location i on treatment k at time t as judged by the rater from location r.

$$i = 1, 2;\ j = 1,..4;\ k = 1,..4;\ t = 1,..4;\ r = 1,2.$$

$$Y_{ijktr} = \mu + \alpha_i + b_{j(i)} + K_k + \tau_t + \theta_r + (\alpha K)_{ik} + (\alpha\tau)_{it} + (\alpha\theta)_{ir} + (K\theta)_{kr} + (\tau\theta)_{tr} + \varepsilon_{ijktr} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

b's and ε's are assumed to be independent random variables with zero means and variances σ_b^2 and σ^2 respectively. The fixed effects are assumed to sum to zero on all subscripts, e.g.,

$$\sum_i \alpha_i = 0,\ \sum_k K_k = 0,\ \sum_i (\alpha K)_{ik} = \sum_k (\alpha K)_{ik} = 0 \ . \ . \ . \ . \text{ etc.}$$

These assumptions are consistent with the usual assumptions of analysis of variance. It is usual also to assume that the random variables are normally distributed. Since the ratings were made on a seven-point scale and there was some a-priori reason to believe that the distributions would be skewed, we could not honestly assume this. However, the procedures of analysis of variance are fairly robust.

It should be understood that the model described by (1) applies to the scores on one item (out of the 18 on the score sheet). It is not advisable to analyze the full set of data as an 18-variate multivariate analysis of variance because

(i) the correlation structure of the ε's is not known, though one can assume high correlation between responses of the same rater on a single performance,

(ii) multivariate techniques are not particularly robust,

TABLE 8

HINES SUBJECTS

ORDER OF RUNS	H1	H2	H3	H4
	A H-1 P-1	D H-2 P-2	B H-3 P-3	C H-4 P-4
	C H-7 P-3	B H-8 P-4	A H-2 P-8	D H-1 P-7
	B H-5 P-6	C H-6 P-1	D H-7 P-5	A H-8 P-2
	D H-3 P-8	A H-4 P-7	C H-5 P-6	B H-6 P-5

PALO ALTO SUBJECTS

ORDER OF RUNS	P1	P2	P3	P4
	A H-5 P-5	D H-6 P-6	B H-7 P-7	C H-8 P-8
	B H-4 P-2	C H-3 P-5	D H-5 P-1	A H-6 P-6
	C H-1 P-7	B H-1 P-8	A H-3 P-3	D H-4 P-4
	D H-8 P-3	A H-7 P-4	C H-2 P-2	B H-2 P-1

Treatments A, B, C, D.

Hines Raters H-1,.... H-8; Palo Alto Raters P-1,.... P-8.

(iii) it is unlikely that any more information would be revealed than in doing 18 univariate analyses, and

(iv) the programming requirements for these calculations would have been beyond the available resources.

DATA ADJUSTMENTS

Each rater had to score each of 17 mobility performance characteristics on a seven-point scale. Since the subjects were all judged to be above average, a score of two was designated as an average performance. The first 12 questions referred to specific aspects of cane techniques and the next five to more general impressions about performance. An 18th question concerned the quality of the videotape and its usefulness for the purpose, and is not really related to other questions.

One rater had some difficulty in rating and omitted five scores - two each on variables 6 and 9 on the same tapes and one on variable 18. The missing observations on variables 6 and 9 were estimated from the general level of the other scores given by that rater for that performance, and the fluctuations of the other rater's scores for that same performance. The missing value for 18 was supplied by considering the rater's response on his other scores for variable 18. This procedure is admittedly unorthodox, but the classical procedures would be extremely complex in the case of this design and an intelligent guess usually serves quite well in that the conclusions are negligibly affected.

Another problem was the fact that one of the subjects regained partial use of one eye before the field trials took place. The raters were not informed of this, however. To eliminate this subject entirely from the data would have made analysis very difficult. Furthermore, compared to other subjects' good performances, his scores were not obviously extraordinary, especially since he was evidently inclined to be overconfident and careless in technique. Therefore, his data were left intact, in the belief that the removal of the "subject effect" would take care of the problem.

RESULTS

The computational results of the analysis are summarized in Tables 9* and 10. The estimates of most interactions have been omitted because such interactions are in general, not significant and uninformative.

The F-ratios given in Table 10 are the ratios of the Effect or Interaction mean square to the Error mean square, except in the case of the

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*α_1 = Location effect for Hines subjects = α_2

θ_2 = Location effect for Palo Alto raters = θ_1

TABLE 9

CLASS ONE QUESTIONS

Estimates		1 Line of travel	2 Detects curbs	3 Crosses streets	4 Auditory Information	5 Non-auditory Information	6 Information from device	7 Long cane technique	8 Appropriate speed	9 Avoids cane contact	10 Avoids body contact	11 Maintains orientation on prescribed route	12 Solves orientation and mobility problems	Average 1 - 12
Mean	μ	5.20	5.72	4.94	5.34	5.25	5.42	5.20	5.31	4.98	5.39	5.70	5.63	5.34
Subject location	α_1	.17	.19	.34	.25	.09	.11	.20	.25	.27	.36	.23	.13	.22
Times	τ_1	-.27	-.28	-.19	-.34	-.19	-.23	-.20	-.25	-.11	-.52	-.64	-.69	-.33
	τ_2	.17	.22	-.13	-.16	0.0	.02	.23	.63	.08	.36	-.58	-.13	.06
	τ_3	.36	.53	.38	.28	.25	.02	.05	0.0	.27	.36	.55	.31	.29
	τ_4	-.27	-.47	-.06	.22	-.06	.20	-.08	-.38	-.23	-.20	.67	.50	-.01
Treatments	κ_1	-.20	.09	-.06	-.03	.19	-.05	-.27	.06	-.48	-.70	-.14	-.19	-.15
	κ_2	-.27	-.16	-.25	-.16	-.02	.08	-.33	-.50	-.11	-.14	.05	-.06	-.17
	κ_3	.23	.16	.25	.09	0.0	-.23	.30	-.31	.33	.30	.11	.13	.11
	κ_4	.23	-.09	.06	.09	0.0	.20	.30	.75	.27	.55	.02	.13	.21
Rater location	θ_2	.58	.44	.53	.34	.69	.36	.61	.72	.64	.52	.30	.25	.50
Subjects b (H)	1	-.88	.09	-.53	-.22	-.34	-.53	-.41	-.56	-.38	-.13	-.44	-.25	-.38
	2	1.13	.59	1.09	1.03	1.03	1.22	.59	.69	.38	.38	.94	1.00	.84
	3	-.75	-.40	-.65	-1.22	-.84	-1.03	-.15	-.69	-.38	-.63	-.94	-1.13	-.73
	4	.50	-.28	.09	.41	.16	.34	-.03	.56	.38	.38	.48	.38	.28
b (P)	1	.59	.47	.78	1.28	.59	.44	1.25	.31	.53	.84	1.28	1.00	.78
	2	.22	.22	.91	.41	.09	.81	.13	.19	.03	-.03	.78	.75	.38
	3	-.91	-.66	-1.34	-1.47	-1.03	-1.56	-1.25	-.56	-.72	-.91	-1.97	-1.38	-1.15
	4	.09	-.03	-.34	-.22	-.34	.31	-.13	.06	.16	.09	-.09	-.37	-.01
Subj.Loc.× Rater Loc.	$(\alpha\theta)_{11}$	.33	.28	.19	.19	.03	.02	.39	.41	.27	.27	.17	.13	.22
Treatment Contrasts:														
(Laser-Long) Fam.		-.06	-.25	-.19	-.13	-.38	.13	-.06	-.56	.38	.56	.19	.13	-.02
(Laser-Long) Unf.		0.0	-.25	-.19	0.0	0.0	.44	0.0	1.06	-.06	.25	-.13	0.0	.09
(Laser-Long)		-.06	-.50	-.38	-.13	-.38	.56	-.06	.50	.31	.81	.06	.13	.07
Unf. - Fam.		.94	.13	.63	.38	0.0	-.06	1.19	.88	1.19	1.69	.19	.50	.64
Type X Fam.		.06	0.0	0.0	.13	.38	.31	.06	1.63*	.44	-.31	-.31	-.13	.11
Time Contrasts														
Linear		.19	.25	.88	2.13*	.63	1.31	.19	-1.00	-.19	.94	5.06°°	4.00°°	1.16
Quadratic		-1.06*	-1.5°	-.50	-.25	-.5	-.06	-.56	-1.25°	-.69	-1.44**	.06	-.38	-.68

°Significant at 2 1/2% °°Significant at 1%

*Significant at 10% **Significant at 5% level

TABLE 9 (cont'd)

CLASS ONE QUESTIONS

Estimates	1 Line of travel	2 Detects curbs	3 Crosses streets	4 Auditory Information	5 Nonauditory Information	6 Information from device	7 Long cane technique	8 Appropriate speed	9 Avoids cane contact	10 Avoids body contact	11 Maintains orientation on prescribed route	12 Solves orientation and mobility problems	Average 1 - 12
Multiple Correlations R^2 = Proportion 4 Variance explained by regression	.54	.51	.52	.54	.44	.46	.60	.69	.54	.57	.63	.62	.5
Error Mean Square σ^2	2.29	1.69	2.43	2.10	2.70	2.44	1.57	1.43	2.22	2.12	2.18	1.47	1.27
Subject σ^2 error b	.39	.01	.58	.87	.24	.75	.42	.16	0.0	.11	1.11	.83	.44

TABLE 9 (cont'd)

CLASS TWO QUESTIONS

Estimates		Relaxed & Confident	Sensitivity to informational changes	Travels safely	Travels efficiently	Total performance	Videotape rating
Mean	μ	5.66	5.41	5.34	5.45	5.22	5.67
Subject location	α_1	0.0	.06	.28	.14	.16	- .11
Times	τ_1	- .59	- .41	- .41	- .52	- .47	- .23
	τ_2	- .03	- .41	.34	.11	- .09	.20
	τ_3	.41	.53	- .03	.17	.34	.08
	τ_4	.22	.28	.09	.23	.22	- .05
Treatments	κ_1	- .09	- .16	- .09	- .27	- .03	.08
	κ_2	- .22	.09	- .09	- .02	- .03	.14
	κ_3	.22	.09	- .22	.05	.03	- .30
	κ_4	.09	- .03	.41	.23	.03	.08
Rater location	θ_2	.41	.41	.75	.48	.53	.23
Subjects b (H)	1	- .03	- .72	- .25	- .22	- .38	- .56
	2	.97	- .78	.63	.78	1.00	.19
	3	-1.28	- .84	-1.00	- .72	-1.00	- .06
	4	.34	.78	.63	.16	.38	.44
b (P)	1	.72	.91	.44	.94	.69	.22
	2	.72	.53	- .56	.68	.81	.09
	3	-1.66	-1.34	- .81	-1.44	-1.48	- .03
	4	.22	- .09	- .19	- .19	- .06	- .28
Subj. loc. × Rater loc. $(\alpha\theta)_{11}$		.25	.06	.13	.20	.09	.17
Treatment Contrasts							
(Laser-Long)Fam.		- .13	.25	0.0	.25	0.0	.06
(Laser-Long) Unf.		- .13	- .13	.63	.19	0.0	.38
Laser-Long		- .25	.13	.63	.48	0.0	.44
Unf.-Fam.		.63	.13	.38	.56	.13	- .44
Type × Fam.		0.0	- .38	.63	- .06	0.0	.31
Time Contrasts							
Linear		2.88°	3.00°	1.13	2.31**	2.5**	.44
Quadratic		- .75	- .25	- .63	- .56	- .50	- .56
	R^2	.63	.59	.53	.66	.58	.36
Error mean square	σ^2	1.55	1.75	2.36	1.15	1.69	1.17
Subject error	σ^2_b	.89	.68	.21	.63	.71	0.00

"Subject location" effect (α in (1)), where theory requires that this ratio be relative to the "subject" mean square. Because of the missing observations, the number of degrees of freedom associated with the error mean square in variables 6 and 9 should possibly be reduced, but this does not have a profound effect on the results.

Since the "treatments" are of principal interest in this study, we examined five specific contrasts between them:

(i) (Laser-Long) Familiar, i.e., $K_2 - K_1$

(ii) (Laser-Long) Unfamiliar , i.e., $K_4 - K_3$

(iii) (Laser-Long) i.e., $(K_2 + K_4) - (K_1 + K_3)$

(iv) Unfamiliar - Familiar, i.e., $(K_3 + K_4) - (K_1 + K_2)$

(v) Type X Familiarity interaction, i.e. $(K_4 + K_1) - (K_2 + K_3)$

The Scheffé multiple-comparisons procedure was used to gauge whether any of these quantities was statistically significantly different from zero. From Table 9 it is obvious that the results were disappointing. Only the Type X Familiarity interaction appears significant, at only the 10% level, for variable 8 - travel at appropriate speed. This seems hard to interpret. Table 10 also indicates that treatment effects are significant, at the 10% level, for variable 10 - avoiding body contact; but the contrasts do not indicate precisely what is important, although they point towards the influence of familiarity of the territory in increasing body contacts.

In order to study the "time effects" for possible trend, we use contrasts of the time effect estimates which represent the linear and quadratic components of regression of τ_1, τ_2, τ_3, τ_4 on 1, 2, 3, 4; i.e., we pretend the times are equally spaced:

(i) Linear $(3\tau_4 + \tau_3) - (\tau_2 + 3\tau_1)$

(ii) Quadratic $(\tau_1 + \tau_4) - (\tau_2 + \tau_3)$

These two contrasts are the only ones we intend to consider and they are orthogonal. Therefore, a t - test can be used on each, rather than a multiple comparisons technique.

From Table 9 we see significant linear increasing trends for variables 4 (auditory information), 11 (maintaining orientation), 12 (solving O&M problems), 13 (relaxed and confident travel), 14 (sensitivity to informational changes), 16 (efficient travel), 17 (total performance). Thus it appears that, in general, these characteristics improve with practice, at least over the short term in the experimental situation.

Significant negative quadratic trends, indicating curvature up and then down, are shown by variables 1 (maintaining line of travel), 2 (detection of curbs), 8 (traveling at appropriate speed), and 10 (avoiding body contact). Thus it appears that these characteristics tend to improve and then deteriorate over the short term in the experimental situation. One wonders why 11 (maintaining orientation) improves while 1 (maintaining line of travel) improves and then deteriorates. Otherwise, one may ask what underlying property discriminates between the two types of variables--those which improve steadily and those which improve and then deteriorate.

Table 10 shows that the most consistently nonzero effect is the "Rater location." Palo Alto raters tend to be more generous than the Hines raters in scoring. This is obvious on scanning the data. Although the "Subject locations" do not appear to have any significant effect, it is worth noting that the α_1's are all positive, indicating that the Hines subjects may have a slight edge on the Palo Alto subjects.

The only interaction which occasionally shows a high degree of statistical significance is the Subject-location × Rater-location interaction. The constraints on the values of the: $(\alpha\theta)_{22}$ as defined by the model demand that $(\alpha\theta)_{11} = -(\alpha\theta)_{12} = -(\alpha\theta)_{21} = (\alpha\ )$, so we give only the $(\alpha\theta)_{11}$'s., which are all positive. Thus it appears that there is a tendency for raters to favor subjects from their own location.

The subjects themselves contribute quite substantially to the variation. The individual contributions are given in Table 9 and are seen to be fairly consistent across variables. We notice that subject H2, who regained partial vision in one eye, does very well, but he is not obviously better than subject P1 when one considers each relative to the average performance in his group. If H2's performance were far superior to the rest of his group one would expect that the values of b_{1j} for j = 1, 3, 4 (the other members of the group) would be small and tending to be negative; but H3 appears at least as poor as H2 is good. Likewise, the performance of P1 is balanced by that of P3. Indeed P3 may be pulling the average of the Palo Alto group down, affecting the value of $\alpha_2 = -\alpha_1$. Adjusting for group difference by adding α_1 to the Hines group estimates and subtracting α_1 from the Palo Alto group estimates does create a difference between them. The question arises whether the Hines group is inherently better (at getting high scores) than the Palo Alto group or if the difference (if any) lies in the training and follow up at the two centers.*

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*We remind the reader that the estimates of α_1 do not give any strong support to the hypothesis that $\alpha_1 \neq 0$, other than a consistently positive value across variables.

TABLE 10

CLASS ONE QUESTIONS
ANALYSIS OF VARIANCE

Source	DF	F 1	2	3	4	5	6	7	8	9	10	11	12	Ave.
Subject locations	(1,6)	.35	1.29	1.08	.44	.12	.09	.54	1.48	2.44	2.78	.32	.12	.64
Times	(3,36)	.70	1.99	.43	.68	.20	.21	.36	2.22	.34	1.43	3.66**	3.03**	.79
Treatment	(3,36)	.52	.21	.29	.11	.14	.23	1.20	3.41**	1.02	2.27*	.08	.26	.44
Rater locations	(1,36)	9.33°°	7.25°	7.44°°	3.60*	11.22°°	3.38*	15.13°°°	23.17°°°	11.81°°	8.04°°	2.59	2.72	12.49°°
Subjects w. locations	(6,36)	2.37*	1.03	2.90°	4.30°°	1.71	3.46°°	3.14°	1.90	.84	1.41	5.07°°	5.49°°°	3.71°°
SL × Time	(3,36)								2.16	2.25*				
SL × Treatment	(3,36)										2.39*			
SL × RL	(1,36)	3.01*	3.00*					6.22°	7.40°°	2.03	2.13			2.47
Time × RL	(3,36)								2.26*					
Treatment × RL	(3,36)													

Omitted values are < 2.0

CLASS TWO QUESTIONS
ANALYSIS OF VARIANCE

Source	DF	13	14	15	16	17	Ave.
Subject locations	(1,6)	0.0	.04	1.25	.20	.21	.84
Time	(3,36)	1.9	2.11	.66	1.67	1.24	.47
Treatment	(3,36)	.39	.13	.52°°°	.59°°°	.01°°	.54
Rater locations	(1,36)	6.80°°°	6.03°°	15.25	12.97	10.66	2.98*
Subject w. location	(6,36)	5.60	4.09	1.72	5.36°°°	4.32°°	.77
SL × Time	(3,36)						
SL × Treatment	(3,36)		2.71*		2.86*		
SL × RL	(1,36)	2.57			2.28		
Time × RL	(3,36)	2.11					
Treatment × RL	(3,36)						

TABLE 11

CLASS ONE QUESTIONS
RATER EFFECTS

		1	2	3	4	5	6	7	8	9	10	11	12	Ave.
(Mean Residuals)	H-1	.42	- .22	- .52	.58	.08	- .22	.42	.34	.45	.56	.33	.11	.10
	2	- .42	- .16	- .11	- .86	.42	- .41	- .48	- .47	- .33	- .44	.30	- .23	- .27
	3	- .11	- .16	.59	.47	- .19	.42	.33	.38	.08	- .33	- .95	- .50	.00
Raters	4	1.45	.91	1.28	1.09	1.00	.98	1.14	.69	1.39	.98	.92	.69	1.04
	5	.98	1.00	.93	.13	1.78	1.48	.61	.88	.48	1.14	.52	1.00	.91
	6	- .23	- .50	- .44	- .94	.21	- .61	- .17	- .13	.02	- .02	- .52	- .63	- .33
	7	- .55	- .81	-1.28	- .03	-2.41	-1.11	- .36	-1.16	-1.08	- .30	- .55	- .34	- .83
	8	-1.55	- .06	- .47	.72	- .91	- .55	-1.48	- .53	-1.02	-1.61	- .05	- .09	- .63
	P-1	- .80	- .72	-1.56	-1.34	-1.31	- .98	- .73	- .56	- .70	- .45	- .95	-1.28	- .95
	2	.30	.25	.59	.56	.63	.80	.64	.69	.39	.17	.17	.59	.42
	3	.48	.63	1.13	.50	1.28	- .52	.23	.19	.55	.20	.33	- .06	.41
	4	.52	.63	.25	.69	.22	.39	.70	.69	1.33	1.05	.55	.56	.63
	5	.27	.50	- .50	0.0	.13	.23	.27	.06	- .08	- .05	.20	- .06	.08
	6	- .83	- .72	- .16	- .41	- .56	- .30	- .61	- .44	- .39	- .67	.58	.31	- .35
	7	.83	.31	.59	.94	.38	.70	.48	.06	.33	- .04	.52	.84	.49
	8	- .76	- .88	- .34	- .94	- .75	- .33	- .98	- .69	- .64	- .20	-1.39	- .91	- .73
Mean squares	df													
Rater	14	2.70	1.66	2.88	2.48	4.54	2.35	2.20	1.52	2.31	2.12	1.92	1.79	1.64
Residual	22	2.04	1.71	2.14	1.86	1.52	2.50	1.17	1.37	2.17	2.11	2.35	1.27	1.03
F(14,22)		1.32	.97	1.34	1.33	2.98	.94	1.88	1.11	1.06	1.01	.82	1.41	1.60
	R_r^2	.749	.700	.741	.751	.805	.660	.816	.821	.724	.738	.753	.799	.796

TABLE 11 (cont'd)

CLASS TWO QUESTIONS
RATER EFFECTS

		13	14	15	16	17	18
(Mean Residuals)	H-1	- .17	.13	- .44	.03	.09	.08
	2	- .45	0.00	.38	.03	- .03	- .52
	3	- .56	- .56	- .16	- .67	- .38	.64
Raters	4	1.13	1.25	1.16	.89	1.13	.20
	5	1.13	.94	1.50	.89	1.13	.08
	6	- .75	- .31	- .06	- .08	- .19	.11
	7	.03	- .50	-1.15	- .05	- .72	.36
	8	- .34	- .94	-1.22	-1.02	-1.03	- .95
	P-1	-1.03	-1.13	-1.81	- .80	-1.16	.36
	2	.50	.19	.56	.55	.47	- .02
	3	.88	.63	.81	.33	.50	- .30
	4	.25	.88	.75	.61	.69	.73
	5	- .38	- .03	- .06	.02	.31	.33
	6	- .41	- .34	- .69	- .33	- .31	- .55
	7	.50	.50	.38	.45	.78	.64
	8	- .31	- .69	.06	- .83	-1.22	-1.20
Mean square	df						
Rater	14	1.87	2.09	3.49	1.57	2.51	1.37
Residual	22	1.35	1.54	1.64	.90	1.18	1.06
F(14, 22)		1.39	1.35	2.12*	1.75	2.13*	1.30
	R_r^2	.805	.779	.802	.841	.821	.649

The variance due to subjects alone, i.e., σ_b^2 can be estimated from the "Subjects within locations" mean square and the Error mean square. These estimates are given in Table 9. An estimate of 0.0 results when the corresponding F ratio is less than 1.0.

The values of the multiple correlation, R^2, given in Table 9, represent the proportion of variation accounted for by fitting the model (1). The best value is 0.69 and the worst, disregarding variable 18, is 0.44. The fit is not very good and we speculate that this is due to the fact that we have not taken out a "Raters within locations" component. This cannot be done exactly, but an approximate procedure estimates the individual "Rater effect" by averaging the residuals from the fit of model (1) to the data, for each rater. The results are given in Table 11. A high degree of consistency for each rater across variables may be seen. A "Raters within locations" mean square and a new Error mean square has been computed and an approximate F ratio is shown. The results suggest wide variation in the raters' assessment of variable 5 (use of nonauditory information) and possibly variable 15 (travels safely) and 17 (total performance). It is seen, therefore, that the values of R^2 obtained on eliminating the additional rater component are substantially improved, but the error mean square remains about the same.

The entire set of calculations was repeated for the average score on the "Class one questions." This might serve as a summary score. The same tendencies are reflected in the estimates, but the detail is obscured, as is any indication of specific significant effects. For example, no significant trend is indicated in the estimates of time effects. Comparison of the error mean square for this average score and the 12 individual error mean squares indicates a very high average correlation coefficient between the variables--about 0.58 if the "Rater" component of variance is not removed, and about 0.52 if it is. The difference in the two estimates is probably due to estimation error.

Variable 18 (videotape rating) needs to be considered separately since it is not a mobility rating. In fact, there is no reason why model (1) should apply, unless the raters are highly influenced, in rating 18, by the previous 17 scores they have given. The estimates for variable 18 do not follow the same tendencies established by variables 1-17, α_1 is negative and the only negative treatment effect is K_3. The individual subject effects are quite small: there is a slight correlation between the variable-18 values and the "average of 12" values, and the signs of the values are the same in both cases. Only the "Rater Locations" effect appears significant--at the 10% level: thus indicating that Palo Alto raters were less critical of the tapes than were the Hines raters.

Chapter 6.

SUMMARY OF REPLIES TO QUESTIONNAIRE

INTRODUCTION

The questions comprising the follow-up questionnaire were administered in batches at prescribed intervals through the follow-up period. The point in time at which a particular question would be posed was listed against that question by means of a simple code. Thus the symbols T1, T2 and T3 associated with a question served to indicate that it should be asked during one or more of the telphone interviews. Similarly the symbols V1 and V2 referred to questions to be asked during visits made by the O&M research team.

The objectives of the questionnaire were two-fold; first to provide an insight into the subjective factors governing user acceptability; second to gather suggestions for the structural improvement of the laser cane. A total of 40 questions were posed. The replies to the questions are summarized in the following section.

THE REPLIES

Q1. Is the process of learning to use the laser cane, in your view: very easy, fairly easy, difficult, or very difficult? (T2, T3, V2)

> Initially six subjects answered "fairly easy" and two subjects answered "very easy." One of the latter changed his opinion to "fairly easy."

Q2. How would you rate your confidence in the device: very high, high, low, or very low? (T1, T2, V1, T3, V2)

> Replies to this question usually fell in the "high" or "very high" category although opinions fluctuated toward the lower categories when failures and malfunctions occurred.

Q3. Do you find the device comfortable to use? Please explain. (T1, V1, T3, V2)

> All of the subjects replied "yes" consistently, but some qualified their opinions with remarks to the effect that the diameter of the cane shaft required some time to get accustomed to and that the position of the tactile stimulator could be improved. Three subjects pointed out that the laser cane was more difficult to handle in areas with grass lines or cracked sidewalks because the tip caught too easily in the cracks, etc.

Q4. When using the laser cane, how, in your opinion, does it compare with the long cane in the following areas? (V1, T3, T2)

a) Weight

b) Balance

c) Touch

d) Position in which the device is held

i) All but one of the subjects said that they were aware of the heavier weight of the laser cane; but the majority claimed that they were able to adjust to the weight, given time. Two subjects indicated that the weight reduced maneuverability in some situations.

(ii) Replies to this question showed some evidence of instability. Some subjects rated the balance as fair-to-good. Three subjects preferred the long cane.
Four subjects concluded that there was little difference. One subject thought that the laser cane had superior balance.

(iii) Opinions on touch also fluctuated. The majority, however, appeared to favor the long cane or later took the position that the two canes were much the same. One subject concluded that the laser cane was superior.

(iv) The angle at which a cane is held can depend on the grip. Subjects with small hands or short fingers adopted unusual grips in order to reach the tactile stimulator and consequently had a tendency to hold the cane at an acute angle with respect to the ground. In one case, this was thought to be the reason why waist-high obstacles were missed.

Q5. Is the device reasonably durable? (T3, V2)

The subjects who experienced the most failures consistently responded "no." Those who experienced the least difficulty said "yes." Several subjects thought that the cane was structurally strong enough to withstand normal collisions with obstacles, although at the same time expressing doubts about its electronic durability.

Q6. Is the device reasonably maintenance-free? (V1, T2, T3, V2)

Most of the subjects were emphatic in their opinion that the device in its present form was not "reasonably maintenance-free." These opinions reflected the frequency of cane breakdowns that they had experienced. Two subjects who encountered few problems answered "yes" to the question.

Q7. Do you feel relaxed using the laser cane? (V1, T2, T3, V2).

All subjects consistently responded that they were relaxed using the laser cane. Five subjects felt it took a while, after returning home, to achieve relaxed travel. One subject expressed his concern for the safety of the cane in congested areas.

Q8. Do you feel as relaxed as you do when using your long cane or collapsible cane? (V1, T2, T3, V2)

All subjects stated consistently that they were as relaxed with the laser cane as with the long cane. Several subjects stated that they were more relaxed with the laser cane than with the long-cane, particularly on unfamiliar territory.

Q9. Are the audible signals easily interpreted? (T1, V1, T2, T3, V2)

In total agreement all subjects responded "yes" the audible signals were "easily interpreted." On several occasions a subject qualified his answer stating "under most circumstances." The most commonly mentioned situations that presented signal interpretation difficulties were areas with heavy pedestrian traffic, overpowering auto traffic noise, and after rain storms. These situations created an overabundance of signals, masked signals or meaningless information.

Q10. Do you have any difficulty telling the difference between the audible signals of the laser cane? If so, which one(s) confuse you? (T1, V1, T2, T3, V2)

Most of the subjects consistently reported they had "no difficulty" distinguishing the audible signals of the laser cane. However, a few stated that the Middle-and Lower-channel frequencies "appeared to be too close together."

Q11. Can you readily feel the tactile stimulator? If not, does it require undue concentration? (V1, T2, T3, V2)

Almost all of the subjects stated "yes" consistently. One subject, whose opinion fluctuated, owned a cane which had a weak tactile stimulator. One subject could feel the stimulator through medium thick gloves during winter. Others mentioned that without gloves in winter their fingers "got numb from the weather" and they experienced difficulty with the tactile stimulator. A side comment that two subjects made was that they found it difficult to maintain finger contact with the stimulator when weather conditions were humid or cold. Only one of the subjects felt that the tactile stimulator, with the exceptions listed, required undue concentration.

Q12. Which signal, audible or tactile, do you prefer to use for the Middle Channel? If you have preferences, under what circumstances do they apply? (V1, T2, T3, V2)

Two subjects preferred the tactile stimulator when it could be used. Four subjects preferred the audible signal outdoors and the tactile signal indoors, especially in pedestrian traffic, while two subjects almost exclusively preferred the audible signal. Qualifying statements often pointed to situational preference and a desire for both types of signals.

Q13. Does your index finger ever become fatigued or numb to the tactile stimulator? If so, under what circumstances? (T1, V1, T2, T3, V2)

Several subjects said that they initially experienced fatigue and numbness, however, toward the end of the program all subjects answered "no." The only qualification to that answer was that in very cold weather the hand would get numb due to the cold, and then it was difficult to feel the signals.

Q14. Which channel do you use the most? The least? (V1, T2, T3, V2).

All subjects consistently agreed that the Middle Channel was used the most. Three subjects stated the Upper Channel was the least used, while five subjects used the Lower Channel the least.

Q15. Are there any occasions on which you do not respond to the signals of the laser cane. If so, under what circumstances do you not respond? (V1, T2, T3, V2)

All subjects answered "yes" to the first part of this question. In situations such as heavy pedestrian traffic, narrow corridors, crowded buildings, elevators and highly familiar routes, the subjects largely ignored the laser signals.

Q16. With reference to question 15, what objects do you fail to respond to? V1, T2, T3, V2)

Lists of objects included clusters of bicycles, crowds of pedestrians, objects close to buildings, and garbage cans. Subjects finding themselves among objects of this type would ignore laser signals--particularly those arising from the Lower Channel and adopt conventional long-cane touch technique.

Q17. In which situations do you feel that the cane is most useful to you? (V1, T2, T3, V2)

All of the subjects said that the laser cane was most useful in unfamiliar areas. Some subjects listed the locating of edges--building lines, elevated platforms, etc. Others mentioned conditions of light pedestrian traffic and loud noise.

Q18. For what particular purpose is each channel most useful?
&
Q19. For what objects is each of the three channels most useful? (V1, T2, T3, V2)

All subjects agreed that the Upper Channel was useful for the detection of overhanging branches, signs, etc. Some subjects monitored objects at the side of the travel path, rolling their wrists, on occasion. One subject gauged the distance of pedestrians or obstacles by reacting to the signals with a stop response. Two subjects stated that they seldom used the Upper Channel in their home areas, while two others utilized it as a secondary warning system or scanning system for side openings.

The Lower Channel was utilized regularly by only two subjects, the purpose being to detect elevated train platform edges and shoreline them. Their comments on the Lower Channel were quite favorable. The remaining subjects had little use for the channel with the exception of detecting a known flight of stairs. None of the subjects interviewed said that the Lower Channel was useful for detecting curbs. The subjects all consistently listed use for the Middle Channel basically as an obstacle detector, with the most frequently mentioned obstacles being poles, parking meters, pedestrians, and building fronts. The amount of benefit received by the users in pedestrian traffic was said to be related to the number of pedestrians, although dense crowds generated more signals than could be usefully distinguished. The next most important use of the Middle Channel was split between providing a directional-change indication and

scanning for landmarks. The most commonly mentioned objects which could be detected were bushes, light posts, building fronts and off-sidewalk landmarks along routes. At least three subjects also located openings with the channel.

Q20. Do you feel that the range at which it is possible for you to detect objects with each channel is adequate? (T2, V2)

Four subjects consistently responded "yes." Two subjects wanted the range of the Middle Channel extended and two subjects wanted an extension of two more feet in the range of the Upper Channel. Also, at least one subject wanted a few extra feet added to the range of the Lower Channel. One subject found the present setting of 14 feet on the Middle Channel difficult to utilize in narrow indoor quarters or complex outdoor environments.

Q21. Do you find the laser cane more useful in a familiar environment or in an unfamiliar one? (T3, V2)

Regardless of how much the subjects traveled in unfamiliar areas, all consistently stated they found the laser cane more useful in an unfamiliar area.

Q22. What general differences in technique or utilization do you note with the device in familiar and unfamiliar environments? (T3, V2)

With the exception of minor differences in technique such as slowing the pace, widening cane arc or rolling the wrist to scan peripheral travel areas, the same cane technique was used by all subjects. In an unfamiliar area, scanning movements were common, with the cane thrust farther forward. All subjects consistently agree that, in familiar areas, prior knowledge reduces the amount of information from the device which is used. All subjects also agree that they pay more attention to the laser signals if they are in an unfamiliar area. Responses to this question were only moderately consistent in specifics but quite consistent in theme.

Q23. Does the device provide more aid to you in orientation or in the recognition of landmarks in familiar areas than the long cane? (T2, T3, V2)

Most subjects were consistently quite positive that the laser cane was "more helpful" in the described areas than the long cane. One subject, when first questioned, said "no."

Q24. Does the device aid you in orientation or in the recognition of useful landmarks in unfamiliar areas; how does this capability compare with that provided by your long cane in unfamiliar areas? (T2, T3, V2)

Most of the subjects consistently agreed that the laser cane was more effective than the long cane in orientation and in the recognition of landmarks in an unfamiliar area. One subject changed his response to "no" on the last interview, stating the long cane was more helpful due to its physical contact with objects which enabled the user to identify the objects. With laser beam contact, this advantage is lost because the beams are unable to convey information about texture.

Q25. Does the laser cane or its signals create any confusion in orientation procedures or hinder use of environmental information? (T1, V1, T2, T3, V2)

Seven subjects consistently answered "no" while one subject qualified his statement by pointing out that the combination a high noise level and busy traffic created a situation in which "one could easily become confused." Another subject said that the laser cane frequently attracted enquiries from the public and in the process of replying he could lose his sense of direction.

Q26. Does the laser cane give reliable and useful direct travel path information? (T1, V1, T2, T3, V2)

Consistently the responses of the four subjects were quite positively "yes," with qualifying statements relating to the Lower Channel.

Q27. Does the laser cane appear, at times, to be giving inexplicable signals? (T1, V1, T2, T3, V2)

As expected, there were inconsistent responses by all eight subjects during various segments of the follow up program. Primary reasons were malfunctions and difficulties with the Lower Channel.

Q28. Can you readily react to the tactile and/or audible signals of the device? (T1, V1, T2, T3, V2)

All subjects consistently responded "yes" with no qualifying statements.

Q29. Can you readily determine the direction and width of objects with the laser cane while traveling at your normal gait? (T1, V1, T2, T3, V2)

The majority replied that at their normal gait they could determine the direction of objects, but not the width, unless the objects were quite large. Several qualifying statements by students indicated that the dimension of width was difficult to ascertain at normal walking speeds, particularly in the case of obstacles such as bicycles and glass doors. One subject stated consistently, with some qualification, that he could detect both direction and width.

Q30. Can you roughly estimate your distance from a detected object soon enough to take the proper action? (T1, V1, T2, T3, V2)

Almost all of the subjects consistently replied "yes," while two subjects responded "yes, most of the time" during early interviews. On the last interview, one subject said "not on everything" because he felt that the detection range varied according to the type of obstacle detected with his cane.

Q31. Do you feel your line of travel has improved using the laser cane in comparison with your usual line of travel when using your long cane? (T2, T3, V2)

Six subjects consistently replied "yes" while two subjects consistently answered "no." One subject thought that the laser cane improved his line of travel considerably while another thought that his long cane travel was straighter because he plowed ahead in blissful ignorance of the margin by which he was missing obstacles.

Q32. Do you feel your speed of travel has been changed by using the laser cane as compared to your usual rate using the long cane? (T2, T3, V2)

This question was inconsistently answered by six subjects while the remaining two subjects consistently answered "no." Four subjects for the most part, and specifically on the last interview, answered "yes," claiming a slight increase in speed with the laser cane. No subject reported that the laser cane decreased his travel speed.

Q33. Do you feel that, compared to your long cane, the laser cane provides you with any added information or a state of well-being that enables you to perform differently when traveling? (T3, V2)

The majority of the eight subjects commented that they "felt more comfortable" traveling with the laser cane. All subjects listed the early-warning nature of the device and fewer collisions with obstacles as very highly valued benefits of the laser cane. Several subjects also stressed that the additional detection range of the beams adds a convenience factor in searching for landmarks or scanning the environment. One subject commented that he sometimes could create a crude picture in a known environment using the laser cane.

Q34. Are you relaxed while using the laser cane and its signals? (T1, V1, T2, T3, V2)

Toward the end of the follow-up program all subjects responded "yes" consistently to this question. However, in earlier answers some subjects indicated that the pressure to attend to laser signals made them feel tense. One subject indicated that he feared damage to the cane and was tense and apprehensive while traveling.

Q35. Does the laser cane or its signals cause you to become uncomfortable when you are around people? Do you feel the same or differently with the long cane? (T3, V2)

Five subjects responded "no" and three subjects answered "yes." One subject felt more comfortable with the laser cane because he thought that the audible signals reduced the number of collisions he made with alert pedestrians and another subject stated that, with the exception of the fact that people looked at him, he felt better with the laser cane. Two subjects said that they felt more uncomfortable and self-conscious when in the company of other people because the audio signals attracted attention. All answers for each subject were consistent.

Q36. Is the frequency or range of your travel influenced in any way when the laser cane is available? (T3, V2)

The answers given to this question on two occasions were not always consistent. At the last interview, however, most of the subjects replied "no" to the question. Three subjects responded "no" throughout the follow up interviews. For the most part, these subjects needed to travel to get to school, to work or to conduct personal business rather than for leisure.

Q37. Do you make any modifications of your conventional long-cane technique when using the laser cane? (T1, V1, T2, T3, V2)

All subjects were quite consistent in stating that, basically, their cane technique was the same with the laser cane as with the long cane. Three subjects held the laser cane closer to their bodies with bent elbows. All subjects, at times, adopted the new technique of rolling the wrist to scan the side of their path or to locate openings. In addition, all subjects reported that they carried out more scanning movements to utilize the sensing capability of the device, when attempting to locate desired landmarks. One subject developed the new technique of holding the cane in the perpendicular plane to ascend and descend stairs and further extend his use of the laser beam.

Q38. What improvements or modifications, if any, would you like to see incorporated in the present laser cane? (T3, V2)

All subjects agreed quite strongly that basically they desired a more durable and reliable cane. The suggested improvements, both mechanical and electronic, are listed below in order of frequency.

A. Increased durability and reliability of the cane.

B. Smaller diameter of crook and less bulky packaging.

C. Decrease in weight of cane.

D. Increased durability of controls against accidental breakage (dropping).

E. Relocation of controls for utilization by cane hand only while traveling.

F. More durable lower shaft.

G. Move tactile stimulator closer to end of crook.

H. Strengthen tactile stimulator.

I. Add abrasive surface or grip to cane since hands in humid or rainy weather slip out of position.

J. Add finger guard or pad so one knows if he is holding cane in proper position to receive the tactile stimulation. (One subject complained that he had cut his finger twice on the tactile stimulator.)

Q39. What additional information would you like to add to this interview? (T1, V1, T2, T3, V2)

The majority of the answers to this question were usually given in response to other questions. Additional comments were concerned with repair problems associated with the canes and with the various personal adjustments that must be made in order to utilize the laser cane and its signals effectively. Several subjects required a period of months to accomplish the adjustment task, with one subject once hovering on the brink of returning his cane.

One subject commented that he preferred the long cane in snow and wet weather while another thought that he was a more confident traveler with the laser cane and became disorientated less frequently. The provisions for separating the upper and lower sections of the cane drew criticism because it was thought to be unnecessarily difficult to realign the components correctly when assembling. A subject from Palo Alto reported that he had given demonstrations of the laser cane to several groups and organizations.

Q40. Would you like to continue to use the laser cane? Can you give a rough percentage estimate of the extent to which you would like to use the laser cane in the future? (T3, V2)

All subjects were quite consistent in answering this question affirmatively over the course of the follow up period. Five subjects said that they would use the cane 100% of the time in lieu of the long cane, except on occasions when they are accompanied by a sighted guide. One subject stated that he would use the laser cane 95% of the time, but added no qualifying conditions. Another subject stated that in his small college town he does not have as much use for the laser cane as he might in other areas. All subjects were strong in their positive opinions of the laser cane, although quite concerned about its breakdown frequency.

SUMMARY OF SUGGESTED MODIFICATIONS

The summary provided here is concerned with recommended modifications which extend beyond the minor changes which were implemented both prior to and during the study. These are divided into three parts. Part (i) lists those made by the eight subjects. Part (ii) contains the recommendations and observations which were put forward both by the subjects and the O&M specialist colleagues of the research staff. Part (iii) concludes with a summary of the observations and recommendations agreed to by the O&M research staff. Each part reflects the topics of special interest to the group involved. No ordering in terms of importance has been attempted and no value judgments are implied by the presentation of these proposals in three parts.

Part (i) Recommendations made by subjects

1. A Palo Alto subject suggested making a one-piece cane instead of the present two-piece one.

2. All Palo Alto subjects advocated elimination of the Lower Channel.

3. The lower shaft sometimes rotates out of the correct position and makes it difficult to align the upper and lower shafts correctly for proper cane tip orientation. A Palo Alto subject suggested that an eccentric coupling concept might be used to solve this problem. A Hines subject suggested that the junction of the upper and lower shafts could be connected by a triangular-shaped union which he thought would be easier to sense than the two raised dots which are used to indicate the correct alignment.

4. Some subjects claimed that the Lower Channel signal was too loud and tended to mask the other channels. They suggested that the loudness level should be reduced.

5. It was suggested that a prescription cane should be made available with only Upper and Middle channels available. In addition, the upper signal should be softer than the middle signal.

6. Two of the subjects complained that the grip was too large for people with small hands.

7. One subject recommended putting a raised ring around the tactile stimulator so the index finger would not rest against it. He felt that this would enable the finger to be more sensitive to the movement of the tactile stimulator when it is activated.

8. Another subject suggested that the Lower Channel components should be located at the bottom of the cane and that they should be made to function more accurately.

9. It was suggested that a zippered cover for the cane be made, particularly for the upper shaft.

10. The Hines subjects recommended retaining the present Forward or Middle Channel detection range.

11. The Hines subjects recommended retaining all three channels but wanted all to be more reliable.

12. The screws holding the cane together tend to come loose and one of the Palo Alto subjects carries a screwdriver with him to tighten them. He therefore suggested that a setting compound be used to prevent the screws from rotating under vibration.

13. Some of the subjects thought that the upper and lower shaft of the cane did not fit as snugly as it should and suggested that this feature should be improved.

14. At least one subject reported that when the cane first returns after being repaired, the tactile stimulator vibrates strongly, but gradually loses its effectiveness as time passes.

15. One Hines subject stated that since in hot, humid weather his hands perspire freely, an abrasive surface should be provided around the grip to keep the cane hand from slipping.

16. This same subject recommended positioning all the controls in such a way that they can be operated with the cane hand while he is moving.

17. A Palo Alto subject recommended recessing the tactile stimulator.

Part (ii) Recommendations and observations made by subjects and O&M specialists

1. The reliability and durability of the laser cane must be improved and the breakdown frequency must be reduced.

2. The cane should be more streamlined and the weight and diameter of the upper shaft reduced.

3. The amplitude of vibration of the tactile stimulator must be made more uniform across canes and the stimulator must be relocated higher up the shaft to accommodate persons with smaller hands.

4. The present Range-Setting Control sticks out too far from the cane shaft and is vulnerable when the cane falls. It is recommended that the controls on future canes be made flush with the shaft, or recessed, to eliminate or reduce the possibility of breakage due to falling.

5. Future canes must be weather-proofed so that they will work when it rains.

6. A very high degree of quality control must be the rule with future canes.

7. There was unanimous agreement that the protruding prism associated with the Upper Channel must be eliminated.

Part (iii) Recommendations and observations made by O&M researchers

1. Future laser canes should not be made of boron because this material is not as safe as we would wish. In accidents involving collisions and broken shafts, the filaments which appear at the break are dangerous.

2. Consideration should be given to redesigning the entire outer shell of the cane because it has lacked durability when under mechanical stress and when dropped.

3. Unless the Lower Channel is made more reliable and stable and can give useful and dependable information, it seems that it should be eliminated or made optional.

4. An acceptable battery lifetime may be shorter than has hitherto been thought necessary. A two-hour battery lifetime is sufficient if spare batteries can be carried.

5. Provision for attaching a good telemetry system, including an earphone for the purpose of monitoring, should be included when the laser cane is manufactured.

6. The audio outputs should be investigated to determine which frequencies are most compatible with traffic patterns and less likely to be masked by traffic sounds.

7. The use of quick-charge batteries should be investigated and adopted if practical.

8. Removable rather than sealed batteries should be used, if practical.

9. A charging unit which can be plugged into an auto cigarette lighter receptacle might be produced as optional equipment.

10. The battery tester on the present cane is a useful tool but could be even more useful if it were made to indicate low voltage automatically by means of an audio or tactile signal or both.

11. Some future canes must be built for left-handed as well as right-handed users.

12. A vibratory system activating the entire crook of the cane or upper shaft should be investigated as a superior substitute for the tactile stimulator.

Chapter 7.

CONCLUSIONS

INTRODUCTION

In this the concluding chapter, we gather together the main findings which have emerged from the evaluation study. It will be recalled that the Subtask Checklist and the Task Rating Form did not entirely meet our expectations and that the data were insufficiently reliable to allow us to draw firm conclusions. Inadequate control made a contribution to some of the difficulties experienced with the rating methods. For this failure the panel must accept much of the responsibility, although, under the circumstances, it is unlikely that a group of part-time, widely scattered researchers of varying experience could have foreseen all of the pitfalls that had to be avoided. Nevertheless, however vexing they may be, these shortcomings should not be allowed to disguise the fact that the laser cane did not stand out as a travel aid strikingly more effective than the long cane and hence any differences which may have been present in the data were easily masked by other factors. To the credit of the metrically based procedures, it must be noted that, at the very least, the time spent in carrying them out gave the evaluators ample opportunity to observe the traveling subjects in a wide variety of surroundings and to discuss thoroughly with them their impressions and opinions of the laser cane. From these encounters, numerous valuable insights and tangible proposals were developed which have been recorded in this report.

The other sources of data which have contributed to our conclusions include the opinions expressed by colleagues of the O&M research staff and of course those of the panel members. In addition we have utilized the replies obtained from our Subject Questionnaire and the repair records which were kept on the ten laser canes. Also not overlooked are such observations as the fact that, at the end of the program, all eight subjects continued to use their laser canes although one of the volunteers returned his cane some months later. The obvious implication of this statement could be countered by arguing that, like the Victorian aspidistra, the laser canes were retained primarily as conversation pieces. However, the frequently expressed distaste of most subjects at the idea of being closely observed (particularly by strangers) while using the laser canes, leads one to think that they do not relish any notoriety that the canes may attract.

Drawing, therefore, upon all of these sources, we submit the following as the major findings of this evaluation study, listed under three subheadings:

Utility of the Laser Cane

1. On the basis of both the observational, subjective and objective data the overall mobility performance of above-average long-cane travelers is only marginally improved if the laser cane is used.

2. The laser cane is most effective in two principal situations:

   (a) in moderate density urban traffic along familiar routes provided that the cane's acoustic signals are not masked by traffic noise

   (b) in unfamiliar urban areas with low traffic activity.

3. The laser cane is least effective:

   (a) in residential areas whether familiar or unfamiliar to the traveler

   (b) in the high density, very noisy traffic conditions which prevail downtown during big city rush hours

   (c) in the confined conditions prevailing in the interiors of buildings, elevators and crowded corridors.

4. The blind users place a higher value on their ownership of a laser cane than their performance gain would appear to justify. A corollary of this observation is that laser-cane users believe that their performances with the laser cane are better than the assessments of skilled mobility trainers would indicate.

5. There is no evidence which would indicate that the availability of the laser cane significantly increased the travel frequency of the subjects.

Structure of the Laser Cane

1. The next batch of canes* should be designed to achieve a considerably higher standard of reliability than prevailed in this study. Specifically, it is recommended that the first few C-5 models should be subjected to a regime of environmental testing with the objective of achieving the expectation of a minimum-time-between-failure of not less than six months.

2. The structural modifications listed earlier in this report should be given careful consideration. From this list four proposals are repeated here for special emphasis.

   (a) The lower shaft should be made from a stronger, less brittle material.

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*An order for 35 C-5 laser canes was placed with Bionic Instruments, Inc., before the preliminary evaluation program was completed.

(b) The lower shaft should be keyed with the body of the laser cane so that the two components can be easily and precisely reconnected.

(c) The optical component housing should be made smaller and less vulnerable to damage.

(d) The Lower Channel should be re-engineered to achieve its design goals of reliably detecting down curbs.

3. User efficiency would be increased if the tactile stimulator could be redesigned to increase its ability to capture the traveler's attention. A vibrating handle is a possible solution, if the power demands it would make can be met.

RECOMMENDATIONS FOR THE FUTURE

1. Plans should be laid well in advance to ensure that the maximum amount of information can be gathered from the next batch of 35 laser canes when they become available.

2. Consideration should be given to conducting the next evaluation trial with subjects who fall into the categories of poor traveler, novice traveler, and good long-cane traveler, respectively.

3. In future studies more training time should be allocated and the training regimen should be very carefully planned to increase efficiency.

APPENDIXES

CONTENTS

Appendix I

PRELIMINARY DATA COLLECTION

INTRODUCTION

During the training program objective data were collected and recorded on a pilot basis for the purpose of assessing the performance of the laser cane, the subjects' ability to learn particular tasks, and the appropriateness of the teaching format. The data-collection procedures were directed primarily at early skill acquisition and incidentally carried the benefit of providing additional practice with the device.

Six different evaluation procedures were used at various stages of the training program. The overall intent of these procedures was to gain an insight to progressively more complex aspects of device utilization. Thus after an initial 5-8 hour introduction to the three channels of the devices, a detection test, an avoidance test, and an obstacle-course test were administered. Further into the program (2nd, 3rd, and 4th weeks) three Channel Use Recordings were made as the subjects traveled in various environments. At the end of the fifth week, performance ratings of the subjects, traveling with the long cane and the laser cane over four routes, were conducted by a panel of O&M specialists who observed the runs. During these runs assessments of specific mobility subtasks and critical travel events were made by two investigators according to a checklist.

In this appendix each testing procedure is outlined and discussed separately. The impressions and recommendations of the testing team are also included. Several improvements in procedure were incorporated into the follow-up program and are discussed more completely in later appendixes.

Of the fifty or so hours spent on the training course, seven hours were specifically used for testing. Three hours were occupied on the dual tasks of recording data and providing the subjects with routine travel lessons. In general the above-average travelers employed in the project completed the various tasks somewhat faster than anticipated. It is conceivable that, in the absence of any testing procedures, the instructional time for good long-cane travelers may fall around forty hours or less. Less capable subjects may dictate more extensive training. A totally open-ended program, allowing for individual differences, would of course be ideal. However, from the results of the tests which were administered and the comments obtained from students and from instructors, it appears that the instructional material developed in this study was both useful and appropriate.

DETECTION TEST

METHODOLOGY

The purpose of the detection test was to measure the detection range of the Middle Channel of the laser cane while recording each subject's ability to perceive the audio and tactile information display and respond to it appropriately. The test was administered after 5-8 hours of initial instruction and was conducted in a controlled environment.

The test area was an outdoor asphalt parking lot. A portion of the lot 110 feet by 65 feet was utilized with the placement of two vertical poles 15 feet apart connected by a cord strung at shoulder height. The cord acted as a guideline in aiding the subject to walk in a straight line from pole to pole by loosely grasping the cord in the left hand while utilizing the laser cane in the right hand. The subjects practiced using the rope guideline prior to testing.

The subjects were asked to walk from pole to pole at their own rate of speed using the laser cane in the conventional Touch Technique and to stop when they perceived a signal (audio or tactile) from the device indicating that the beam had detected an obstacle. Randomly selected obstacles were positioned at various distances along the path. The ten obstacles were positioned so their largest detection surface faced the travel path. The ten obstacles were:

Code Number	Color	Composition	Size
1. Garbage Can	Tan	Metal	32 gallon
2. Ladder	Brown	Wood	6 foot
3. Box	Brown	Cardboard	36 x 18 inches
4. Bicycle	Green	Metal	24 inches
5. Waste Receptacle	White/Olive	Metal	34 x 18 inches
6. Clothes Tree	Gray	Metal	1" square 66" high
7. Person	White Shirt Dark Pants	Natural	6 foot
8. Shrubbery	Green	Natural	Medium Size
9. Vertical Pole	Silver	Metal	1 1/2"dia. 36" high
10. Lattice Surfaced Wall	Tan	Wood	4'x 4'section

Each subject was given two random trials at each obstacle using the tactile stimulator and two trials at each obstacle using the audio signal from the Middle Channel of the cane. The beam range was set at maximum (12 - 14 feet). A total of forty trials per subject were recorded on data forms (Table A1). Two measurements in inches were recorded on each trial which terminated in the subject either responding to a cane signal by stopping, or making cane contact with the obstacle.

The first measurement was the distance in inches from the tip of the laser cane to the obstacle when the warning signal was first heard on a special monitoring device used by an investigator. The purpose of this measurement was to record the distance at which the laser beam detected various obstacles and the exact distance from the obstacle that the subject first received the warning stimulus. The second measurement was the distance between the cane tip and the obstacle measured when the subject had made a complete stop. The two measurements represent a detection range measurement for the device and the subject's reaction distance to the stimulus.

TABLE A1

DETECTION TESTS: MIDDLE CHANNEL ONLY
(Setting at far range. All measurements in inches)

DATE _____

TIME _____

OBSTACLES

		1	2	3	4	5	6	7	8	9	10
AUDIBLE TRIAL 1	M. D.										
	S. D.										
AUDIBLE TRIAL 2	M. D.										
	S. D.										
TACTILE TRIAL 1	M. D.										
	S. D.										
TACTILE TRIAL 2	M. D.										
	S. D.										

M. D. = Monitor detection (Distance of cane tip from obstacle when monitor indicates that signal has been transmitted.)

S. D. = Subject detection (Distance of cane tip from obstacle when subject stops or checks his forward pace.)

RESULTS

In Table A2, the detection distances measured in inches per obstacle and individual are listed, with each distance representing the mean of the combined audio and tactile trials. Only trials where both the laser cane and the subject responded were computed in the means. There were some individual differences in detection ability between the laser canes used by different subjects. Subject P2 utilized a cane that originally had the best detection ability, averaging 102 inches for all trials, while the cane of Subject P3 averaged only 57 inches. The mean detection range for all canes was 79 inches per trial.

TABLE A2

MEAN DETECTION DISTANCES (INCHES) - DETECTION TEST - ALL TRIALS

Subject	Obstacle										All Obstacles
	1	2	3	4	5	6	7	8	9	10	
H1	71	57	98	112	99	21	87	83	42	92	79
H2	76	71	84	74	85	45	66	83	54	71	71
H3	81	117	107	77	106	49	85	94	57	102	88
H4	55	45	88	79	92	28	64	73	41	70	63
P1	95	62	117	72	80	64	97	112	74	114	89
P2	108	79	128	84	104	80	98	126	85	129	102
P3	65	28	92	29	38	30	61	70	32	100	57
P4	80	76	119	91	100	85	88	106	75	110	96
All Subjects	79	67	104	77	88	50	89	93	58	98	79

The detection distances also reflected some variation with respect to the types of obstacles detected. The furthest obstacles detected (3,5,8,10) were the cardboard box, waste receptacle, shrubbery, and the lattice-surfaced wall. Obstacles (2,6,9) which were detected at the shortest distances were the ladder, clothes tree, and the vertical pole.

Category A of Table A3 shows that the laser canes detected target obstacles and provided signals successfully on 314 trials from a total of 320 trials. Moreover, of the 314 laser-cane signals, the subjects responded to 302. As a group the subjects responded slightly better to the audio signal than to the tactile. The mean group reaction distance was 15 inches per audio trial compared to 21 inches per tactile signal. The subjects failed to respond to 2 audio trials and 10 tactile trials. On the whole, in the controlled testing situation, the short reaction distances and the low number of non-responses appear to indicate good man-machine integration. From these results it is apparent that, with a minimum amount of instruction and practice, the subjects were able to perceive the warning stimuli generated by the device.

TABLE A3

CANE AND SUBJECT DETECTION RESPONSES - DETECTION - GROUP DATA

Category	H1	H2	H3	H4	P1	P2	P3	P4	Total	Total Trials
A. Number of trials laser cane did not detect obstacle	0	0	0	0	2	0	3	1	6	(320)
B. Number of trials Subject did not respond to audio signal	0	0	0	1	0	0	1	0	2	(158)
C. Number of trials Subject did not respond to tactile signal	0	0	0	1	0	0	4	5	10	(156)
Subject mean reaction distance (inches for audio trial)	9	19	16	19	12	12	13	17	Mean = 15"	
Subject mean reaction distance (inches for tactile trials)	6	19	18	20	18	16	20	49	Mean = 21"	

COMMENTS

During the administering of the test, noticeable differences among the canes were observed. Several of the subjects throughout this and subsequent testing commented at some point on the variability among the tactile stimulators of various canes. Some canes transmitted the tactile signals with a greater amplitude than others. Another point observed was that some subjects at times in the testing displayed improper cane hand position. Ideally, the laser cane should be held with the cane hand centered directly in front of the midline of the subject's body. This position affords the furthest detection range. If the cane is positioned to either side of the midline, reduced range and incorrect obstacle localization results. On several occasions this was observed during the testing and, in subsequent portions of the follow-up program, this continued to be observed.

AVOIDANCE TEST

METHODOLOGY

Following the detection test,an avoidance test was given which assessed the performance level achieved by subjects in circumventing selected obstacles in a controlled environment. It is well known that even when an instrument which can detect objects and enable the subject to avoid contact is available it is not always used. The laser-cane traveler may seek contact deliberately to acquire more knowledge of the object and the environment in general or, in cases where known landmarks exist, provide confirmation of their location. Other reasons for contact may vary from lack of attention to inaccurate interpretation of the information. Early experience with the laser-cane demonstrated several of these reasons for contacts. However, whatever he should choose to do with the information, a traveler should be confident that once having detected an object with his mobility aid, he can circumvent it if he so desires. In addition,it is of some importance that a subject, in the final analysis, be able to function with a device at close to his normal travel speed.

The successful avoidance of an obstacle can be seen as being dependent upon four factors:

(i) The detection of an obstacle at a sufficient distance to enable the subject to react to the signal in time,

(ii) An accurate percept of the distance and position of the obstacle in relation to the subject's direction of motion,

(iii) An appreciation of the dimensions of the obstacles, and

(iv) The subject's ability to make a rapid mental assessment of these factors and, after avoiding the obstacle, resume the original line of travel.

The avoidance test was given in the same outdoor area as the previous test and the same ten obstacles were used. (See Table A4.)

The obstacles were randomly spaced about the practice area. Each subject individually was given two trials per obstacle, using the tactile stimulator on one trial and the audio system on the other for a total of twenty trials. All three channels were used with the Middle Channel set at the "far" range. The trials required the subject to use the laser cane in the conventional Touch Technique manner and to walk across the practice area attempting to detect, avoid, and circumvent an obstacle without any physical body or cane contact. A sound source (radio) was placed opposite the traveler and switched on for a minute to provide the subject with an indication of the direction he should take. Unless the subject deviated from his collision course with the obstacles no additional sound clue was provided. During these trials, the radio was placed at various distances behind the obstacles to ensure that the subjects would not be able to guess the distance of any of the obstacles. The distances between obstacles and their order of presentation were varied to prevent test learning. All subjects were permitted to travel at their own travel speeds. A trial terminated when a subject either success-

fully detected and circumvented an obstacle or made body or cane contact with it. There was no predetermined order of selecting obstacles resulting in varied approach distances and irregular patterns of approach around the practice area. All of the avoidance trials were monitored by an investigator with a telemetry system. Several dummy trials in which no obstacles were used were introduced from time to time. The use of the telemetry monitor determined whether or not the laser beam had detected an obstacle, and provided the subject with a signal. If, on occasions, the subject drifted off course and missed the obstacle, or the laser cane failed to detect the obstacle, no record of the trial was made and the test was repeated again later.

The scoring for the trials consisted of marking one of three defined categories. A "yes" for a successful trial (circumventing an obstacle without any contact), "CC" for an unsuccessful trial (making cane contact while attempting to circumvent an obstacle), "BC" for an unsuccessful trial (making body contact while attempting to circumvent an obstacle. It was possible to score a "CC" and "BC" for the same obstacle if both occurred.

Two conditions were required before the subjects were scored on a trial;

(i) The telemetry system must have verified that the laser cane did in fact provide the subject with a signal.

(ii) The subject must have verified he received the signal by motioning with his left hand to inform the scorer. The individual results were recorded on the data sheet shown in Table A4.

RESULTS

Table A5 contains the individual results of the avoidance test for the eight subjects. In varying degrees, the individuals performed at adequate skill levels for beginning students. Subject P2 had the best combined trials score with only two cane contacts out of his twenty, while subject P3 made the most contacts with six cane contacts and one body contact in his trials. As a group the subjects averaged 4.5 contacts over twenty trials. In trials comparing the use of the audio versus the tactile signal the subjects showed little difference in performance levels. As a group, as seen in Table A6, the subject performance level was only slightly improved when the audio system was used. The combined trials for the group showed that they were successful in 124 trials out of a total of 160 trials (i.e., 78% of the time).

OBSTACLE COURSE TEST

METHODOLOGY

To conclude the performance testing of the subjects during the initial phase of instruction, an obstacle course test was administered. The procedure followed the avoidance tests and preceded the start of training in residential areas.

TABLE A4

DATA SHEET FOR AVOIDANCE TEST

STUDENT -- H1 H2 H3 H4 P1 P2 P3 P4 ALL CHANNELS USED

DATE _____ MIDDLE CHANNEL RANGE AT FAR

OBSTACLES	AUDIO TRIAL 1		TACTUAL TRIAL 2	
1. ASH & GARBAGE CAN				
2. WOODEN 6' LADDER				
3. CARDBOARD BOX				
4. GREEN 24" BICYCLE				
5. METAL RECEPTACLE				
6. CLOTHES TREE				
7. PERSON				
8. SHRUBBERY				
9. VERTICAL METAL POLE				
10. WOOD LATTICE SURFACE				

SYMBOLS USED

YES = Correct Response - Circumventing obstacle without contact of any sort.
CC = Incorrect Response - Making cane contact while attempting to circumvent obstacle.
BC = Incorrect Response - Making body contact while attempting to circumvent obstacle.

(BOTH CC AND BC CAN BE SCORED ON SAME OBSTACLE IF THE OCCURRENCES TRANSPIRE)

GROUND RULES

1. ALL CHANNELS ARE TO BE USED. THE MIDDLE-CHANNEL RANGE IS TO BE SET AT "FAR."
2. Trial 1 involves the use of all channels. The Middle Channel signal to be specified as audio only. (The student will not be allowed to use the tactile stimulator.)
3. Trial 2 involves the use of all channels with the Middle-Channel signal being displayed only by the tactile stimulator. (Turn off student's Middle-Channel audio switch.)
4. Two conditions must be met before a student can be scored when attempting to avoid and circumvent an obstacle (if not, repeat the test):
   a. The student must hear or feel signal. This he shows by flipping his wrist to let the scorer know.
   b. A research team member, via the monitoring system, must have heard that the cane provided the student a signal.

TABLE A5

INDIVIDUAL DATA - AVOIDANCE TEST

OBSTACLES		1	2	3	4	5	6	7	8	9	10	TOTAL SUBJECT CONTACT
SUBJECT												
H1	AUDIO	X	X	X	X	X	CC	X	X	X	X	1
	TACTILE	X	CC	X	X	X	CC	X	X	X	CC	3
H2	AUDIO	X	CC	X	X	X	CC	X	X	X	X	2
	TACTILE	X	X	CC	X	X	X	X	X	X	CC	2
H3	AUDIO	X	X	CC	X	X	X	CC	X	X	X	2
	TACTILE	X	X	X	CC	X	CC	X	CC	X	X	3
H4	AUDIO	X	CC	X	X	X	CC	X	X	X	BC	3
	TACTILE	X	X	CC	X	X	X	X	X	CC	X	2
P1	AUDIO	X	X	X	CC	CC	X	X	X	X	X	2
	TACTILE	X	X	CC	X	X	X	X	X	CC	X	2
P2	AUDIO	X	X	X	X	X	X	X	X	X	X	0
	TACTILE	X	X	X	CC,BC	CC	X	X	X	X	X	2
P3	AUDIO	X	X	X	CC	CC	X	X	X	X	X	2
	TACTILE	CC	X	X	CC,BC	CC	X	X	CC	X	X	4
P4	AUDIO	X	X	X	CC	CC	X	X	X	X	X	2
	TACTILE	X	X	X	BC	X	CC	X	X	X	X	2
TOTAL OBSTACLE CONTACT		1	3	4	7	5	6	1	2	2	3	

CC = CANE CONTACT
BC = BODY CONTACT
X = SUCCESSFUL TRIAL

TABLE A6

AVOIDANCE TEST - GROUP DATA

	Successful Trials	Unsuccessful Trials Cane Contact	Unsuccessful Trials Body Contact
Audio Trials 80	66 (83%)	13 (16%)	1 (1%)
Tactile Trials 80	58 (73%)	19 (24%)	3 (3%)
Total Trials 160	124 (78%)	32 (20%)	4 (2%)

The obstacle course tests were conducted on the same outdoor practice area as the previous tests. The asphalted area was marked with a 30 foot by 90 foot grid. The ten obstacles used in the previous tests were then arranged in a specified pattern (see Table A7). Three different starting positions were chosen. Each subject began from each randomly selected starting position twice, once with the long cane and once with the laser-cane to make a total of six trials.

At the beginning of the test, each subject was instructed that his task was to walk as directly as possible towards the sound source and to locate it by physical contact. The subject was informed that he would encounter a number of obstacles along the way and that he was to walk around them with as little physical contact as possible and proceed towards the sound source. He was told that he could transverse the course at his own speed, although, he was asked not to stop along the route. The student was also instructed that, on the Middle Channel, he may use either the tactile or audio output or both. The Middle Channel was set at its "far" range.

A data form (Table A8) containing a schematic diagram of the obstacle course was used for each trial. The travel path of each subject was drawn in by an observer; body contact with an obstacle was recorded by the notation "BC" and cane contact by the notation "CC." The subject's total travel time (the time which elapsed from the time he started moving to the time he physically contacted the sound source) was recorded although a fast time was not the primary objective of the trial.

RESULTS

The individual results of the subjects are shown in Table A9. Subject H1 recorded the test trial performances with the laser cane by transversing the course without contact in all three trials. Subjects H3, H4, P1, P3 recorded small improvements with the laser-cane, and Subjects H2, P2, P4 scored about the

same amount of contact with either device. Using the laser cane the subjects recorded nine perfect runs out of the twenty-four total trials to only one with the long cane. Table A10 contains the group results showing the total number of contacts with the long cane to be about twice that of the laser-cane, while the laser cane trials averaged seven seconds more per trial.

CHANNEL USE RECORDING

METHODOLOGY

During the second, third, and fourth weeks of training, recordings were made of the subjects using the laser cane in an attempt to assess man-machine factors. The channel-use recordings attempted to measure the magnitude, distribution, and utilization of the signals generated by the laser cane over typical travel routes.

Each subject was monitored once a week for three weeks while traveling during a regular lesson. Recordings were made during the second, third, and fourth week on:

(i) a residential travel route,

(ii) a combined residential--light business travel route,

(iii) a business travel route.

The subjects were aware that the recordings were being made and were allowed to choose whatever laser-cane setting they felt to be necessary.

The laser-cane signals were monitored via a telemetry system enabling the investigator to record each signal and observable subject response. The subject response was assessed according to three defined categories of "appropriate," "inappropriate," and "no-response" on the data form shown in Table A11. A "no response" resulting in a body or cane contact was recorded with a "C". As a group, the subjects traveled 240 blocks while crossing 240 streets on these runs. The mean signal input per run of ten blocks was 358 signals. It was found that the subject received about 35 signals per block distributed among the three channels as follows; four signals on the low channel, 26 signals from the middle channel, two from the upper channel, and two combination signals. The lowest number of signals generated in a run was 146 signals, the highest was 986 signals, and the median was 347 signals.

RESULTS

Table A12 contains the group data for all the recordings. The results show that most subjects were observed to respond appropriately to signals about 50 percent of the time. An exception was the down channel which was ignored almost 80 percent of the time.

COMMENTS

The administration of the channel use recording procedure posed several difficulties to the investigators. The results should be viewed as crude, indicators rather than exact statements. The rapidity of signal generation,

spurious signals due to malfunctions and weakly defined response categories made very accurate data difficult to obtain. Coupled with these problems was the inherent difficulty of observing slight behavioral changes in skilled performance.

In general, the data show that the subjects were obliged to process a considerable signal load during their travel. With the exception of the lower channel, the subject either responded "appropriately" to the signal or did not respond at all. Very few "inappropriate" responses were recorded. Interestingly, whether the subject responded inappropriately or not at all, very few physical contacts were made.

ORIENTATION AND MOBILITY TASK RATING SCALE

METHODOLOGY

At the end of the training program the travel performance of the subjects was rated by a group of Orientation and Mobility Specialists on four travel routes. On two of these routes the subjects used the laser cane and on two comparable routes the long cane was used. All four routes, labeled A through D, were eight blocks in length and included eight street crossings. Routes A and B passed through areas that contained four residential blocks and four blocks containing light business. Routes C and D passed through heavy downtown urban areas. The long cane was employed on routes A and D and the laser cane on routes B and C.

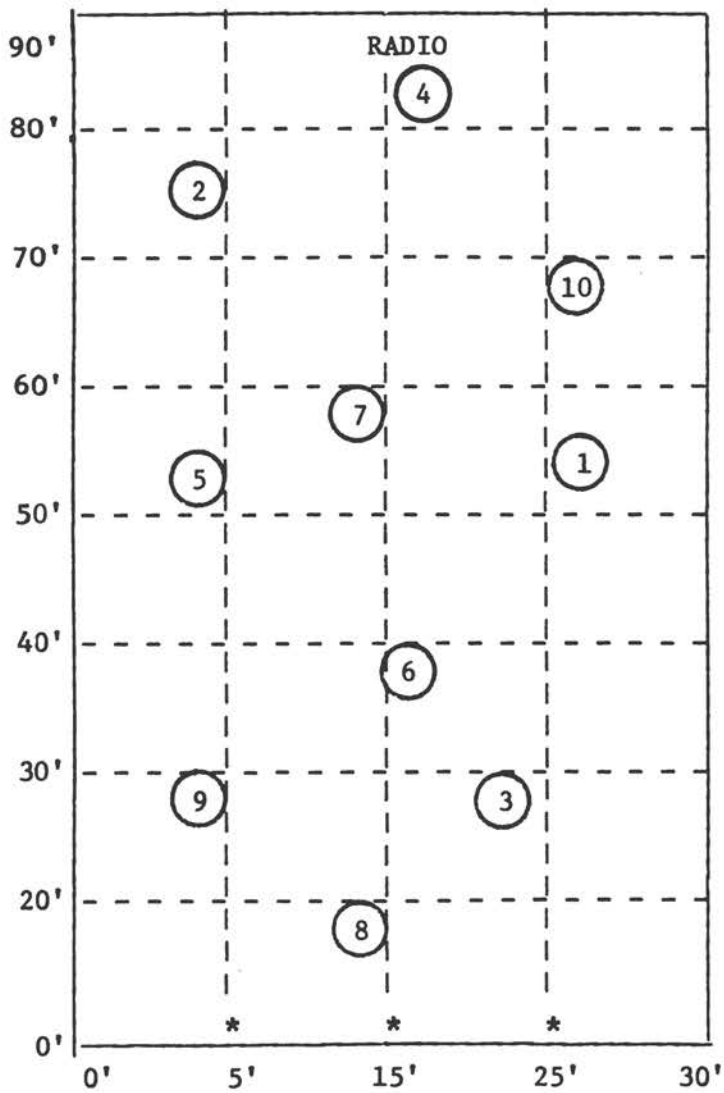
The subjects were not familiar with any of the chosen routes prior to undertaking the evaluation runs but, just before setting out, were informed verbally about the pattern of the run and the distance to be traveled. The names of streets, landmarks, or compass directions, however, were not given. The subjects were assured that on any occasion on which assistance might be required, it would be provided by one of the investigators and they were asked not to accept any assistance from the general public. Any subject who became disoriented and was unable to gain his orientation within five minutes was provided with assistance. Also in situations in which a subject's personal safety was in jeopardy, or a wrong turn or route reversal was made, assistance was given by the investigators.

The O&M raters followed the progress of each subject and, on the conclusion of his run, marked an O&M Task Rating Scale Form (Table A13). The rating scale contained eleven questions divided into two categories. Category one contained eight questions dealing with specific characteristics of travel performance, while category two contained three questions asking for judgments on the subjects overall performance. For each question, the rater judged the performance on a five-point scale whose extremes were labeled "very well" and "very poorly." The rating scale and the questions were discussed with each rater prior to his observations to ensure that he fully understood each question. All raters were instructed to mark each performance separately and to main uniform criteria. All rating forms were completed immediately following each observation and returned to an investigator.

TABLE A7

OBSTACLE COURSE TEST

STANDARD PLACEMENT AND DIMENSIONS



*Quasi-random starting points for 3 trials with each cane.

OBSTACLES

1. Ash and garbage can
2. Wooden 6' step ladder
3. Cardboard box
4. Green 24" bicycle
5. Metal waste receptacle
6. Clothes tree
7. Person (wearing dark pants and white shirt)
8. Shrubbery
9. Vertical metal pole
10. Wood lattic surface

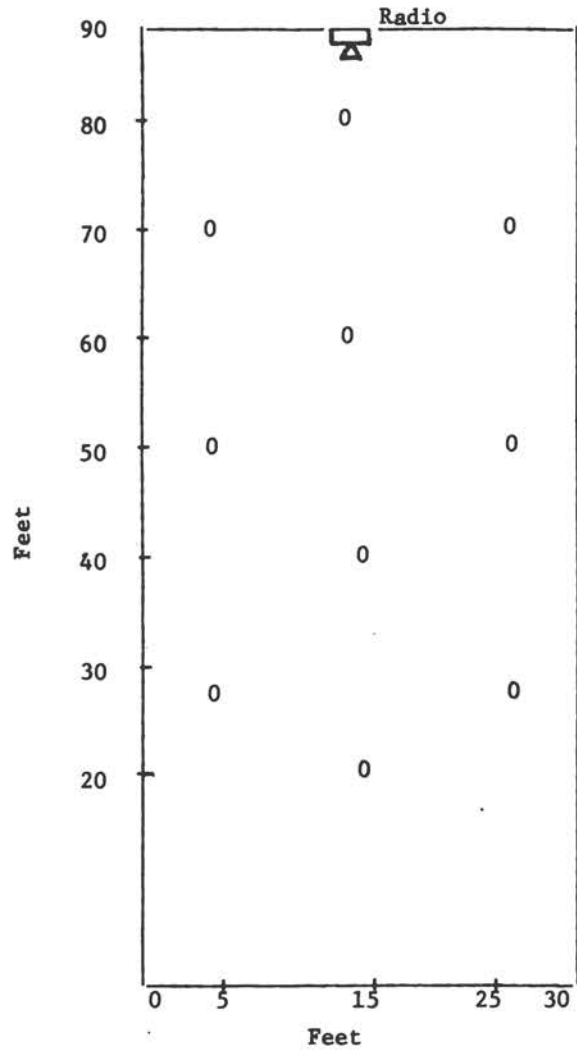
TABLE A8

OBSTACLE COURSE TEST

Student -- H1 H2 H3 H4 P1 P2 P3 P4 Long Cane Trial -- 1 2 3

Date _____ Laser Cane Trial -- 1 2 3

Middle Channel Preference: Audible ____ Tactile ___ Both ___



	LONG CANE TRIALS			LASER CANE TRIALS		
	1	2	3	1	2	3
Body Contact (BC)						
Cane Contact (CC)						
Time						

TABLE A9

INDIVIDUAL DATA - OBSTACLE COURSE TEST

	LONG CANE			LASER CANE		
	CANE CONTACT	BODY CONTACT	TIME (SECONDS)	CANE CONTACT	BODY CONTACT	TIME (SECONDS)
SUBJECT H1						
TRIAL 1	1	0	41	0	0	65
TRIAL 2	2	0	39	0	0	42
TRIAL 3	1	0	35	0	0	45
SUBJECT H2						
TRIAL 1	1	0	27	1	0	29
TRIAL 2	1	0	22	1	0	35
TRIAL 3	2	1	30	1	0	28
SUBJECT H3						
TRIAL 1	1	1	34	2	0	44
TRIAL 2	1	0	30	0	0	33
TRIAL 3	2	0	34	0	1	34
SUBJECT H4						
TRIAL 1	2	1	30	0	1	30
TRIAL 2	1	0	30	0	0	33
TRIAL 3	1	0	28	1	0	31
SUBJECT P1						
TRIAL 1	2	0	30	0	0	34
TRIAL 2	2	0	27	1	0	33
TRIAL 3	1	0	27	1	0	33
SUBJECT P2						
TRIAL 1	1	0	28	1	0	34
TRIAL 2	1	0	28	0	0	30
TRIAL 3	0	0	26	0	0	29
SUBJECT P3						
TRIAL 1	1	0	27	0	0	38
TRIAL 2	3	1	36	1	0	36
TRIAL 3	2	1	33	1	0	38
SUBJECT P4						
TRIAL 1	2	1	33	1	0	51
TRIAL 2	1	0	31	1	0	47
TRIAL 3	1	0	29	1	0	47

TABLE A10

OBSTACLE COURSE TEST - GROUP DATA

Trials (48)	Long Cane (24)	Laser Cane (24)
Perfect Trial Without Contact	1	9
Body Contact with Obstacles on Trials	6	2
Cane Contact with Obstacles on Trials	33	14
Total Contact with Obstacles	39	16
Average Time per Trial (seconds)	30	37

An interesting point to note is that the most commonly contacted obstacle with either cane was the bicycle which was positioned in front of the sound source. This presented repeated problems to all subjects. In the 24 trials with the laser cane, contact was made with the bicycle 11 times and only 5 times with 3 other obstacles. In the 24 long-cane trials the subjects contacted the bicycle 21 times and made contact with 4 other obstacles 18 times.

COMMENTS

The small number of contacts per trial was to a large extent attributable to faults in the construction of the maze pattern. Two of the starting points on the course left fairly open alleys through the maze to the sound source. This factor, in addition to the subjects' demonstrated ability to learn the maze pattern, caused the number of contacts to be quite low, and so reduced the efficiency of the test. A more difficult randomized maze pattern with occasional changes to alternative patterns would have improved the effectiveness of the testing procedure.

TABLE ALL

CHANNEL USE RECORDING

DATE & WEEK _____

STUDENT H1 H2 H3 H4 P1 P2 P3 P4

TYPE OF AREA _____(general category)

NUMBER OF BLOCKS _____

NUMBER OF STREET CROSSINGS _____

CHANNEL	APPROPRIATE RESPONSE	INAPPROPRIATE RESPONSE	NO RESPONSE*
LOWER			
MIDDLE			
UPPER			
COMBINATION			

*Mark a no response that results in a cane or body contact with a " C ".

TABLE A12

LASER CANE SIGNAL INPUT AND UTILIZATION - GROUP RESULTS - CHANNEL USE TESTS

	SIGNAL RESPONSE AND CONTACT							
	PERCENT OF TOTAL SIGNAL INPUT	TOTAL NUMBER OF CHANNEL SIGNALS	APPROPRIATE RESPONSES	INAPPROPRIATE RESPONSES	CONTACT FOLLOWING INAPPROPRIATE RESPONSES	NO RESPONSES	CONTACT FOLLOWING NO RESPONSES	TOTAL CONTACTS
CHANNEL SIGNAL								
LOWER	11%	999	196 (20%)	27 (2%)	0	776 (78%)	0	0
MIDDLE	76%	6461	3024 (47%)	241 (4%)	16	3196 (49%)	241	257
UPPER	9%	776	432 (56%)	35 (5%)	0	299 (39%)	2	2
COMBINA-TION	4%	367	177 (48%)	50 (14%)	6	140 (38%)	5	11
TOTAL NUMBER OF SIGNALS		8593	3829	353	22	4411	248	270
PERCENT OF SIGNAL INPUT	100%	44%		4%	.2%	51%	3%	3%

TABLE A13

ORIENTATION & MOBILITY TASK RATING SCALE

DATE _____
STUDENT _____
RUN ____A____B____C____D_____
EVALUATOR _____

CATEGORY ONE

1. Uses environmental information _____

   A. very well |—|—|—|—| very poorly

   B. If not sufficient information available to rate mark X here _____

2. Travels in straight line _____

   A. very well |—|—|—|—| very poorly

   B. If not sufficient information available to rate mark X here _____

3. Crosses streets _____

   A. very well |—|—|—|—| very poorly

   B. If not sufficient information available to rate mark X here _____

4. Maintains orientation _____

   A. very well |—|—|—|—| very poorly

   B. If not sufficient information available to rate mark X here _____

5. Detects curbs _____

   A. very well |—|—|—|—| very poorly

   B. If not sufficient information to rate mark X here _____

6. Solves orientation and travel problems _____

   A. very well |—|—|—|—| very poorly

   B. If not sufficient information available to rate mark X here _____

TABLE A13 (cont'd)

7. Avoids bodily contact _____

A. very well |—+—+—+—| very poorly

B. If not sufficient information available to rate mark X here _____

8. Uses mobility aid _____

A. very well |—+—+—+—| very poorly

B. If not sufficient information available to rate mark X here _____

CATEGORY TWO

Indicate the performance levels you feel the traveler has exhibited in all his O&M tasks, on a scale ranging from "Excellent" down to "Poor."

1. Travels safely _____ excellent |—+—+—+—| poor

2. Travels effectively _____ excellent |—+—+—+—| poor

3. Total O&M performance _____ excellent |—+—+—+—| poor

TABLE A14

RATING QUESTIONNAIRE		1				2				3				4				5				6				7				8			
CLASS ONE																																	
RATER		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
SUBJECT																																	
H1 RUN	A	3	3	3	3	3	4	3	2	3	3	3	3	3	3	3	3	3	4	4	3	3	4	3	3	4	3	5	4	3	4	4	4
"	B	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	3	5	4	5	5	4	4	4	4	5	3	5	5	5	4	5	5
"	C		4	3	4		4	3	4		4	4	4		4	4	3		4	5	5		4	3	4		4	4	4		4	5	4
"	D		4	3	4		4	3	4		4	3	4		4	3	4		4	4	4		4	4	4		3	3	4		4	5	4
H2 RUN	A	4	4	3	4	5	4	4	4	4	3	4	4	3	4	3	3	5	4	5	5	4	4	4	2	3	3	5	3	5	4	5	5
"	B	4	4	4	4	5	4	5	5	4	4	4	4	4	4	5	4	5	4	5	5	3	4	4	4	5	3	5	5	5	4	5	5
"	C	4	4	4	4	4	4	4	4	4	4	4	4	3	4	5	3	5	5	5	5	5	5	5	4	4	4	5	5	4	5	5	4
"	D	4	5	4	4	4	5	4	4	4	4	3	4	4	5	4	4	5	5	5	5	4	5	4	4	4	4	4	4	4	5	5	5
H3 RUN	A	4	3	4	4	4	4	4	4	4	3	4	4	4	4	5	4	3	3	3	3	5	4	5	5	4	3	4	4	4	3	5	4
"	B	3	3	3	3	3	3	4	3	3	3	4	3	3	4	4	3	3	3	3	2	3	4	4	3	5	3	5	5	3	4	5	3
"	C	3	4	3	2	3	4	3	2	3	4	3	3	3	4	3	2	4	5	4	4	3	4	3	2	3	3	3	3	2	4	3	2
"	D	3	4	3	4	3	4	3	3	3	4	3	3	3	4	3	3	3	4	4	4	3	4	4	4	3	3	3	3	4	4	4	4
H4 RUN	A	4	4	4	4	4	5	4	4	4	4	3	4	4	5	5	4	4	4	4	4	4	4	4	4	5	4	5	5	4	4	5	4
"	B	4	4	4	4	4	5	4	4	5	4	3	4	4	5	5	5	4	4	4	5	4	4	4	5	4	4	5	5	4	5	5	4
"	C	5	5	4	5	5	5	4	5	5	5	4	4	5	5	5	5	5	4	5	5	5	5	5	5	4	5	5	5	4	5	5	5
"	D	5	5	5	5	5	5	5	4	5	5	5	4	5	5	5	5	5	4	5	5	5	5	5	5	4	3	5	4	5	5	5	5
P1 RUN	A		5	5	5		5	5	4		5	4	5		5	5	5		5	4	4		5	5	5		5	4	4		5	5	5
"	B		3	4	4		4	5	4		3	4	5		3	5	3		5	5	3		4	5	3		4	3	3		3	3	5
"	C		4	5	4		4	4	4		3	4	3		5	5	5		5	5	5		5	4	3		4	4	4		4	5	4
"	D		4	5	5		4	4	4		4	5	4		5	5	5		5	5	5		4	4	3		3	4	4		4	5	5
P2 RUN	A		4	5	5		5	4	4		2	4	5		4	5	4		5	5	5		5	5	3		5	4	4		5	5	5
"	B		5	5	5		5	5	4		4	5	4		5	5	5		4	3	4		5	5	3		4	4	4		5	5	5
"	C		5	4	5		5	5	5		4	4	5		5	4	5		5	5	5		5	4	3		5	5	5		5	5	5
"	D		5	5	5		4	5	4		5	5	5		5	5	5		5	5	4		5	5	3		4	5	4		5	5	5
P3 RUN	A		4	5	5		4	5	4		5	5	5		5	5	4		5	5	5		5	5	3		4	5	4		4	5	4
"	B		2	4	4		5	5	5		4	5	5		2	4	3		5	5	5		2	4	3		5	5	5		4	4	4
"	C		5	4	5		5	5	5		4	4	5		3	5	4		5	5	5		3	5	3		4	4	5		4	4	4
"	D		3	4	2		4	5	4		3	4	4		5	5	4		5	5	5		3	4	3		5	5	4		4	4	4
P3 RUN	A		4	5	4		4	5	4		4	5	5		4	5	4		5	5	5		4	5	5		4	4	4		5	5	4
"	B		4	4	4		5	4	4		3	4	4		4	5	4		5	5	5		4	5	3		4	4	5		5	5	4
"	C		5	5	5		5	5	5		4	5	5		4	5	4		5	4	5		4	5	3		5	5	5		5	5	5
"	D		5	5	5		4	5	4		5	5	5		5	5	5		5	5	5		5	5	3		5	5	4		5	5	5

TABLE A14 (cont'd)

RATING QUESTIONNAIRE CLASS TWO	1	2	3
RATER	1 2 3 4	1 2 3 4	1 2 3 4
SUBJECT			
H1 RUN A	4 4 4 5	3 4 3 2	3 3 3 3
" B	5 4 4 5	5 4 5 4	4 5 5 5
" C	3 4 4	4 4 4	4 3 4
" D	3 4 4	4 4 4	4 4 4
H2 RUN A	3 3 4 3	5 5 5 4	4 4 5 4
" B	5 3 4 4	5 4 5 5	5 4 5 5
" C	4 4 5 5	4 4 5 5	4 4 5 4
" D	4 5 4 4	4 5 5 4	4 5 5 4
H3 RUN A	3 2 3 3	4 4 4 4	4 4 5 4
" B	3 3 3 3	3 4 4 3	3 4 4 3
" C	3 4 3 2	3 4 3 2	3 4 3 2
" D	3 4 3 3	3 4 3 3	3 4 3 3
H4 RUN A	4 4 5 4	5 5 5 5	4 5 4 4
" B	4 4 5 4	5 5 5 5	4 5 4 4
" C	4 5 5 4	4 5 5 5	4 5 5 5
" D	4 4 5 4	4 5 5 4	4 5 5 5
P1 RUN A	5 5 5	5 4 5	5 5 5
" B	3 3 5	3 4 4	3 4 4
" C	4 4 4	4 5 4	4 5 4
" D	5 5 5	4 5 5	4 5 5
P2 RUN A	3 5 5	4 5 5	4 5 5
" B	4 5 5	5 5 4	5 5 4
" C	5 5 5	5 5 5	5 5 5
" D	5 5 5	5 5 5	5 5 5
P3 RUN A	4 5 5	5 5 5	4 5 5
" B	4 4 5	2 4 3	3 4 3
" C	4 5 4	4 4 4	4 4 4
" D	4 5 4	4 4 4	4 4 4
P4 RUN A	4 5 5	4 5 5	4 5 5
" B	4 5 5	4 5 4	4 4 4
" C	5 5 5	4 5 5	4 5 5
" D	4 5 5	4 5 5	4 5 5

RESULTS

The results of the rating are contained in Table A14. Unfortunately, during their work, several raters did not follow the scoring procedure of marking one of the five points on the scale and instead made marks in between the scale points. These incidents were handled by recording the next highest point on the scale. In addition, each rater was given an alternative option to answering every question. This option stated that if insufficient information was available with which to answer a question an "x" could be marked instead of the usual marks. When the results were collected to form Table A14 a neutral score of three was given for each "x".

From these rating data it can be seen that, in general, the subjects' performance scores were fairly consistent. The subject as a group did quite well with either aid, and on many occasions received the highest possible score with both aids. With the exception of Subject H1 who obtained considerably higher performance scores using the laser cane in the residential--light business area, no general travel improvement with the laser cane over the long cane emerges from the individual results. Isolated higher scores appear in the laser cane data of Subjects H3, P1 and P3. However, a relatively uniform distribution of scores is evident (see Table A15) if the data of the eight subjects are pooled.

TABLE A15

O&M RATING SCALE RESULTS - ALL QUESTIONS - GROUP DATA

Runs	Incidents of Improved Scores (Long Cane)	Incidents of Improved Scores (Laser Cane)	Incidents of Identical Scores
Residential-Light Business Routes	75	74	159
Urban Downtown Routes	50	42	205
All Routes	125	116	364

In examining both category one and category two questions, the most significant variation in scores occurred in connection with question seven. On this question the raters scored several subjects higher when using the laser cane in avoiding bodily contact (while traveling in all areas) than when using the long cane.

Agreement between the raters observing the same performance was surprisingly high considering the nature of the task and the individuality of human judgment.

All raters observing the same performance gave identical scores 92 times out of a possible 352 times to several questions. It also should be mentioned that some other questions did show that there were substantial differences of opinion among the raters.

ORIENTATION & MOBILITY SUBTASK CHECKLIST

METHODOLOGY

During the four assessment runs, while the O&M raters were observing the subjects' performance, investigators (O&M specialists) scored an O&M Subtask Checklist (Table A16 and A17) for each run. The O&M Subtask Checklist was composed of two parts each scored by a different observer. The purpose of the checklist was to assess travel performance in terms of a number of discrete subtasks. The checklist for Scorer 1 specified critical travel events related to the subject's line of travel, veering, and orientation problems. The scoring procedure for recording performance at these critical points was either a numerical total, indicating frequency of occurrence, or a yes-no response indicating occurrence or nonoccurrence. Table A18 details the complete scoring procedure. At the completion of each run, Scorer 1 also indicated the time of day that the run took place and the subject's total travel time.

Scorer 2 indicated the type of weather during the run, the density of automobile and pedestrian traffic, and any unusual occurrences during the run in addition to his assessment of particular subtasks. He was also responsible for the subjects' safety during the runs. Since the scoring had to be completed during live observation the scope and complexity of the subtasks specified in the checklist was kept to workable proportions.

RESULTS

The results obtained from the subjects are contained in Table A19. Each specific subtask is discussed separately.

A. Obstacle Negotiation:

1. Cane Contact

During runs in residential-light business areas (runs A & B) the subjects averaged 9 cane contacts with obstacles while using the laser cane and 17 contacts while using the long cane. Seven of the eight subjects recorded fewer cane contacts with obstacles when using the laser cane in the same type of area. Subject H1 recorded the same number of cane contacts with either cane. The decrease in cane contacts when using the laser cane varied with individuals with six subjects (H2, H3, H4, P2, P3, P4) showing a reduction of fifty percent or more. The number of cane contacts made with pedestrians during the residential--light business runs totaled two with long cane to one with the laser cane.

The subjects achieved less dramatic reductions in cane contact with obstacles when using the laser cane in the downtown urban areas,

runs C and D. They averaged 17 cane contacts with obstacles using the laser cane to 22 cane contacts with the long cane. The highest individual reduction in cane contacts was achieved by Subject H3 who made 10 fewer contacts with obstacles while using the laser cane. The major area of improvement in urban downtown performance lay in the reduced number of cane contacts with pedestrians, although the number of incidents was high with either cane (totals were laser cane 63, long cane 108). Overall, the subjects averaged 8 cane contacts with the laser cane to 14 cane contacts with pedestrians while using the long-cane. Subjects H1, H2, H3, and H4 all recorded reduced cane contact, while subjects P1, P2, P3, and P4 recorded either the same number or slightly fewer cane contacts with the long cane.

2. Body Contact

The results show that the differences in number of body contacts varied with the type of route traveled. In the residential--light business areas (runs A and B) the number of body contacts with obstacles showed a significant difference between the long cane and laser cane. In the case of figures for body contacts with pedestrians the magnitudes in residential areas are so small that no conclusion can be drawn. However, in urban downtown areas many more body contacts with pedestrians are made yielding totals of 9 contacts for the laser cane and 24 contacts for the long cane.

Subjects H1, H2, H3, P1, P2 and P3 made fewer body contacts with obstacles while using the laser cane, while Subject H4 made the same number as he did when using the long cane in the residential--light business area. The number of body contacts with pedestrians for routes A and B did not differ. In this travel area the subjects averaged 2 fewer body contacts with obstacles when using the laser cane. The subjects achieved little difference in performance with respect to body contacts with obstacles in the runs C and D, averaging 1 or less with either cane.

The number of body contacts made with pedestrians (long cane 2, laser cane 1) was quite small on routes A and B. In the urban downtown areas, Subjects H2, H4, and P4 recorded a reduced number of body contacts with pedestrians when using the laser cane. Subjects H1 and P1 showed no change, and Subjects H3, P2, and P3 reduced the number of body contacts with pedestrians using the long cane.

The group totals for each category of obstacle negotiations are recorded in Table A20. In reviewing the obstacle negotiation results the advantage of the laser cane can be seen as enabling a reduction of the number of incidents of cane and/or body contacts.

The laser cane is more effective as an obstacle detector in residential--light business areas where it reduces contact in general and in the urban downtown areas where the major benefit lies in the reduction of cane and body contact with pedestrians.

TABLE A16

ORIENTATION & MOBILITY SUBTASK CHECKLIST

SCORER 1

DATE _____ BLOCKS IN RUN _____

STUDENT __H1__H2__H3__H4___P1__P2__P3__P4 NUMBER OF STREET CROSSINGS _____

RUN _____A_____B____C_____D_____ NUMBER OF PENSION AREAS _____

BLOCK

SCORER 1

1. BREAKS STRAIGHT LINE TRAVEL _____

1	3	5	7
2	4	6	8

2. VEERS OFF TRAVEL PATH _____

1	3	5	7
2	4	6	8

3. RECOVERS FROM ORIENTATION PROBLEMS _____

1	3	5	7
2	4	6	8

STREET CROSSING

SCORER 1

1. DETECTS DOWN CURBS _____

1	2	3	4	5	6	7	8

2. PROPERLY ALIGNS FOR CROSSING _____

1	2	3	4	5	6	7	8

3. STARTS CROSSING AT CORRECT TIME _____

1	2	3	4	5	6	7	8

4. NEEDS ASSISTANCE TO COMPLETE CROSSING _____

1	2	3	4	5	6	7	8

+ or - scoring for number 3 under Block and numbers 1,2, & 3 under Street Crossings. All other categories are scored by using a vertical line for each response.

TABLE A16 (cont'd)

ORIENTATION & MOBILITY SUBTASK CHECKLIST FORM

SCORER 1

END OF RUN

SCORER 1

1. TRAVEL TIME _____

STARTING TIME _____
FINISH TIME _____
TOTAL TRAVEL TIME _____

2. TIME OF DAY _____

AM	NOON	PM
8_____	_____	1_____
9_____		2_____
10_____		3_____
11_____		4_____
		5_____

TABLE A17

ORIENTATION & MOBILITY SUBTASK CHECKLIST FORM

SCORER 2

STUDENT ____H1____H2____H3____H4____ P1____P2____P3____P4

RUN _____A_____B_____C_____D

DATE _____

BLOCK

SCORER 2

1. MAKES CANE CONTACT (Collision) _____

	1	2	3	4	5	6	7	8
Obstacle								
Pedestrian								

2. MAKES BODY CONTACT (Collision) _____

	1	2	3	4	5	6	7	8
Obstacle								
Pedestrian								

STREET CROSSINGS

1. MAKES CANE CONTACT (Collision) _____

	1	2	3	4	5	6	7	8
Obstacle								
Pedestrian								

2. MAKES BODY CONTACT (Collision) _____

	1	2	3	4	5	6	7	8
Obstacle								
Pedestrian								

3. VEERS ON STREET CROSSING _____

	1	2	3	4	5	6	7	8
Towards parallel traffic								
away from parallel traffic								

TABLE A17 (cont'd)

END OF RUN

SCORER 2

1. PEDESTRIAN TRAFFIC ON RUN _____

Heavy _____
Medium _____
Light _____

2. AUTOMOBILE TRAFFIC ON RUN _____

Heavy _____
Medium _____
Light _____

3. WEATHER DURING RUN _____

Sunny _____
Overcast _____
Raining _____

4. UNUSUAL OCCURRENCES (if any)

_____

_____

_____

_____

_____

_____

TABLE A18

GROUND RULES FOR O&M CHECK LIST

GENERAL GROUND RULES FOR THE RUNS

1. The Subjects will be informed that they must not accept help from any one other than their Orientation and Mobility Specialists.

2. The Subjects will be given a brief, simple explanation of the various Runs and no street names or compass directions will be included in the instructions.

3. The instructions for the Runs will include a general alphabetical or geometrical, etc., pattern of the route, the number of blocks, right and left for change of direction, and specifically how to get to his destination and locate it.

4. The Evaluation Team members will be responsible for the safety of the Subjects and will be the only ones to assist the Subjects should they require help; the Rating Team members will be a passive group, responsible only for scoring duties and observing at a distance.

SUBTASK SCORING RULES

1. There will be a 5-minute time limit within which the Student will have the opportunity to get himself oriented and headed towards his destination if he gets in trouble, before the O&M specialist offers him assistance.

2. If the Subject gets disoriented and heads in the wrong direction, scoring will cease until he is brought back and allowed to proceed from the point at which the disorientation occurred. The specific manner of handling this problem will be left to the discretion of the O&M specialist.

3. No sighted assistance must be accepted by any Subject.

BLOCK - Scorer 1

1. Breaks Straight Line of Travel -
   a) The edges of the sidewalk are considered to be the boundaries of straight line travel.

   b) A break in straight line of travel occurs when the Traveler makes unintentional cane contact with building lines, grasslines, parallel curbs, or any shorelines bordering the sidewalk.

   c) Cases of veering are scored by a vertical line for each response.

TABLE A18 (cont'd)

2. Veers Off Travel Path -

This is understood to mean the act of walking off the main pavement into added paved areas such as driveways, vacant lots, gas stations, parking areas, etc.

3. Recovers From Orientation Problems -

This category is self-evident and the scoring will be done by making a + sign for Yes and a - sign for No.

STREET CROSSINGS - Scorer 1

1. Detects Down Curbs -

Scoring for this category will be (+) for Yes and (-) for No.

2. Properly Aligns for Crossing -

Scoring for this category will be (+) for Yes and (-) for No.

3. Starts Crossing at Correct Time -

The Subject is said to start his crossing at the correct time when he does so prudently and safely and responds intelligently and appropriately to situations as dictated by traffic patterns, stop signs and traffic lights, and his own good judgment.

4. Needs Assistance to Complete Crossing -

Scoring will be entered by making a vertical line for each response; if no assistance is needed, the block will remain blank.

End of Run

1. Travel Time will be the responsibility of Scorer 1. He will record the time the Run begins and ends and the total travel time.

2. The time of day will be recorded by Scorer 1.

BLOCK - Scorer 2

1. Makes Cane Contact (Collision)

a) Cane contact is defined as any unintentional physical cane contact with a person or object.

b) Scoring will be entered by making a vertical line for each response; if no contact is made, the block will remain blank.

TABLE A18 (cont'd)

2. Makes Body Contact (Collision)

   a) Body contact is defined as any physical body contact with a person or object.

   b) Scoring will be the same as #1 above, cane contact.

STREET CROSSINGS

1. Makes Cane Contact (Collision)

   a) Same as #1 and #2 above.

2. Makes Body Contact (Collision)

   a) Same as #1 and #2 for Scorer 2.

3. Veers on Street Crossing

   a) A Subject is considered not to have veered if he remains within the boundaries of the width of the sidewalk in residential areas and within the boundaries of the building line and the parallel curb in business districts.

   b) Scoring is the same as for the other categories for Scorer 2 in Block and Street Crossings.

RULES NOT INCLUDED IN ABOVE LISTING

1. All data sheets will be duplicated and the originals will be sent to Hines.

2. All Evaluators and Scorers will sign all Rating Sheets.

3. The Rating Sheet Scorers will be given general instructions of a brief and simple nature and specific criteria for the Rating Scale will not be discussed.

4. Should the Subject veer off the main sidewalk onto added pavement such as driveways, gas station areas, etc., any objects or persons contacted with his cane or body must be recorded.

TABLE A19

SUBJECTS		OBSTACLE NEGOTIATION								RECOVERS FROM ORIENTATION PROBLEMS		BREAKS STRAIGHT LINE TRAVEL	VEERS OFF TRAVEL PATH
		BLOCK				STREET				BLOCK		BLOCK	BLOCK
		CANE CONTACT OBSTACLE	CANE CONTACT PEDESTRIAN	BODY CONTACT OBSTACLE	BODY CONTACT PEDESTRIAN	CANE CONTACT OBSTACLE	CANE CONTACT PEDESTRIAN	BODY CONTACT OBSTACLE	BODY CONTACT PEDESTRIAN	YES	NO		
H1	RUN A	10	0	1	0	0	0	0	0	0	2	47	8
	" B	10	0	0	0	0	0	0	0	0	1	59	5
	" C	17	4	0	0	2	1	0	1	0	2	13	8
	" D	24	18	2	0	2	3	0	1	0	2	25	4
H2	RUN A	11	0	4	0	0	0	0	0	0	2	42	2
	" B	3	0	0	0	0	0	0	0	0	1	53	5
	" C	17	7	0	0	2	4	1	0	0	2	11	6
	" D	21	24	0	6	1	11	0	4	3	0	22	4
H3	RUN A	21	0	3	0	1	0	0	0	3	1	74	14
	" B	5	1	0	0	0	0	0	0	1	2	46	10
	" C	18	6	1	1	2	0	0	0	0	1	12	4
	" D	28	9	3	0	0	1	1	0	0	1	24	4
H4	RUN A	9	0	0	1	0	0	0	0	0	1	79	8
	" B	3	0	0	0	0	0	0	0	0	1	60	6
	" C	5	6	1	0	0	2	0	0	0	0	7	5
	" D	10	21	1	5	0	3	1	2	0	0	14	3
P1	RUN A	24	1	12	0	0	0	0	0	2	0	46	1
	" B	20	0	4	0	0	0	0	0	3	0	70	3
	" C	19	8	2	0	0	0	0	0	4	1	19	6
	" D	22	4	0	0	0	4	0	0	4	0	17	4
P2	RUN A	18	0	9	0	0	0	1	0	8	0	52	8
	" B	9	0	5	0	0	0	0	0	2	0	41	4
	" C	12	9	0	2	1	1	0	0	0	0	5	2
	" D	18	7	0	1	0	0	0	0	0	0	14	1
P3	RUN A	13	1	6	0	1	0	0	0	2	1	65	10
	" B	3	0	3	0	1	0	1	0	0	2	43	2
	" C	13	8	0	5	0	2	0	0	3	0	4	4
	" D	15	3	2	4	0	0	0	0	0	0	5	0
P4	RUN A	31	0	5	0	0	0	0	0	0	0	92	0
	" B	14	0	2	0	0	0	0	0	0	1	34	4
	" C	31	5	1	0	0	0	0	0	0	1	11	1
	" D	33	0	0	1	0	0	0	0	1	0	30	2

TABLE A19

	DETECTS DOWN CURBS (BLOCK)		PROPERLY ALIGNS AT CROSSING (STREET)		STARTS AT CORRECT TIME (STREET)		VEERS ON STREET CROSSING (STREET)			NEEDS ASSISTANCE (STREET)		TRAVEL TIME (minutes)
	YES	NO	YES	NO	YES	NO	TOWARD STREET	AWAY FROM STREET	NO	YES	NO	
H1 RUN A	7	1	6	2	8	0	1	5	2	0	8	30
" B	8	0	6	2	8	0	0	2	6	0	8	28
" C	8	0	6	2	6	2	1	2	5	1	7	40
" D	7	1	7	1	7	1	0	3	5	1	7	33
H2 RUN A	6	2	8	0	8	0	2	1	5	0	8	30
" B	7	1	8	0	8	0	3	0	5	0	8	22
" C	8	0	7	1	5	3	0	2	6	1	7	40
" D	7	1	5	3	6	2	0	2	6	1	7	32
H3 RUN A	7	1	6	2	8	0	2	1	5	1	7	30
" B	6	2	8	0	7	1	0	2	6	0	8	25
" C	7	1	6	2	7	1	1	2	5	1	7	40
" D	8	0	6	2	7	1	1	4	3	1	7	30
H4 RUN A	7	1	7	1	8	0	1	5	2	0	8	20
" B	8	0	8	0	8	0	0	2	6	0	8	25
" C	8	0	7	1	6	2	0	3	5	0	8	22
" D	8	0	8	0	7	1	0	2	6	0	8	25
P1 RUN A	7	1	8	0	8	0	1	4	3	0	8	20
" B	8	0	8	0	6	2	1	4	3	0	8	24
" C	8	0	7	1	8	0	1	4	3	1	7	25
" D	8	0	7	1	8	0	0	1	7	0	8	23
P2 RUN A	8	0	8	0	7	1	0	4	4	0	8	22
" B	8	0	8	0	8	0	0	2	6	0	8	20
" C	8	0	5	3	8	0	0	2	6	0	8	21
" D	8	0	7	1	8	0	0	3	5	0	8	19
P3 RUN A	8	0	8	0	8	0	0	2	6	0	8	22
" B	8	0	8	0	7	1	0	4	4	0	8	32
" C	8	0	8	0	8	0	0	2	6	0	8	31
" D	8	0	8	0	8	0	1	2	5	0	8	29
P4 RUN A	8	0	8	0	7	1	0	2	6	0	8	24
" B	8	0	5	3	8	0	1	6	1	0	8	15
" C	7	1	5	3	7	1	0	3	5	0	8	26
" D	8	0	7	1	7	1	0	0	8	0	8	27

TABLE A20

OBSTACLE NEGOTIATION - GROUP DATA

Routes	Device Used	Number of Cane Contacts			Number of Cane Contacts			Number of Cane & Body Contact		
		Obstacle	Pedestrian	Total	Obstacle	Pedestrian	Total	Obstacle	Pedestrian	Total
Residential Light-Business Routes										
A.	Long Cane	139	2	141	41	2	43	180	4	184
B.	Laser Cane	68	1	69	15	1	16	32	2	85
Urban Downtown Routes										
C.	Laser Cane	139	63	202	6	9	15	145	72	217
D.	Long Cane	174	108	282	10	18	28	184	126	310
Combined Routes										
A & D	Long Cane	313	110	323	51	20	71	364	130	494
Combined Routes										
B & C	Laser Cane	207	64	271	21	10	31	228	74	302

B. Orientation

1. Recovers From Orientation Problems (Block)

The eight subjects while traveling the 32 runs encountered 61 orientation problems of which 33 were dealt with independently within the time limit. On 28 occasions the subjects were given assistance. On only 6 runs were no records made of subjects having orientation problems. Subject P3 encountered as many as 8 orientation problems on one run while subject H4 met only 2 during all his 4 runs. Of the total number of 32 runs traveled, only 14 were traveled without assistance being given.

The large number of orientation problems and the low success ratio of recoveries are somewhat surprising for the caliber of travelers. From an observer's viewpoint the anxiety level created by the testing situation, the complexity of the travel routes, and the limited amount of route information which was provided may have contributed to the high totals.

The individual results show little major difference in the number of orientation problems experienced or their outcome when using either device. Except for Route A, the subjects dealt with their orientation problems independently about 50 percent of the time. The group totals (Table A21) show only a light reduction of orientation difficulties for the laser cane in use in residential--light business areas and a slight increase in the number of problems when using it in the urban downtown areas.

TABLE A21

NEGOTIATION OF ORIENTATION PROBLEMS - GROUP DATA

Route	Number of Orientation Problems	Number of Independent Recoveries	Number of times assistance was given
A	22	15	7
B	14	6	8
C	14	7	7
D	11	5	6
A & D (Long Cane)	33	20	13
B & C (Laser Cane)	28	13	15

C. Travel Path Position

1. Breaks Straight Line Travel (Block)

The breaking of straight line travel was defined as any incident in which the traveler made an unintentional cane contact with the boundaries of the travel path. The width of the sidewalk was considered to define the boundaries of the travel path. All cane contacts with building lines, grasslines, parallel curbs, or any shorelines bordering the sidewalk were recorded as incidents.

The score under the category of breaking straight line travel indicates how efficiently the traveler projects his line of travel, and the traveler's ability to make directional adjustments. For this study this subtask was concerned only with asking how efficiently the traveler maintained his line of travel and adjusted his course in accordance with environmental or device input. Other related categories concerned with veering tendencies and improper cane techniques were not explored. In theory any device that would provide additional information of the traveler's immediate environment should enable him to improve his travel line, by providing appropriate information on which to make directional adjustments.

Table A19 contains the individual results being reviewed here. The subjects averaged 56 breaks (7 per block) in straight line travel per run in the residential--light business areas to 15 breaks (2 per block) per run in the urban downtown areas.

The residential--light business area results indicate that a reduced number of breaks in straight line travel was made by five subjects (H3, H4, P2, P3, P4) when using the laser cane and by three subjects (H1, H2, P1) when using the long cane. An interesting fact to note is that all subjects who reduced their breaks in travel line using the laser cane did so substantially (average 28 fewer breaks) while those with the smaller long cane scores reduced their number of breaks by an average of 15 breaks.

The urban downtown area runs contained, as would be expected, fewer breaks per run in general yet show a marked score reduction when the laser cane was used. Seven subjects reduced the number of their breaks by an average of 12 using the laser cane when compared to their scores with the long cane. Subject P1 reduced his score by 2 breaks when utilizing the long cane. The total number of breaks made by individuals ranged from 4 to 92 with a median of 34.

2. Veers off Travel Path

Veering off of the travel path was defined as any incident in which the traveler walked off the main pavement into another area such as a driveway, vacant lot, gas station, parking lot, etc. The

frequency of these incidents was recorded per block and run. This subtask category, being concerned with the number of deviations from the travel path, is closely related to orientation skill.

The individual results are contained in Table A19. Five subjects (H1, H3, H4, P2, P3) received lower scores for travel path deviation when using the laser cane in the residential--light business areas averaging 5 fewer deviations. Three subjects (H2, P1, P4) received reduced scores when using the long cane, averaging 3 fewer deviations per person on the residential--light business area runs. The number of veers off the travel path ranged from 0-14, with 5 as the median. The subjects averaged 6 deviations using the long cane compared with 5 deviations when using the laser cane.

The urban downtown routes results show that six subjects (H1, H2, H4, P1, P2, P3) made an average of 3 fewer deviations with the long cane and that only subject P4 achieved a slightly reduced travel path deviation score using the laser cane. Subject H4 obtained the same score with either device. As the results point out, the laser cane reduced the number of veers off the travel path for over half the subjects in the residential--light business area, but was not as effective in the urban downtown area where it may have contributed to the slightly improved performance of only one subject.

D. Detects Down Curbs

The detection of down curbs score was assessed on only eight curbs--one at the end of each block traveled. Alleyways were not counted in the totals. The detection of down curbs score for the subjects as a group was excellent. The individual results are listed in Table A19. From the 32 runs the subjects obtained perfect scores on 21 occasions, scores of 7 detected curbs on 9 runs and scores of 6 on 2 runs. Subjects P2 and P3 earned perfect scores on all of their runs and each subject received at least one perfect score on one run.

On the residential--light business routes four subjects (H1, H2 H4, P1) recorded slightly improved scores using the laser cane and subject H3 obtained a slightly better score while using the long cane. In use on urban downtown runs, two subjects (H1 and H2) received slightly improved scores with the laser cane while two subjects (H3 and P4) obtained slightly improved scores while using the long cane. The group totals on the combined area routes are listed in Table A22.

TABLE A22

DOWN CURB DETECTION - GROUP DATA

Routes	Number of Curbs Detected	Number of Curbs not Detected
A	58	6
B	61	3
C	62	2
D	62	2
A & D (Long Cane)	120	8
B & C (Laser Cane)	123	5
Total	243	13

The results indicate that the subjects achieved excellent performances on this subtask and left little room for improvement. The only improvement noticed while using the laser cane was that in the residential--light business area four subjects averaged one more detected curb than with their long cane.

E. Properly Aligns at Crossings

The individual results contained in Table A19 indicate no major differences in subject performance scores when aligning at street crossings in residential--light business areas on comparing the twc mobility aids. The scores on urban downtown routes indicate a slight improvement in the long cane performances of four subjects (H1, H4, P2, P4). Subject H2, however, received a slightly better score using the laser cane.

Of the total of 32 runs, the subjects on 14 occasions earned perfect scores, on 8 occasions obtained scores of 7, and on a further 6 occasions received scores of 6. The subjects'level of performance was quite high in all areas.

The group results are listed in Table A23, and indicate no basic change in scoring attributed to using one particular mobility aid.

TABLE A23

STREET CROSSING ALIGNMENT - GROUP DATA

Routes	Number of Proper Street Crossing Alignments	Number of Improper Street Crossing Alignments
A	59	5
B	59	5
C	51	13
D	55	9
A & D (Long Cane)	114	14
B & C (Laser Cane)	110	18
Total	224	32

F. Starts Street Crossing at Correct Time

The individual results in Table A19 again indicate excellent subtask performance with either mobility device. The subjects recorded a perfect score on 17 of the 32 runs, a score of seven on 10 occasions, and scores of six and five on 4 and 1 runs, respectively. On the residential--light business routes, three subjects (H3, P2, P3) gained slightly better scores with the laser cane while subjects P2 and P4 received slightly improved scores while using the long cane. On the urban downtown routes only three subjects (H1, H2, H4) achieved any differences in their scores and the improvements were in favor of the long cane. The group totals are listed in Table A24.

G. Veers on Street Crossings

This subtask category is rather strictly defined. A veer is said to occur on any occasion on which the subject's crossing is completed outside the boundary of the width of the sidewalk in a residential area or outside the boundary of the building line and the parallel curb in a business district. As in past street subtasks, the number of streets crossed was eight. The individual results are recorded in Table A19 under three categories--veers towards parallel traffic, veers away from parallel traffic, and no veers.

RUN A(Hines) LONG CANE ROUTE

BLOCK 1
EAST

BLOCK 2
EAST

BLOCK 3
EAST

BLOCK 4
SOUTH

BLOCK 5 (first half)
SOUTH

BLOCK 5 (second half)
SOUTH

BLOCK 6
WEST

BLOCK 7
WEST

BLOCK 8
WEST

DESTINATION
OLD PRAGUE RESTAURANT

TABLE A24

STREET CROSSING TIMING - GROUP DATA

Route	Number of Starts Correct Time	Number of Starts at Incorrect Time
A	62	2
B	60	4
C	55	9
D	58	6
A & D (Long Cane)	120	8
B & C (Laser Cane)	115	13
Total	235	21

Individually, subjects P3 and P4 improved their scores using the long cane, while four subjects (H1, H3, H4, P2) obtained improved scores using the laser cane in the residential--light business areas. On the urban downtown routes, three subjects (H3, P2, P3) showed a slight improvement in their scores using the laser cane while three other subjects (H4, P1, P4) obtained slightly improved long cane scores. Subjects H1 and H2 obtained the same scores, however.

Table A25 in which the group results are listed shows that the combined scores for the long cane and the laser cane are almost identical. It is of some interest to note that of the total of 255 street crossings attempted by the subjects, they veered on 100, or about 40% of these occasions. Of the 100 veerings, 83 were away from parallel traffic. This high percentage is not in harmony with the earlier figures indicating excellent alignment at crossings where 244 proper alignments were made as compared to 32 improper alignments. It would appear that once a subject started his street crossing many new factors came into play among which the concern for safety is very important. Therefore, directional adjustments tend to be biased in a direction away from the parallel flow of motor traffic.

TABLE A25

STREET CROSSING VEERS - GROUP TOTAL

Route	Number of No Veers	Number of Veers Towards Parallel Traffic	Number of Veers away from Parallel Traffic
A	33	7	24
B	37	5	22
C	41	3	20
D	45	2	17
A & D(Long Cane)	78	9	41
B & C (Laser Cane)	78	8	42
Total	156	17	83

H. Needs Assistance (Street Crossing)

This subtask category concerned the number of times a subject required assistance to complete his street crossing. The individual results are listed in Table A19. The subjects achieved excellent performance scores only requiring assistance on 8 of the 256 street crossings.

Four subjects (H4, P2, P3, P4) received perfect scores on all of their routes. Subject H3 required assistance three times, Subjects H1 and H2 required assistance only twice, and Subject P1 once. Table A26 contains the group results. As the results indicate, the subjects performed capably on their street crossings and in adjusting their veering on crossings. No measurable difference in scores is apparent, however, between their laser cane and long cane performance.

I. Travel Time

The total time taken on each journey was recorded in minutes without a break from the onset of the run to its termination at the destination. Thus the travel time included the time spent recovering from orientation and mobility problems.

RUN B (HINES)
LASER CANE ROUTE

BLOCK 1
WEST

BLOCK 2
WEST

BLOCK 3
WEST

BLOCK 4
SOUTH

BLOCK 5 (first half)
SOUTH

BLOCK 5 (second half)
SOUTH

BLOCK 6
EAST

BLOCK 7 & 8
EAST

DESTINATION
KENICKY'S NATIONAL CLEANERS

TABLE A26

STREET CROSSING ASSISTANCE - GROUP DATA

Routes	Number of times assistance was given	Number of independent street crossings
A	1	63
B	0	64
C	4	60
D	3	61
A & D (Long Cane)	4	60
B & C (Laser Cane)	4	60
Total	8	248

The average time taken per run was 26.5 minutes, the range from 15 to 40 minutes and the median time 30 minutes.

The individual results are listed in Table A19. On the residential-light business routes using the laser cane, five subjects (H1, H2, H3, P2, P4) completed the distance in a time which averaged 5 minutes less than their time with the long cane. On the other hand three subjects (H4, P1, P3) averaged 6 minutes longer when traveling in this area using the laser cane.

Six subjects (H1, H2, H3, P1, P2, P3) completed the course in an average of 5 minutes less time using the long cane than when using the laser cane in urban downtown areas. Subjects H4 and P4 averaged 2 minutes less time using the laser cane on their runs. The group results are listed in Table A27.

The results appear to point to the conclusion that the laser cane leads to a measurably shorter travel time in residential--light business areas but offers little aid in increasing speed in urban downtown areas. In the urban areas, six of the eight subjects traveled at slower rates using the laser cane.

TABLE A27

MEAN TRAVEL TIME - GROUP DATA

Route	Mean Travel Time (Minutes)
A	25
B	24
C	31
D	27
A & D (Long Cane)	26.
B & C (Laser Cane)	27.5
Total All Routes	26.5

Subtask Summary:

At the end of the training program each of the subjects was observed traveling four travel routes using the laser cane and the long cane. Two investigators observing the performances recorded a check list of O&M Subtasks. Each subject traveled two comparable routes in a combined residential--light business area and two comparable routes in a downtown urban area using the laser cane and the long cane. The order in which the mobility devices were used was predetermined as also was the order in which the routes were traveled. All routes were unfamiliar to the subjects. The amount of travel route information provided was minimal and assistance from the general public was prohibited.

It was ventured in the protocol set up before commencing the evaluation that, by the end of training, the subjects would be capable of demonstrating travel improvements, if present, when using the laser cane. This position did not, of course, rule out the possibility that future use of the device in each user's home community could lead to further improvement and additional benefits. However, in practice it was found that this was not the case. In the first place the individual subjects absorbed the instruction at very different rates. Another factor which hindered accurate assessment of possible benefits of the laser cane was the unfamiliarity of the routes. The very limited knowledge that each subject had about the route he was about to take had the effect of increasing travel stress and hindering full use of the device.


RUN C (HINES)
LASER CANE ROUTE
LEE
BLOCK 1
EAST
BLOCK 2
EAST
BLOCK 3
EAST
BLOCK 4
SOUTH
BLOCK 5 (first half)
WEST
BLOCK 5 (second half)
WEST
sheim
BLOCK 6 (first half)
WEST
BLOCK 6 (second half)
WEST
BLOCK 7
WEST
BLOCK 8
NORTH
BLOCK 8 (elevated view)
NORTH
DESTINATION
DUTCH MILLS CANDY STORE

In reviewing the various subtask results it is apparent that there were situational benefits gained by the use of the laser cane on an individualized basis. The individual's travel experience and the geographical characteristics of the routes traveled contributed to the outcome. With the good traveler the magnitude of improvement when present was often marginal.

The most easily observable benefit of the laser cane is its obstacle detection ability. The performances in residential--light business routes showed many substantial reductions in cane and body contact with obstacles. Downtown route results,on the other hand, showed a moderate reduction in cane contacts with obstacles, but large reductions in cane and body contact with pedestrians.

The second major area of improvement was in subtask C (Breaks straight line travel). About one-half of the subjects reduced their error in line of travel to some degree when using the laser cane. This, of course, varies with locality since directional adjustments on the basis of laser beam information are dependent on the presence of objects bordering the travel path. If nothing is present to reflect the beam, little advantage is afforded by an obstacle detector. In urban downtown areas, seven of the eight subjects, in varying degrees, reduced their contacts with boundary lines. The advantage in this particular travel environment seems to increase with the presence of building lines from which directional information can be more easily obtained.

The third area of scoring differences was associated with subtask D (Veers off travel path). About one-half of the subjects reduced their tendencies to veer when using the laser cane in a residential--light business area. Curiously, however, in the urban downtown areas the subjects,while on laser cane runs, for the most part recorded more veers off the travel path than while on long cane runs.

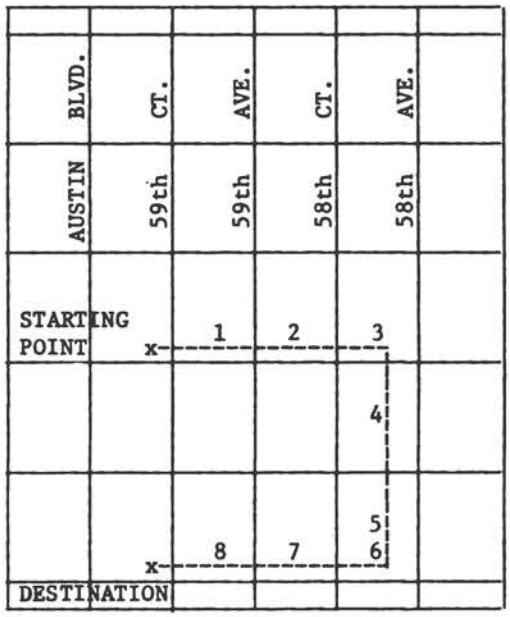
The last subtask category which yielded any measurable difference in performance was concerned with travel time. In the residential--light business areas the majority of the subjects returned a very slightly faster time when using the laser cane while in urban downtown areas the reverse was true.

COMMENTS

The O&M Subtask Checklist and Rating Scale were modified for use in the follow-up program. Travel performances were recorded via videotape and audio commentary in familiar and unfamiliar travel environments negotiated with both the laser cane and the long cane. The use of videotaping techniques enabled many more subtasks to be examined than was possible during onsite observations. These modified techniques are described in chapters 3-5.

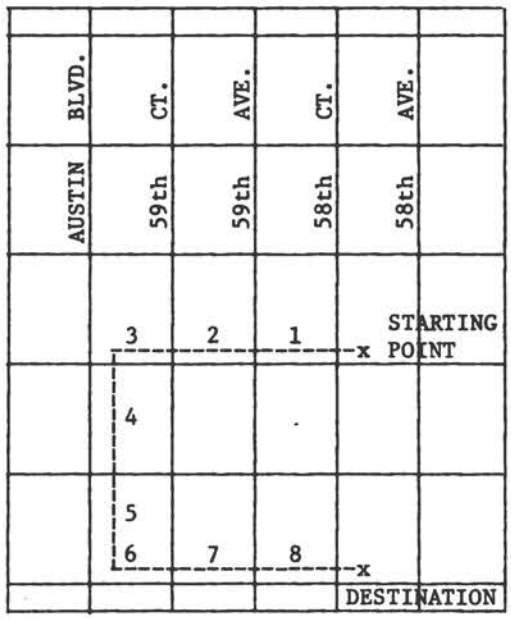
EVALUATION ROUTES (TRAINING AREA - HINES)

(See plates facing pages 108 - 114)



ROUTE A - LONG CANE

BLOCKS 1 - 4 ARE RESIDENTIAL AREAS
BLOCKS 5 - 8 ARE BUSINESS AREAS



ROUTE B - LASER CANE

BLOCKS 1 - 4 ARE RESIDENTIAL AREAS
BLOCKS 5 - 8 ARE BUSINESS AREAS

Fig. A1

RUN D (HINES)
LONG CANE ROUTE

BLOCK 1
EAST

BLOCK 2 (first half)
EAST

BLOCK 2 (second half)
EAST

BLOCK 3
EAST

BLOCK 4
SOUTH

BLOCK 5
WEST

BLOCK 6
WEST

BLOCK 7
WEST

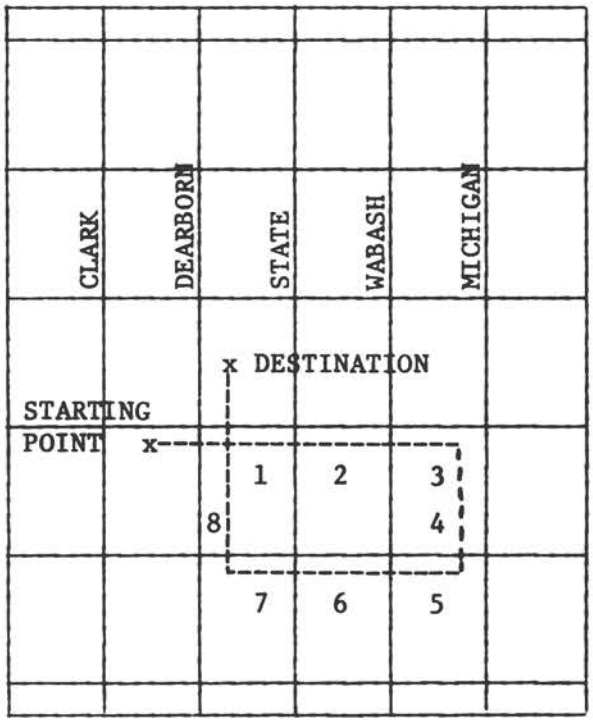
BLOCK 8 (first half)
NORTH

BLOCK 8 (second half)
NORTH

DESTINATION
KOPPER KETTLE RESTAURANT

EVALUATION ROUTES (TRAINING AREA - HINES)

(See plates facing pages 108 - 114)



WACKER DRIVE

LAKE

RANDOLPH

WASHINGTON

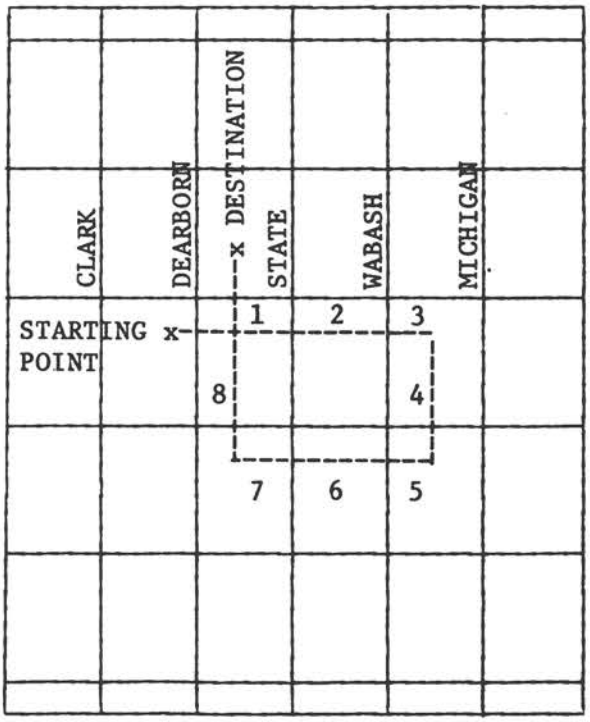
MADISON

MONROE

N
W E
S

ROUTE - C LASER CANE

BLOCKS 1 - 8 ARE DOWNTOWN CHICAGO AREAS



WACKER DRIVE

LAKE

RANDOLPH

WASHINGTON

MADISON

MONROE

N
W E
S

ROUTE D - LONG CANE

BLOCKS 1 - 8 ARE DOWNTOWN CHICAGO AREAS

Fig. A1 (cont'd)

Appendix II

LESSONS USED IN TRAINING

INTRODUCTION

The training program was conducted concurrently with the gathering of data arising from a variety of test procedures but, throughout the five week period, the primary emphasis was on the training. The instructional procedures described in this report are those that were followed by the Hines VA investigators; however, with few exceptions arising mainly from differences in locale, they are the same as those used by the Palo Alto VA investigators. Some of the lessons used in the training course were identical to those used in the regular orientation and mobility rehabilitation programs at the two VA hospitals, while others were lessons and drills designed to meet the special demands which arose in teaching use of the laser cane. The material was presented in a series of assignments, each one of which embodied a concept or principle that the panel judged to be basic to the use of the laser cane. Each lesson was conducted in an open-ended manner so that the same lesson procedure was presented during several successive one-hour or two-hour periods until the principle had been mastered. The basic approach was to isolate each function of the cane and to explore and master it separately. The lesson environment was rigidly controlled with the first lessons presented in open areas likely to give rise to a minimum number of extraneous laser cane signals. As the subject progressed, the functions of the cane were explored in exercises carried out in environments which became more and more complex. The ultimate goal of the training was to prepare the subjects so that they would be able to use the laser cane in any area of public travel.

The Panel Members were of the opinion that a total of 20 hours of training and experience with the laser cane on actual runs was necessary before any testing began. Table A28 provides an example of the typical training format with a breakdown of the approximate number of hours spent on travel, objective testing and performance rating.

TABLE A28

TRAVEL AREAS AND OBJECTIVE & SUBJECTIVE TESTS	HOURS
Pre-course travel (residential and business)	2
Indoor travel	15
Objective tests (detection-avoidance-obstacle	7
Residential travel	4
Residential/small business district travel	3
Business district travel	12
Chicago Loop travel	5
Post course travel (O&M Task Rating and Mobility Subtask Check List)	4
Total	52

PRE-COURSE EVALUATION OF LONG CANE SKILLS AND TRAVEL TECHNIQUES

INTRODUCTION

The first two lessons given to participants in the Preliminary Evaluation of the C-4 Laser Typhlocane were designed to get some initial assessment of the subjects' long cane skills and their relative mastery of basic O&M skills and techniques. For this purpose, two assignments were given which tested each subject's ability to travel along a prescribed residential route and a business district route, using his own long cane. Prior to starting the two journeys, the investigators explained to the subjects the goals and purpose of the training course and their roles and responsibilities.

Lesson A

Starting Point: (NE) Fifth Avenue & Harrison Street

Destination: A ten-block rectangular round-trip travel pattern.

Procedure: Subject will travel north one block from (NE) Fifth Avenue & Harrison to (SE) Congress, turn right and walk east to (SW) First Avenue, then turn right and go south to (NW) Harrison, and come back west to (NE) Fifth Avenue, the starting point.

Objectives:

1. To provide the subject with the opportunity to travel a distance of ten blocks in a residential area and demonstrate his ability to cope adequately with the travel conditions and situations which occur during the course of the trip.

2. To provide the opportunity for the investigators to make an initial evaluation of the subject's current cane and travel skills.

3. To acquaint the subject with the scope and purpose of the Course, along with its goals and the responsibilities of the investigators and the subjects.

Lesson B

Starting Point: (NW) Second Avenue & Lake Street

Destination: The Baptist Retirement Home at (SW) Fourth Avenue and Pine Street.

Procedure: Starting at (NW) Second Avenue & Lake Street, subject will travel east to Fifth Avenue on the north side of Lake Street. Upon reaching (NE) Fifth Avenue, subject will turn left and travel south, on the east side of Fifth Avenue, to (NE) Pine Street. He will then walk east, cross Fourth Avenue, and follow the left (north)

Lesson B (cont'd)

shoreline half way the block between Fourth and Third until a wide sidewalk is reached. This sidewalk leads to the south entrance of the Baptist Retirement Home. Subject will walk north to the door and enter the building.

Objectives:

1. To test the subject's ability to travel 10 1/2 blocks in a business district, remain oriented and locate his destination at the end of the trip.

2. To provide the opportunity for the investigators to make an evaluation of each subject's current cane and travel skills and his ability to cope with the travel demands of a business district.

3. To test the subject's ability to use traffic and other environmental information as travel aids.

INTRODUCTION TO THE C-4 LASER TYPHLOCANE

Lesson A

Purpose: To introduce subjects to the C-4 Laser Typhlocane, its history, nomenclature, purpose, and use.

A. Give brief history of the laser cane and its forerunners, the Cranberg Signal Corps Obstacle Detector manufactured by RCA, the G5 Obstacle Detector, and versions C-2 and C-3 developed by Mr. J. Malvern Benjamin,Jr. of Bionic Instruments, Inc., (see Bulletin of Prosthetics Research, Spring 1968) under the sponsorship of the Research and Development Division, Prosthetic and Sensory Aids Service, VA Central Office (1953).)

1. Since lasers are used, there necessarily is a question about safety. Experts are confident that the gallium-arsenide lasers used in the C-4 cane are of such low power that the hazard is negligible. Even direct exposure to the eyes would be below the damage level.

2. Animals have been used to test the damage level of the GaAs lasers and the results of these experiments confirm the belief that laser beams of the energy used in the C-4 cane are safe for humans to use.

Lesson A (cont'd)

Procedure:

A. Familiarization with the laser cane

1. Give subject cane to examine and ensure that as each part is discussed its location is pointed out to him.

2. Discuss the following parts and vital statistics of the C-4:

   a. The C-4 weighs 1 1/3 lb.
   b. It is 1 3/6 in. in circumference.
   c. Top part of cane is 21 in. and bottom part is from 40-54 in. with 2-in. and 4-in. extensions.
   d. Sound generator at the end of the crook.
   e. Sound volume and ON/OFF switch control.
   f. Range set for Forward Channel.
   g. At top of cane is circuitry that drives 3 lasers that generate the 3 separate light probes which look down, up, and forward.
   h. The lasers which are situated behind the source lens system.
   i. Tactile stimulator.
   j. Receiving optics and photodiodes or detectors.
   k. Quick disconnect
   l. Cane made of light, stiff material, epoxy-reinforced with boron filaments originally, but experiments are being conducted with other materials.
   m. Device emits pulses of infrared light which, if reflected from any object in front of it, are detected by a photodiode placed behind a receiving lens.
   n. The angle made by deflected rays passing through the receiving lens indicate the distance to the object detected - this is called "optical triangulation".
   o. Cane detects objects which extend 2 to 2 1/2 ft. aboveground.
   p. Down channel warns of drops 9 in. or deeper.
   q. Up channel warns of obstacles at head level 2 ft. forward of the cane tip.
   r. The power source for the laser cane are Nickel Cadmium batteries, 600 mv. 12v.
   s. LASER means: Light Amplification by Stimulated Emission of Radiation.
   t. Cane designed to give best results when held at 45-deg. angle.
   u. Charging jacks.
   v. Charge cane overnight (batteries <u>can</u> be overcharged).
   w. Discharge cane in the morning 15-20 minutes before using.
   x. Check all channels before use.
   y. Battery test button.

Lesson A (cont'd)

B. Travel with the laser cane but with the power turned off.

1. Instruct subject to travel with the laser cane with the power off and use it as a conventional long cane.

2. Instruct subject to make a trip indoors to the PX and return to the Blind Section, Building No. 13.

Objectives:

1. To acquaint the subject with the history of the laser cane and its development.

2. To introduce the subject to a C-4 laser cane.

3. To discuss the gallium arsenide lasers used in the C-4 laser cane and to assure the subject that tests have shown the lasers to be of such low power that the potential hazard from them is negligible.

4. To familiarize the subject with the nomenclature of laser cane use, its vital statistics, and its care and maintenance.

5. To enable the subject to become accustomed to the weight and balance of the C-4 cane by traveling with it with the power turned off.

INTRODUCTION TO THE FORWARD CHANNEL

Lesson B

Purpose: To introduce subject to the Forward Channel and the use of the tactile stimulator.

Procedure:

1. Review tactile stimulator position on the C-4 with subject and show him exactly how it is located with the index finger.

2. Review the various controls for turning cane on and off, volume, etc.

3. Stand subject out of laser range from a wall. Ask him to turn power on and walk toward wall until initial beam contact is made. Have subject stop as soon as beam contact is made. Then have subject walk towards the wall until cane contact is made. The maximum range setting will be used for this first drill. As subject walks forward, ask him to measure mentally the distance to the wall so that he can estimate the distance from initial beam contact to cane contact.

Lesson B (cont'd)

4. Ask subject to repeat exercise No. 3 but this time use the minimum range setting.

5. Next, allow subject to scan with cane at maximum range setting to attempt to detect and localize variously placed objects within detection range of subject. Now, repeat the same drill with the range setting at the minimum level.

6. Use cardboard box approximately 4 ft. in height and 18 to 20 in. in width. Have subject detect the box, walk towards it, and make cane contact with it. Then have subject detect the box, walk towards it, and then attempt to circumvent it without making cane or body contact. Try using both maximum and minimum range settings.

7. Now, have subject try to detect, localize, and walk to a pole approximately 2 in. in circumference and 7 ft. in height, maintaining beam contact with it until he is close enough to it to grasp it or at least make cane contact with it. Next, have subject detect the pole, travel towards it, circumvent it, and regain his original line of travel.

8. After the student can detect and avoid several different types of obstacles, instruction on beam monitoring can start with the use of the Forward Channel. At a later date, beam monitoring utilizing all the channels should be incorporated. In order to better parallel a borderline for direction taking, location of a destination, or maintenance of better field of view when circumventing an obstacle, beam monitoring either on an intermittent or constant level may be employed with only slight alteration of the normal Touch Technique.

   A. Intermittent beam monitoring. This type of monitoring is conducted on a sampling basis and can be performed by gently rotating the wrist at the end of the sweep of the cane arc to the side of interest. The same function can also be accomplished by rolling the wrist during execution of the arc. The subject should practice both techniques at near and far range settings.

   B. Constant beam monitoring. This type of monitoring is useful when one must locate a break in the borderline. The most economical manner of providing a constant beam contact is to position the cane by grip held or angle held at the borderline. The subject should be informed that his beams are constantly pointing to his lateral aspect and he must maintain good manual

Lesson B (cont'd)

cane technique to provide frontal protection. The subject should practice this technique in the corridors at both the rear and far range settings.

9. Set up two poles approximately 3 1/2 ft. apart and have subject travel towards the poles, detect them, and walk between them as he would go through a doorway.

10. Allow the subject to travel through wide and narrow doorways.

11. Have the subject travel in a long, traffic-free corridor and endeavor to make only beam contact with the walls. The subject will use the maximum range setting.

    A. Allow the subject to make beam contact with both walls of the corridor and try to walk in the center of the beam arc. Point out the advantages of caneless and bodyless contact and the distance at which beam contact can be made.

    B. Ask the subject to maintain beam contact with just one wall and attempt to walk parallel to it, remaining far enough from it to avoid cane or body contact.

    C. Make the subject aware of the difference between lateral and direct-path signals, and between mobile and stationary objects.

    D. Point out to the subject that if he travels too close to the wall, he is likely to make cane and/or body contact because the beam will make contact with the wall ahead and only slightly lateral and that the cane probably will touch the wall before the beam has a chance to make contact. Have the subject make return trip with and without laser power.

Objective:

1. To review Lesson A, Procedure A.

2. To enable the subject to learn to develop an awareness of the tactile stimulator.

3. To help the subject learn to appreciate the concepts of beam width and contact distances, dimensions of objects, colors and reflectivity of objects and how they relate to detectability, distances, etc.

4. To help the subject learn to appreciate the distances at which he must initiate evasive action if he is to avoid physical contact with objects.

Lesson B (cont'd)

5. To give the subject experience in detecting and reacting to objects using both near and far range settings.

6. To afford the subject the opportunity of using beam contact both for purposes of achieving willful contact or avoidance.

7. To give the subject confidence in the knowledge that he can achieve detection, localization, and avoidance of objects, even as small as 2 in. in circumference.

8. To enable the subject to experience the feeling of traveling without the expectancy of making cane or body contact and with the knowledge that, if anything intercepts his path, he will receive early warning.

9. To give the subject the opportunity of traveling both with and without beam protection and allow him to draw his own conclusions relative to the merits of both.

10. To give subject the experience of pedestrian encounters.

INTRODUCTION TO THE UP AND DOWN CHANNELS

Lesson C

Purpose — To introduce subject to the Up and Down Channels and familiarize him with their function and use.

Procedure:

A. Review Lesson B with the subject and let him practice traveling while employing the tactile stimulator of the Forward Channel.

   1. Allow the subject to practice using the tactile stimulator while traveling in corridors and make a few round-trips to a relatively distant destination.

   2. Introduce the audible system of the Forward Channel and allow the subject to practice using it singly and in combination with the tactile stimulator.

B. Introduction to the Up Channel

   1. Ask the subject to turn off the audible system of the Forward Channel so that he may be better able to concentrate on and hear the signal for the Up Channel.

      a. The investigators may excite the Up Channel as frequently as desired by using a long cane or stick to induce the stimuli.

Lesson C (cont'd)

2. When the subject has been given ample practice, becomes alert to the Up Channel signal, and has begun to react to it quickly and accurately, allow him to practice listening to the multiple signals of the audible system of the Forward Channel in addition to sound from the Upper Channel.

   a. Also suggest that subject use the manual protective technique when he hears the Up Channel signal to protect himself from possible contact with overhanging objects.

C. Introduction to the Down Channel

1. Take the subject to the top of a flight of stairs and let him hear the down signal and learn to distinguish it from the Up Channel and the audible system signal of the Forward Channel.

2. Allow the subject to start a good distance from the top of the stairs, walk towards them, and stop when he hears the Down Channel signal. After several tries at this drill, and when the subject and investigator are satisfied that the subject has begun to react appropriately to the down signal, allow the subject to approach the down stairway and descend it.

3. Give the subject the experience of hearing, and trying to distinguish, the multiple signals of all the channels.

D. Give the subject the opportunity of traveling to a distant destination with his long cane and making the return trip with the laser cane.

E. Give the subject travel practice in the corridors and through doorways without his cane or manual protective techniques, but supervise him very closely.

Objectives:

1. To give the subject more practice and experience in using the tactile stimulator.

2. To introduce the use of the audible system of the Forward Channel and give the subject practice in using it singly, and in combination with the tactile stimulator.

3. To introduce the subject to the Up Channel and to give him practice in listening to and responding to the signal.

Lesson C (cont'd)

4. To encourage the subject to use the manual protective technique when the Up Channel is excited.

5. To introduce the subject to the Down Channel, give him practice in listening to it, and distinguishing it from the Forward and Up Channel signals. Allow ample time for practice and maturity.

6. To give the subject more experience in making comparative trips with his long cane and laser cane.

7. To help make the subject aware of his own natural perceptive powers and reinforce the importance of always utilizing these natural resources fully, whether operating with or without sighted guides or mobility aids!

REVIEW OF ALL CHANNELS

Lesson D

Purpose: To review all three channels and the audible system of the Middle Channel.

Procedure:

1. Ask the subject to make several trips to various departments and destinations indoors.

2. Start out by having the subject make short segments of a given trip using each of the three channels separately (use both systems of the Middle Channel together).

3. Make a round trip to a distant destination using all three channels.

4. Make a practice run in a sparsely populated corridor and give the subject more practice in listening to and reacting to multiple signals from two or all three of the channels simultaneously.

5. Choose a heavily populated corridor and give the subject ample experience with pedestrian encounters and object confrontations along walls. Have the subject practice the detection of openings.

6. Video tape the subject's performance indoors to provide a permanent record of his progress at the end of his first week of training.

Veterans Administration Hospital \ Hines, Illinois

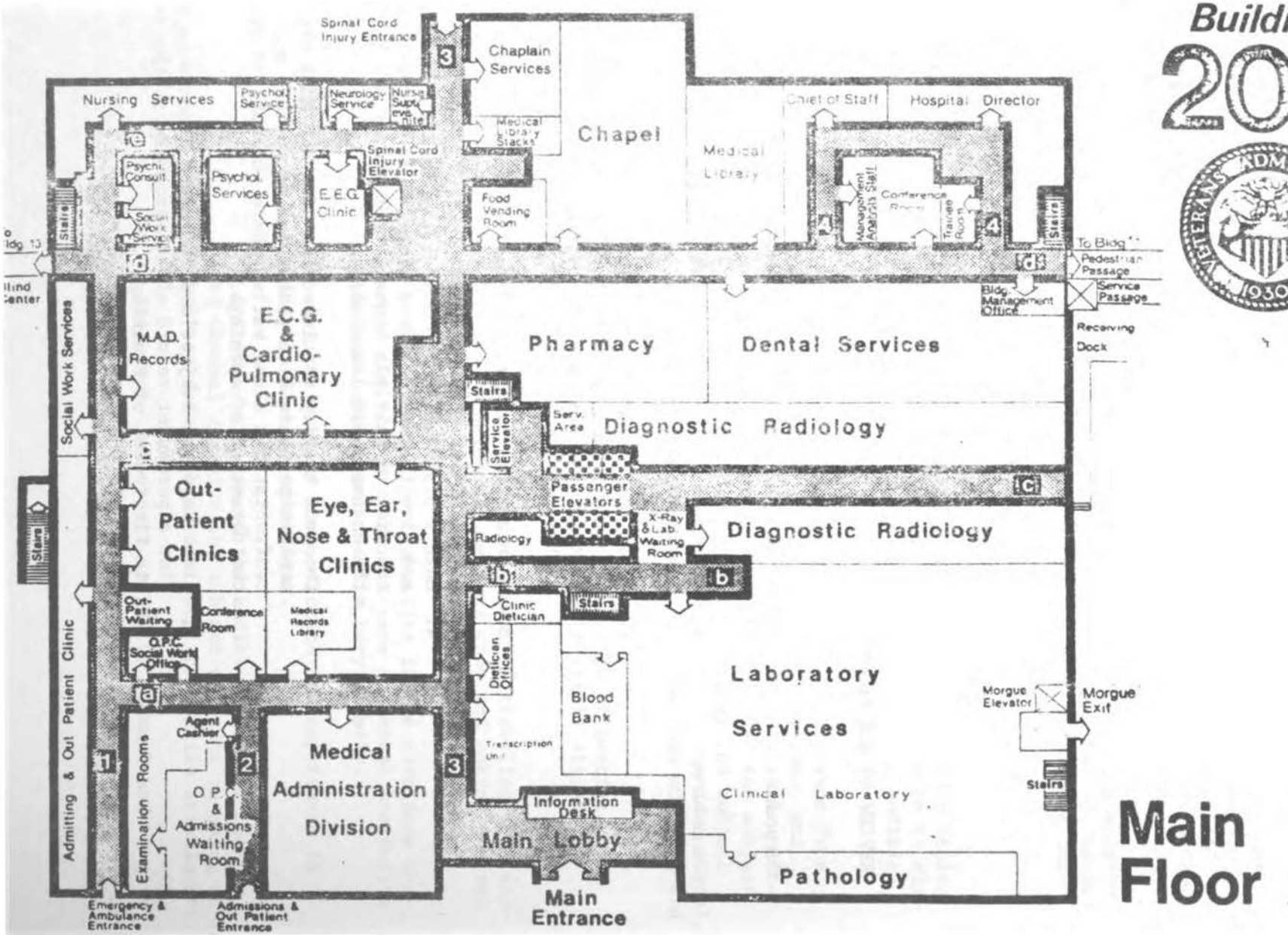


Fig. A2

Veterans Administration Hospital \ Hines, Illinois

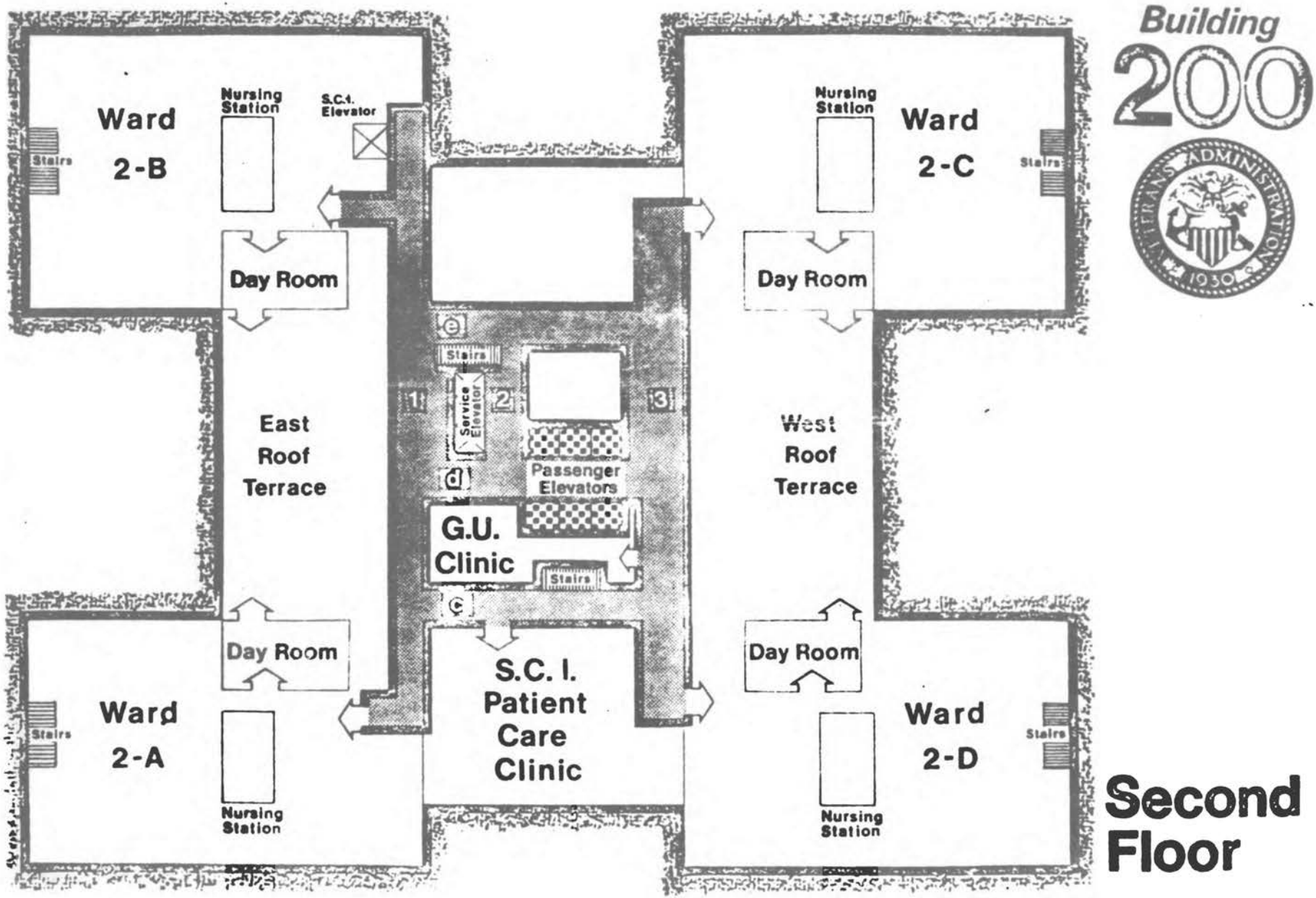


Fig. A2 (cont'd)

Lesson D (cont'd)

Objectives:

1. To provide opportunities for the subject to review previously learned techniques and reinforce his ability to use all three channels of the laser cane.
2. To give the subject practice in detecting, distinguishing, and reacting to individual and multiple signals.
3. To afford the subject practice in handling object confrontations and coping with pedestrian encounters.
4. To give the subject practice in "beam-trailing" walls and detecting openings by using Middle and/or Up Channels.
5. To make a permanent visual record of subject's progress after one week of training.

Lesson E

Three testing procedures were utilized in the early phase of training to obtain objective data which would indicate device viability, subject learning ability of discrete device skills, and the appropriateness of the teaching format. Emphasis was placed on various testing procedures which would promote learning by the subjects. In future program planning these techniques may be modified to give more immediate feedback to the subjects when testing data are not required. The test procedures follow:

Detection Drill

Purpose: The purpose of this drill is primarily to provide training in learning to recognize and respond to the tactile stimulator and audible system signals of the Forward Channel.

Procedure: See Appendix 1 entitled "Preliminary Data Collection" for a description of testing procedures, the number and description of obstacles used, and Table A4 on which the results of the detection drills were tabulated, as well as the dimensions of the test area on Table A7.

1. Place the subject in a controlled area, such as an unused parking lot, and ask him to walk at various angles towards several different types of obstacles usually found outdoors.
2. The subject, on receiving any of the channel signals, should stop, whereupon the investigator will provide feedback on the detection distance and response distance plus information about the obstacle confronted and the dynamics involved.

Lesson E (cont'd)

3. Ask the subject to repeat the drill at different range settings, gait speeds, and various types of obstacles.

4. Time for correction of cane technique or clarification of various signals should be anticipated and provided.

Objectives:

1. To measure the distance from the cane tip to the obstacle at time when warning signal is first heard through the monitoring device carried by one of the Specialists.

2. To use monitoring device to ensure that the laser cane beam is actually detecting the target obstacle.

3. To ascertain the instant that the subject receives the audible signal or tactile stimulation.

4. To correlate position information (see No. 3) with observations of the subject's successes or failures to respond to signals or to avoid collisions.

5. To gauge how far the subject travels before reacting to tactile or audible stimuli.

6. To record the distance between the cane tip and the obstacle at the moment when the subject stops in response to the tactile stimulator or audible signal.

Avoidance Drill

Purpose: To evaluate the subject's ability to successfully circumvent an object in his travel path without any physical body or cane contact with it and the degree to which he is able to reestablish his original line of travel after having oypassed the obstacle.

Procedure: See Appendix I "Training Data Collection Procedures" for a description of the procedures for avoidance measurement, the Data Sheet for Avoidance Test, and the individual and group avoidance test data. The same test area described earlier was used for all the test drills.

1. Ask the subject to walk across the practice area towards a sound source (AM/FM radio) using the laser cane with the conventional touch technique. He should attempt to detect, avoid and circumvent each obstacle

Lesson E (cont'd)

without making body or cane contact with it. The subject will be told that the radio will be positioned so that each obstacle will be directly in his travel path as he walks towards the sound. The distance between the sound and the obstacle will be varied to ensure that the subject will not be able to easily guess the distance of the obstacle from himself by the loudness of the radio. The sound will be present only so long as required to get the subject heading in the right direction or to re-direct him should he veer away from a collision course with the obstacle.

2. If a signal is felt or heard by the subject, he may inform the scorer by flipping his left wrist or use any other prearranged signal.

3. All avoidance trials will be monitored by the telemetry system which will be used by a Specialist to ascertain whether or not the laser beam has detected an obstacle, and if subject had the opportunity to receive the information.

4. If, for any reason, the trial results in no object detection, it will be repeated again later.

5. The order in which obstacles are presented will be arbitrary and a trial will be terminated when a subject either successfully detects and circumvents an obstacle or has made physical body or cane contact with it.

6. All subjects will be permitted to travel at their own pace. The trials will be timed with a stopwatch.

7. Scoring will consist of "Yes" for correctly detecting and circumventing an obstacle, "CC" for making cane contact with the obstacle, and "BC" for making body contact with an obstacle. "CC/BC" will be used when both cane and body contact is made with the same obstacle.

8. Results will be tabulated on a Data Sheet Avoidance Test Form.

Objectives:

1. To determine the degree to which the traveler, using the Touch Technique with the laser cane, can detect an obstacle and consistently circumvent it while traveling at his normal pace and while avoiding cane or body contact with an obstacle.

Lesson E (cont'd)

2. To determine if the subject can detect an object at a sufficient distance to enable him to react to it in time to make corrections in his line of travel.

3. To help the subject learn to determine the position of an object in space relative to his own position as he moves towards it.

4. To give the subject practice in learning to estimate the distance of objects.

5. To help the subject gain an appreciation of the dimensions of an object as he scans and moves toward it.

6. To give the subject practice in making rapid mental assessments of the above factors, analyzing them, making the necessary corrections to avoid contact with the object, and reestablishing his original line of travel after circumvention.

Obstacle Course Drill

Purpose: To get an evaluation of the subject's performance as he receives laboratory training in learning to use the audible and/or tactile information from the Forward Channel during the process of negotiating a course through a standardized obstacle maze.

Procedure: See Training Data Collection Procedures for a description of the procedure for conducting the obstacle course tests, the placement and dimensions of the standard obstacles and the Obstacle Course Test Recording Sheet.

1. Have subject walk in controlled practice area, at various speeds, through an obstacle course consisting of several types of outdoor obstacles. Allow him to use both his long cane and laser cane. A sound source should be used.

2. The arrangement of the obstacles on the course should become progressively more difficult.

3. All channels and range settings should be employed.

4. Various methods of intermittent beam monitoring may be attempted.

Lesson E (cont'd)

Objectives:

1. To test the subject's ability to utilize an object detector in a controlled, artificial setting.
2. To evaluate the subject's ability to navigate through an area in which he must deal with a large number of obstacles.
3. To provide useful training exercises and to simulate travel experiences, under static and controlled conditions to get better acquainted with the C-4 laser cane.
4. To help the subject become more sensitive to the tactile stimulator and Forward Channel audible system of the laser cane.
5. To use the obstacle course exercises as teaching clinics to analyze, diagnose and prescribe training and teaching procedures and to obtain immediate feedback.
6. To stress the importance of achieving normal gait speeds and a fluid continuity of motion.

RESIDENTIAL TRAVEL IN MAYWOOD

INTRODUCTION

For the accomplishment of the objectives for residential training, certain appropriate lessons were taken from the lesson plans used for the regular O&M Program at Hines. The first few lessons were designed to acquaint each subject with outdoor travel in a gradual and progressive manner. Few direct path obstacles, pedestrians, or complicated routes were encountered. Light traffic, square intersections, blocks of uniform length, and simple street crossings were characteristic of these early lessons. The sidewalks usually had shorelines between them and the curbs with trees populating these areas and hedges, fences, garages, etc., on the building line side of the pavement. The curbs were no deeper than six inches in some instances and less than that in others. There were areas which contained overhanging tree branches and in some areas hedges projected over the pavement. The last few lessons utilized a residential area that required the students to cross busy streets, bridges over an expressway, paved parking lots where the sidewalk was part of the paved area, streets at 3-way intersections with stop signs as the traffic controls, and to travel from a residential starting point to business establishments in a small business district. Certain characteristics of the laser cane were observed as follows:

1. The Down Channel had a tendency to generate warning signals at times when the investigators could find no visible cause for it to do so.

2. The Down Channel would generate sound at times when the cane was jarred due to impact with the space separating the slabs of cement that make up the sidewalk.

3. The traveler may be informed of water puddles on the pavement by a signal from the Down Channel and if curbs are high enough, he can avoid stepping off the curb by shorelining on the curb side.

4. If a pedestrian crosses too closely in front of the laser cane, the Up Channel is likely to be excited as well as the Forward Channel.

5. When crossing a blacktop street, the Down Channel often generates sound until the traveler is within a few feet of the curb he is approaching.

6. If the cane goes under a car or tailgate of a truck, the Down Channel may be activated because the light that normally would be reflected back to the receiving optics does not return.

Objectives:

1. To give the subject practice in using the laser cane in a residential setting and to help him learn to gain pertinent external information about his environment with the aid of the laser cane.

2. To evaluate the subject's ability to use the laser cane effectively and to react appropriately to individual and multiple signals.

3. To evaluate the subject's ability to acquire good cane skills and effective travel techniques while being concerned with detecting and reacting to signals from objects in his environment, and remaining oriented and in contact with that environment.

4. To provide the subject with opportunities to gain more experience with the laser cane, to learn to check off-path objects, and to get clear path indications.

5. To help the subject to develop initiative in finding new ways to put the laser beam to work.

6. To point out to the subject how the combination of slanting pavement and blacktop streets in this area can enable him to anticipate curbs even though they may not be 9 in. or more in height.

7. To provide an opportunity for the subject to gain more experience in analyzing laser cane signals and to instruct him in their use for orientation and navigation purposes.

LESSON PLANS FOR RESIDENTIAL TRAVEL IN MAYWOOD

Lesson A

Starting Point: (NW) 5th Avenue & Roosevelt Road

Destination: Ninth Avenue & Fillmore Street and return

Procedure: Subject will travel north (on west side of 5th Avenue) to Fillmore and then go west (on the south side of Fillmore) to 9th Avenue, crossing 6th, 7th, and 8th Avenues enroute. After reaching (SE) 9th Avenue and Fillmore, the subject will retrace his steps back to the starting point.

Lesson B

Starting Point: (NW) First Avenue & Fillmore Street

Destination: Grocery store at (SW) 5th Avenue & Lexington

Procedure: This is a roundtrip of 12 blocks crossing 10 streets. The subject will go north (on the west side of First Avenue) across Harvard to Lexington (SW) and then head west (on the south side of Lexington) across 2nd, 3rd, 4th, and 5th and locate the grocery store there on the SW corner of the 5th Avenue Lexington Street intersection. He will then make the return trip by recrossing 5th Avenue, traveling south (on the east side of 5th) past Harvard to Fillmore at which point he will head east (on the north side of Fillmore) to (NW) Fillmore and First Avenue.

Lesson C

Starting Point: (NE) 5th Avenue & Harrison Street

Destination: (NE) 5th Avenue and Harrison Street. This is a round-trip rectangular travel pattern involving 10 blocks and 6 street crossings.

Lesson C (cont'd)

Procedure: Subject will travel north (on the east side of 5th Avenue) to (SE) Congress, go east (on the south side of Congress) past 4th, 3rd, and 2nd to (SW) First, then south (on the west side of First Avenue) to Harrison, and head back west (on the north side of Harrison) to (NE) 5th Avenue & Harrison, crossing 2nd, 3rd, and 4th Avenues enroute.

Lesson D

Starting Point: Home at 1919 South 9th Avenue

Destination: Lexington Primary School at (NE) 5th Avenue & Lexington Street

Procedure: Subject will walk about 1/4 block to Lexington (on the east side of 9th Avenue) and go east (on the south side of Lexington) to and across 5th Avenue after crossing 8th, 7th and 6th Avenues. He will then cross Lexington, head east (on the north side of Lexington) following his left (north) shoreline past a wire fence to the 2nd sidewalk on the left which is approximately midway the block.

RESIDENTIAL/SMALL BUSINESS TRAVEL IN MAYWOOD

INTRODUCTION

The small business area in Maywood is approximately two blocks long on one of the main thoroughfares, Fifth Avenue. An intersection controlled by a 4-way stop sign is located at the south end. The area provides a good opportunity for the traveler to practice shorelining along building lines and detecting openings and open doorways, although one is likely to find more bicycles parked along the building lines and curbs than are usually found in larger business areas. Baby carriages are more likely to be seen in this area also. There is a railroad track at the north end of the district. Solid building lines flank both sides of Fifth Avenue with a vacant lot on the west side of the street and a vacant lot and paved parking lot on the east side. The area has parking meters.

The main objectives of the residential/small business area travel in Maywood are stated below:

1. To evaluate and contrast the subject's travel skills as he walks with the laser cane from the residential area to the small business area.

2. To evaluate the subject's comprehension of laser cane use and potential and to help him appreciate the fact that the laser beam now gives him the option of obstacle contact or avoidance.

3. To assess the subject's initiative and motivation in completing and understanding mobility assignments.

4. To continue to give the subject practice in the art of orientation and in the use of environmental clues to establish his position in space.

5. To provide an opportunity for the subject to evaluate and measure his own progress toward becoming a more effective traveler with the laser cane.

Lesson Plans for Residential/Business District Travel in Maywood

Lesson A

Starting Point: (SE) 9th Avenue & Bataan Drive

Destination: Chris & Tom's Grill which is located on the east side of 5th Avenue approximately one block north of Quincy Street.

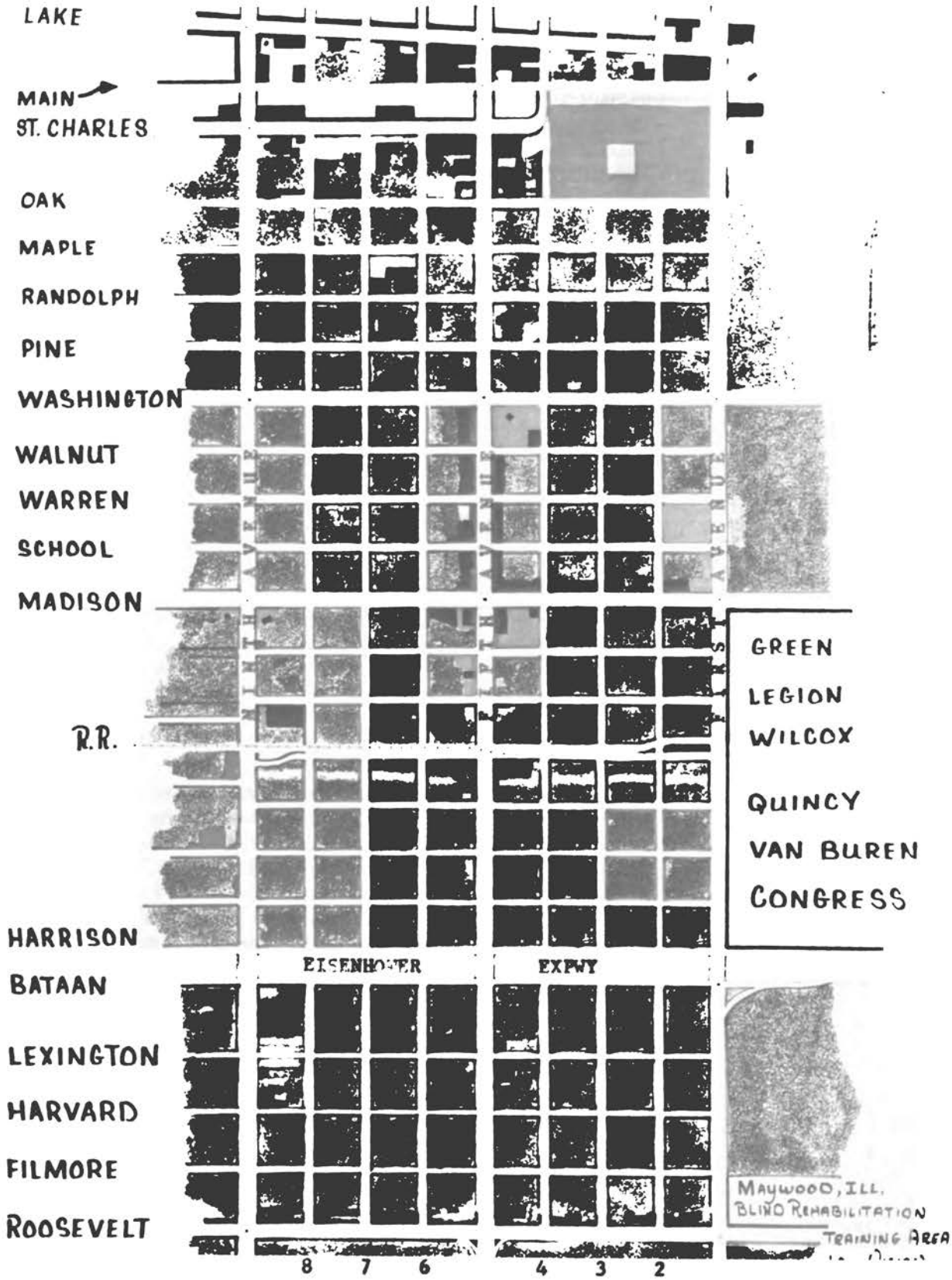
Procedure: Subject will travel east (on the south side of Bataan Drive) to 5th Avenue (SW) then head north (on the west side of 5th Avenue) across Bataan Drive, the bridge over the Eisenhower Expressway, and Harrison. Subject will then cross 5th Avenue and continue walking north (on the east side of 5th Avenue) crossing Congress, Van Buren,and Quincy. After crossing Quincy, continue north but maintain beam contact with the building line on the right until the end of the building line and a vacant lot is reached. At this point, about-face and follow the building line back south to the second opening which is a double opening with two doors leading into separate business establishments. Locate the south or door to the right, open it, and enter the Grill.

Lesson B

Starting Point: (NW) First Avenue & Harrison Street.

Destination: Fountain Lunch Cafe, located on the west side of 5th Avenue slightly more than a block north of Quincy Street.

Procedure: Subject will travel east (on the north side of Harrison) to 5th Avenue and cross it. He will then travel north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OAK
MAPLE
RANDOLPH
PINE
WASHINGTON
WALNUT
WARREN
SCHOOL
MADISON
R.R.
HARRISON
BATAAN
LEXINGTON
HARVARD
FILMORE
ROOSEVELT
GREEN
LEGION
WILCOX
QUINCY
VAN BUREN
CONGRESS
EISENHOWER
EXPWY
MAYWOOD, ILL.
BLIND REHABILITATION
TRAINING AREA
8 7 6 4 3 2

Fig. A3

(on the west side of 5th) crossing Congress, Van Buren and Quincy Streets. After crossing Quincy, continue traveling north and maintain beam contact with the building line on the left and follow it to the end after which there is a wide vacant lot. When the building line resumes at the north end of the lot, locate the first door at the beginning of building line. It (the door) faces out on an angle (SE) across 5th Avenue, towards Chris & Tom's Grill.

Lesson C

Starting Point: (SE) 9th Avenue and Congress Street.

Destination: The Maytown Restaurant which is located on the west side of 5th and is the first recessed opening south of Madison Street.

Procedure: Travel north (on the east side of 9th Avenue) to Madison Street, crossing Congress, Van Buren, Quincy, Wilcox, the railroad tracks, Legion, and Green. Then go east (on the south side of Madison Street) to 5th Avenue. Upon reaching 5th Avenue and Madison Street (SW) walk south, follow the building line on the right, and find the first recessed opening. Open the door and enter the restaurant.

BUSINESS DISTRICT TRAVEL IN MAYWOOD & OAK PARK

INTRODUCTION

The main Maywood business area used for O&M purposes stretches along 5th Avenue from Green Street on the south to Lake Street to the north. This area covers some 12 blocks with a set of RR tracks in the northern section between St. Charles and Main Street (see map of Maywood).

Oak Park is situated between Maywood and Chicago. The business area chosen for the O&M assignments is at the west end of the village and extends from Bonnie Brae on the west to South and North Forest on the east. Travel northward from Lake Street is usually two to three (and on occasions four) blocks and normally just one block to the south of Lake Street (see map of Oak Park).

The village of Maywood has a population of approximately 30,000 residents and the population of Oak Park is 63,511. Both of these suburbs have, on a smaller scale, most of the things normally found in a large American city.

Lessons appropriate to training subjects to use the laser cane were chosen, with but few exceptions, from the Hines master O&M lesson plans. Training was conducted under all kinds of travel conditions such as normal and peak traffic conditions and light and heavy pedestrian travel, rain, high winds, sunny conditions, different times of the day, etc.

Following are the objectives for business district travel in Maywood and Oak Park:

1. To continue to stress the employment of good cane and travel skills while traveling with the laser cane.

2. To give the subject more practice in trailing building lines with the laser cane beams of the Forward and Up Channels and encourage him to experiment with the Forward Channel range settings to find the most practical range for achieving certain goals.

3. To expose the subject to heavier traffic and more pedestrian encounters.

4. To help the subject get more fully acquainted with loud traffic noises and to enable him to learn how useful the laser cane can be in relatively large business areas, and along streets with heavy auto traffic.

5. To introduce the subject to travel techniques which should be employed by a laser cane user when attempting to negotiate busy, traffic-controlled intersections.

6. To review the points involved in negotiating busy, traffic-controlled intersections and to instruct the subject on how he can monitor pedestrians and cars with his laser beam to ascertain and confirm traffic flow while waiting for traffic clearance to cross streets.

7. To help the subject learn to use the laser beam to monitor turning cars when crossing streets and to check street light posts, mail boxes, building lines, etc., when approaching curbs at busy intersections.

8. To afford the subject the opportunity to review bus orientation and boarding and departing procedures and to gain experience in the use of public transportation with the laser cane.

9. To give the subject experience in locating supplementary landmarks while traveling in stores, and getting information about specific locations and counters inside a store.

10. To evaluate the subject's ability to use the laser cane effectively and to exploit the potential of the laser beam to aid him in traveling in unfamiliar as well as familiar areas.

LESSON PLANS FOR BUSINESS DISTRICT TRAVEL IN MAYWOOD & OAK PARK

Lesson A

Starting Point: (SE) 5th Avenue & Madison Street in Maywood

Destination: (SE) 5th Avenue & Madison Street

Procedure: Review the travel skills and techniques subject uses in negotiating busy, traffic-controlled intersections. Also check on subject's ability to evaluate and interpret traffic sounds for the purpose of determining when the flow of traffic is favorable and when he may safely cross the street. Have subject practice clockwise and counterclockwise crossings before the end of the period. Allow subject to make some of the crossings with the laser power on and with it off. Make some of the crossings from near the curbs and some with approaches from 50-100 feet away from the curbs. Practice using the building line and traffic sounds for alignment and direction-taking. Acquaint subject with useful landmarks which may be used to identify certain corners, help him learn to locate the proper area from which to embark when enroute to another corner across the street, and give him practice in using the laser cane to detect various objects and landmarks which can enable him to handle crossing more intelligently and efficiently. Acquaint subject with the technique of "beam-monitoring" pedestrians and traffic to ascertain and confirm traffic flow and stoplight changes. Point out that the laser beam can also be used to monitor and detect turning traffic and parked cars. Practice using the tactile stimulator alone and also in combination with the audible system of the Forward Channel

Lesson B

Starting Point: (NW) First Avenue & Legion Street in Maywood

Destination: White Way Food Mart at (NW) 4th Avenue and Walnut Street

Procedure: Subject will travel north (on the west side of First Avenue) and cross Green, Madison (traffic-controlled), School (traffic-controlled), Warren, and Walnut. He will then walk west (on the north side of Walnut) to (NW) 4th Avenue & Walnut Street. After crossing 4th Avenue, subject will continue going west and will

Lesson B (cont'd)

maintain beam contact with the building line on his right until he gets to the end of it. Upon reaching the west end of the building, subject will turn right, step up onto an elevated sidewalk and walk north following the building line on his right until he gets to the north end, at which point he will come in contact with a metal food-basket conveyor belt apparatus. He will turn sharply around this conveyor belt to the right and step on a rubber mat which leads to the "IN" door of the White Way Food Mart. This door, as well as the "OUT" door immediately to the east, operates electronically. Subject will enter the store, get familiarization inside, and practice traveling about the store locating various departments and counters and moving up and down the aisles with as little contact as possible.

Lesson C

Starting Point: (SW) 6th Avenue and Washington Blvd. in Maywood

Destination: Coleman Instruments located at (SE) Madison Street & Greenwood Avenue.

Procedure: Subject will walk east (on the south side of Washington Blvd.) across 6th Avenue to 5th Avenue (SW). He will then go south (on the west side of 5th Avenue) past Walnut, Warren, School, and across Madison. Subject will then cross 5th Avenue and head east (on the south side of Madison) to Greenwood Avenue (SE), crossing 4th, 3rd, 2nd, First and Orchard Avenues enroute. After crossing Greenwood Avenue, subject will follow the brick wall on his right to the first opening, turn right, and take the "step - down" walk to the door of Coleman Instruments.

Lesson D

Starting Point: (NW) First Avenue & Oak Street in Maywood

Destination: Gollay's Clothing Store, located on the west side of 5th Avenue between Lake & Main Streets. It is the 2nd opening on the left north of Main Street.

Procedure: Subject will travel north (on the west side of First Avenue) past the RR tracks and across Main Street to Lake Street (SW). Then go west (on the south side of Lake Street to and across 5th Avenue). Next, head south (on the west side of 5th Avenue) past the building line and locate the first opening on the right. Gollay's may also be located by finding the 2nd opening on the

Lesson D (cont'd)

left as one travels north from Main Street. Enter the store and practice laser cane techniques inside.

Lesson E

Starting Point: (SE) Lake Street & Bonnie Brae in Oak Park

Destination: (NE) Lake Street & Bonnie Brae

Purpose: Familiarization of Oak Park business district on both sides of Lake Street from Bonnie Brae to Forest.

Procedure: Subject will travel east (on the south side of Lake Street) to and across S. Forest, passing Harlem Avenue and Marion enroute. After crossing S. Forest, subject will continue to walk east about a quarter of a block (Forest is an off-set street and the south and north extensions form T- junctions with Lake Street), cross Lake Street, N. Forest and head back west (on the north side of Lake) to Harlem & Lake. Subject will then practice street crossings and get familiarization of the business establishments on the NE, SW,and SE corners and the bus stop on the NW corner. The subject will use his laser cane and travel as independently as possible.

Lesson F

Starting Point: (NE) 5th Avenue & Main Street in Maywood

Destination: Bus ride to (SE) Harlem Avenue & Lake Street in Oak Park.

Procedure: Subject will be driven to starting point in car and will walk north (on the east side of 5th) to Lake Street (SE). He will then cross 5th Avenue to the SW corner and board an eastbound bus at that bus stop. Upon reaching the bus stop at (SE) Harlem Avenue & Lake Street, which is east of Harlem on Lake, subject will return to the Harlem-Lake intersection and review street crossings and the landmarks, business establishments, and bus stop on the corners.

Lesson G

Starting Point: (SW) N. Forest & Erie Street in Oak Park

Destination: Bond Clothing Store at (SW) Lake Street & Marion

Procedure: Subject will travel south (on the west side of N. Forest) past Ontario to Lake Street (NW) and then head west (on the north side of Lake). He will cross

Lesson G (cont'd)

Marion and then Lake Street and locate the wide opening facing Lake as he "beam-trails" the building line on his right back towards Marion. Subject will go inside Bond's Clothing Store and locate the men's slacks department after which he will practice traveling to various departments and counters in the store.

Lesson H

Starting Point: (NW) Maple & Erie Streets in Oak Park.

Destination: The Appliances Department in Montgomery Ward's Department Store at (NW) Lake Street & Marion

Procedure: Subject will not be given the location of his starting point but he must solicit aid from pedestrians to get himself oriented and then proceed to his destination. He will be free to get as much verbal information and aid as he feels he needs but he may not be physically helped or escorted to the destination.

Lesson I

Starting Point: (SW) Harlem Avenue and Lake Street in Oak Park.

Destination: Wieboldt's Department Store at (SW) Harlem Avenue & Lake Street.

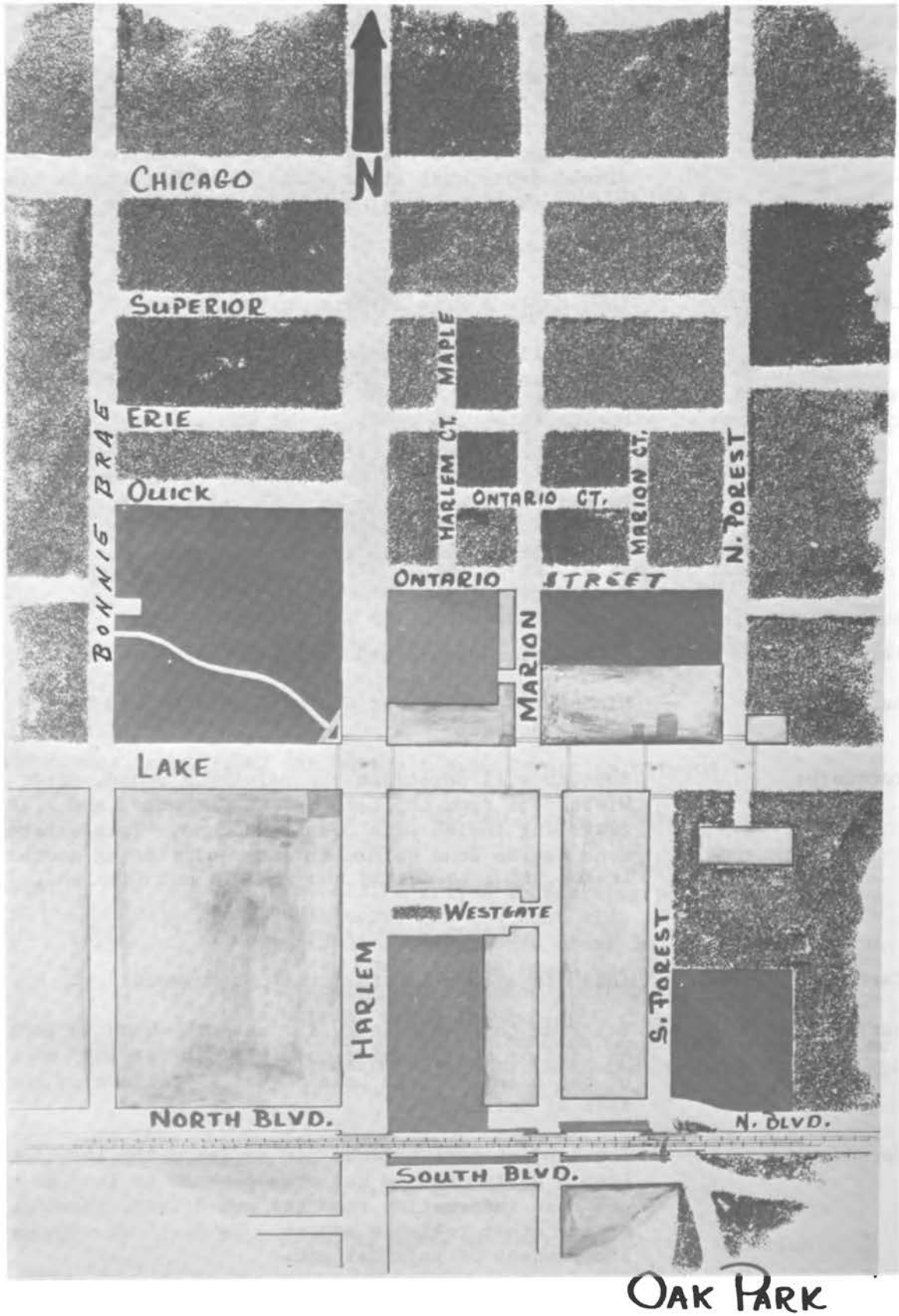
Procedure: Subject will negotiate the revolving doors, enter Wieboldt's from the Lake Street entrance, and practice traveling inside with the laser cane. This assignment can be done before or after completing another lesson, if a roundtrip bus ride is not involved.

Lesson J

Starting Point: (NE) 5th Avenue & Main Street in Maywood

Destination: Bus ride to Lyon & Healy in Oak Park which is located by finding the 2nd wide opening (4th opening) south of the alley between Lake Street & Westgate on the west side of Marion.

Procedure: The subject must solicit aid to learn the location of Lyon & Healy and the bus stop closest to it. He may get this information from the bus driver, passengers, or any other reliable source. He must make the trip independent of physical aid.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MARION
LAKE
WESTGATE
HARLEM
S. FOREST
NORTH BLVD.
N. BLVD.
SOUTH BLVD.
OAK PARK

Fig. A4

Lesson K

Starting Point: (NW) Maple & Erie Streets in Oak Park

Destination: The Customer Service Department at Wieboldt's Department Store located at (SW) Harlem Avenue & Lake Street.

Procedure: Subject will not be given the location of his starting point but must solicit aid from passersby to get himself oriented and then proceed on to his destination. He will be free to solicit as much aid and information as he feels he needs, short of being physically helped and escorted to the destination.

Lesson L

Starting Point: (NE) 5th Avenue & Main Street in Maywood

Destination: Bus ride to Lytton's Clothing Store in Oak Park, located at (NW) Lake Street and N. Forest.

Procedure: Subject will be driven to the starting point from which corner he will walk north to Lake Street and cross 5th Avenue to the bus stop. He must make sure that the bus he boards goes past Harlem Avenue on Lake Street, otherwise he might have to walk from Harlem to Forest. After getting off the bus at (SW) S. Forest and Lake, subject will cross Lake Street, head west across North Forest, find the first opening in the building line on his right facing Lake and enter Lytton's there on the NW corner. He will solicit aid in locating the men's shirt department. If time permits allow subject to practice detecting aisles, circumventing objects, traveling to various counters, etc.

Lesson M

Starting Point: (NE) Randolph & Marion Street in Oak Park

Destination: Marshall Fields Department Store at (NE) Harlem Avenue and Lake Street.

Procedure: Subject will travel north (on the east side of Marion) crossing Pleasant Pl., Pleasant Street, South Blvd., the "L" tracks, North Blvd., and Lake Street. Upon reaching NE Marion & Lake, subject will proceed west (on the north side of Lake) to Harlem Avenue and locate the first opening on his left as he follows the building line heading back east from the curb at Harlem Avenue.

CHICAGO LOOP TRAVEL

INTRODUCTION

Travel in the Chicago Loop was confined, for the most part, to the heart of the downtown area in order that subjects would get maximum exposure to the city with its demanding orientation and travel conditions.

Some of the lessons used for the Chicago Loop assignments were designed specifically by the investigators to achieve certain teaching and training objectives with the laser cane.

The objectives for this final stage of training are listed below:

1. To expose the subject to big-city travel.

2. To observe and evaluate the initiative and resourcefulness displayed by a subject in coming to grips with his travel problems and solving them by an ordered process of analysis, forming judgments, and drawing sound conclusions.

3. To provide an opportunity for the subject to enter business establishments, solicit information and directions, and to locate specified departments within the establishments.

4. To give the subject a review of techniques employed in using "L" and subway stations and taking advantage of the laser beam and structural resources inherent in such structures.

5. To make the subject aware of the fact that information obtained by means of pedestrians or the laser beam must be interpreted, evaluated, doublechecked for errors, accuracy and consistency.

6. To afford the subject the opportunity to test the laser cane in a thickly crowded situation and to experiment with various range settings to determine if the cane can be of use under these travel conditions or if it would be wiser to turn the cane off and use it as a conventional long cane.

LESSON PLANS FOR CHICAGO LOOP TRAVEL

Lesson A

Purpose: Familiarization of Des Plaines "L" Station, Washington & Dearborn Subway Station, and trip around the Loop via: Dearborn north to Randolph, east to Wabash, south to Jackson, west to Dearborn, and north back to the starting point, the subway station at Washington and Dearborn.

Lesson B

Starting Point: Subway station at Washington & Dearborn, located midway the block between Washington & Dearborn on the east side of Dearborn.

Purpose: Familiarization of State Street and the location of certain business establishments on both sides of State Street.

Procedure: Proceed north from the Washington and Dearborn subway station to Lake Street, crossing Randolph enroute. Go east on Lake Street to State Street. Then travel south, on the west side of State Street, to Van Buren. Cross State Street at Van Buren and return to Lake Street on the east side of State Street. If time permits, repeat assignment in reverse or go to a predesignated destination.

Lesson C

Starting Point: (NE) State and Randolph

Destination: Sears, Roebuck and Company at (SE) State and Van Buren.

Procedure: Travel south, on east side of State Street past Washington, Madison, Monroe, Adam, Jackson, across Van Buren to the SE corner and locate the destination on the corner of the intersection of State and Van Buren.

Lesson D

Starting Point: (NW) State and Monroe

Destination: The Prudential Building at (NE) Randolph and Michigan.

Procedure: The subject may take any route he chooses to his destination, a trip of 5 blocks and 5 or 6 street crossings, depending on the route taken.

Lesson E

Starting Point: (NE) Randolph and Michigan

Destination: The Art Institute on the east side of Michigan at Adam.

Procedure: This is a short trip of approximately 4 blocks and 4 street crossings and is usually combined with the trip to the Prudential Building.

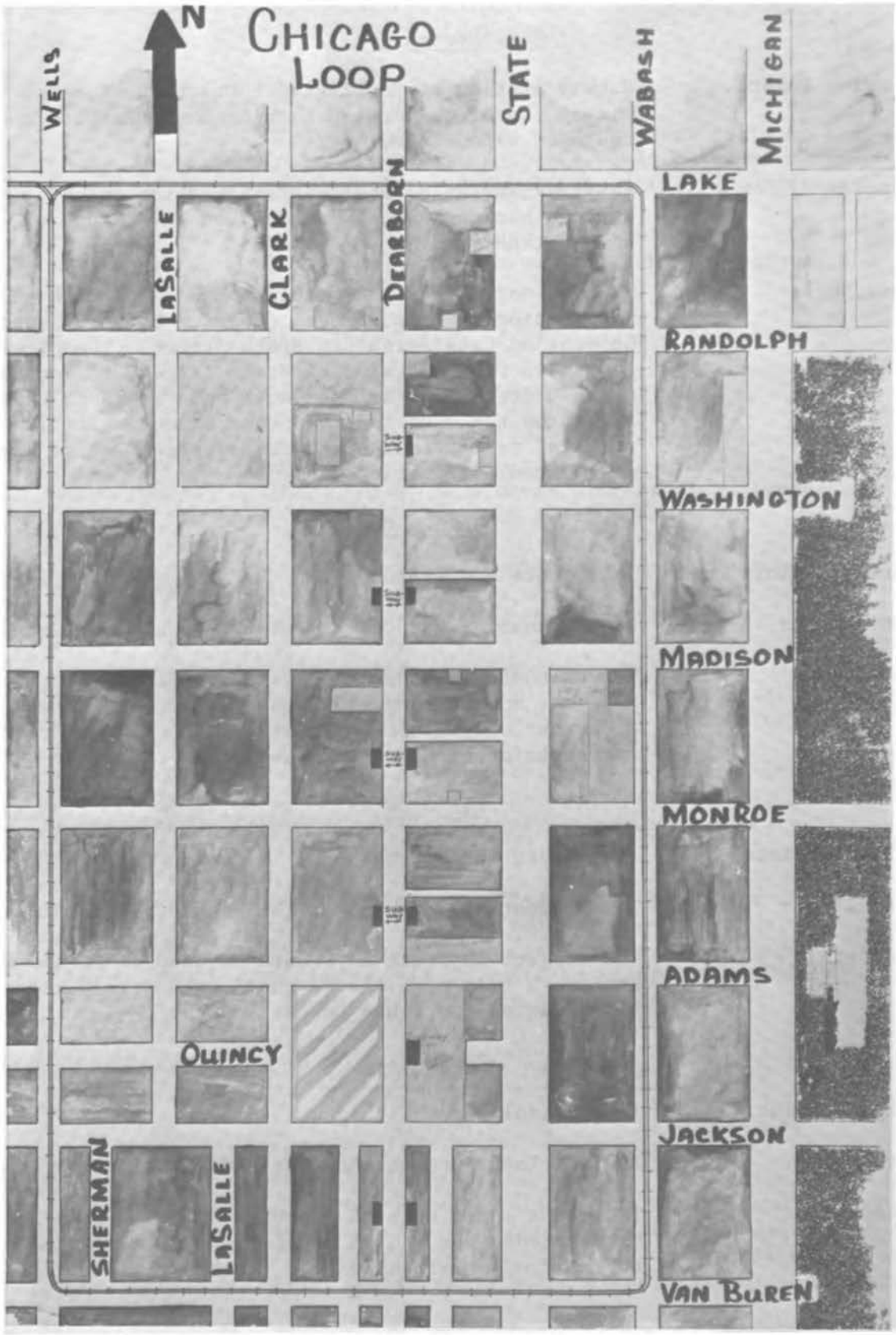

N
CHICAGO LOOP
WELLS
STATE
WABASH
MICHIGAN
LAKE
LASALLE
CLARK
DEARBORN
RANDOLPH
WASHINGTON
MADISON
MONROE
ADAMS
QUINCY
JACKSON
SHERMAN
LASALLE
VAN BUREN

Fig. A5

Lesson F

Starting Point:	(NW) Jackson and Michigan
Destination:	The Greyhound Bus Station at (NE) Randolph and Clark
Procedure:	The route taken is done so at the pleasure of the subject. This trip involves 9 or 10 blocks and street crossings, depending upon the route chosen.

POST-TRAINING EVALUATION LESSON PLANS

The lesson plans for the Orientation and Mobility Task Rating Scale and the Orientation and Mobility Subtask Checklist were designed by the Orientation and Mobility Specialists at Palo Alto and Hines VA Hospitals at the end of the training program for the purposes of having noninvolved Orientation and Mobility Specialists (peer Group) and the Orientation and Mobility Research Specialists themselves rate the performances of the eight subjects, and to get numerical values for the possible differences in a subject's performance when comparing his use of the long cane with the laser cane over unfamiliar routes in suburban and city areas. Complete description of the Orientation and Mobility Task Rating Scale and the Orientation and Mobility Subtask Checklist may be found in the Training Data Collection Procedures section of this study in Appendix 1.

Four travel assignments were designed for the post-training evaluation data-collection procedures and they were coded Routes A, B, C, and D. Routes A and B were in the suburbs of Berwyn and Cicero and Routes C and D were in the Chicago Loop area (see Training Data Collection Procedures, Appendix I for rough maps of the areas used for the assignments). Following are the four evaluation runs:

ROUTE A

Starting Point:	(NW) 59th Ct. & 19th Street (Berwyn/Cicero area)
Travel Aid:	Long Cane
Destination:	Old Prague Restaurant, located at (NW) 59th Ct. & Cermak Rd.
Procedure:	Travel east (on north side of 19th Street) to 58th Avenue, crossing 59th Ct., 59th Avenue, and 58th Ct. Then turn right and walk south (on west side of 58th Avenue) to Cermak Rd., passing 19th and 21st Streets enroute. Proceed west (on north side of Cermak Rd.) to 59th Ct. (NW), crossing 58th Ct., 59th Avenue, and 59th Ct. After crossing 59th Ct., continue west and follow the building line on the right to the first opening and locate the door of the Old Prague Restaurant which has big brass bar handles.

ROUTE B

Starting Point: (NE) 19th Street & 58th Ct. (Berwyn/Cicero area)

Travel Aid: Laser Cane

Destination: Rosicky's National Cleaners at (NE) 58th Ct. & Cermak Rd.

Procedure: Walk west (on the north side of 19th Street) to Austin Blvd., crossing 58th Ct., 59th Avenue, and 59th Ct. Then turn left, cross 19th Street, and continue south (on the east side of Austin Blvd.) and go to Cermak Rd., crossing 21st Street on the way. Travel east, (on north side of Cermak Rd.) to (NE) 58th Ct., crossing 59th Ct., and 59th Avenue as well. Upon reaching (NE) 58th Ct., continue traveling east and find the first opening in the building line facing Cermak Rd.

ROUTE C

Starting Point: (SW) Washington & Dearborn Street (Chicago Loop)

Travel Aid: Laser Cane

Destination: Dutch Mills Candies at (NE) Washington & Dearborn Streets

Procedure: Cross Dearborn Street and go east (on the south side of Washington Street) to Michigan Avenue, crossing State Street and Wabash Avenue. Then go south (on the west side of Michigan Avenue) to Madison Street and cross it. Proceed west (on south side of Madison Street) across Wabash Avenue and State Street, to Dearborn, at which point turn right, cross Madison Street, and walk north (on the east side of Dearborn Street) to Washington Street. Cross Washington Street and find the first opening directly on the NE corner. The door faces out on a diagonal across the intersection and is a combination glass and aluminum door with a handle bar that stretches the width of the door.

ROUTE D

Starting Point: (SW) Randolph & Dearborn Streets (Civic Center - Chicago Loop)

Travel Aid: Long Cane

ROUTE D (cont'd)

Destination:	Kopper Kettle Lounge at (NE) Randolph & Dearborn Streets
Procedure:	Cross Dearborn Street and proceed east (on the south side of Randolph Street) across State Street and Wabash Avenue to Michigan Avenue. Go south (on west side of Michigan Avenue) one block, to Washington Street and cross to south side of the street. Then travel west (on south side of Washington Street) to Dearborn, crossing Wabash Avenue and State Street. Turn right, cross Washington Street and continue north (on east side of Dearborn) to and across Randolph Street. Continue going north following the building line on the right until the first opening (an inset door) is reached.

Appendix III

SUBTASK CHECKLIST

INTRODUCTION

The Subtask Checklist developed out of a desire to record and tabulate countable and objectively measurable events of importance which can occur during travel with a cane.

This appendix contains three sections. The first section lists the definitions which were drawn up to identify the important events. The second section contains Table A29 which consists of a copy of the actual checklist, and the third section contains some concluding observations and suggestions for future improvement.

GUIDELINES FOR COMPLETING THE O&M SUBTASK CHECKLIST

The following is a list of definitions and criteria for use in scoring the Orientation and Mobility Subtask Check List. Each subject on each run will be scored according to what can be seen from the videotape and heard from the taped audio commentary. The term "travel path" in the definitions will be interpreted as that area in front of the subject which is encompassed by the width of the sidewalk.

A. Continuity of Travel

1. Hesitations -- are defined as occasions when, in the opinion of the scorer, there has been an obvious conscious reduction of travel speed or momentary delay in progress without coming to a full complete stop. The only exceptions should be when the cane sticks in the guidelines or in cracks in the sidewalk, or the subject anticipates curb detection. Scoring of hesitations will be done by recording the number of incidents in the appropriate space.

2. Stops -- are defined as situations where the subject comes to a full complete standstill. The only exception to this will be stops at curbs or alleyways. The total number of incidents should be recorded in the appropriate space.

B. Obstacle Negotiation

1. Attempted Circumvention Without Contact -- is defined as any situation where the traveler, on detecting an obstacle in his direct line of travel, alters his line of travel so that he proceeds past the obstacle without making cane or body contact. The score in this case will be the total number of such incidents.

2. Attempted Circumvention With Contact -- is defined as any situation where the traveler,on detecting an obstacle in his direct line of travel, attempts to circumvent it, but makes cane and/or body contact with the obstacle. The total number of incidents should be entered in the appropriate space. An incident may be recorded in only one category.

3. Contact Without Attempted Circumvention -- is defined as any situation in which the traveler does not make any observable attempt to adjust his line of travel around an obstacle which is in his direct line of travel and proceeds straight ahead to make cane and/or body contact with it. The total number of incidents constitutes the score. An incident may be recorded in only one category.

C. Orientation

1. Orientation Problems-- are defined as occasions when the traveler goes off the prescribed route and must search to relocate his travel path. On street crossings the efficient recovery of the travel path by use of the cane after a minor veer does not constitute an orientation problem. The total number of such incidents should be recorded as the score.

2. Independent Recoveries from Orientation Problems -- are defined as situations in which the traveler,after perceiving an orientation problem,reorients himself within a five-minute time limit and continues in the correct direction. The number of these incidents should be entered as the score.

3. Needs Assistance with Orientation Problems -- is defined as an occasion when the traveler is unable to successfully deal with an orientation problem within the five-minute time limit. If the traveler,after relocating the travel path, proceeds in the wrong direction, he will be stopped at the first intersection he reaches or after five minutes, whichever comes first. Record the total number of incidents.

4. Deviations from Prescribed Route -- are defined as situations where the traveler does not follow the prescribed route to his destination, i.e., by crossing the wrong streets, reversing portions of the route, or making wrong turns. Minor veerings off the travel path do not fall within this definition. Add the number of these incidents and enter the total in the appropriate space.

D. Street Crossing

1. Detection of Down Curbs -- A subject qualifies for a "yes" score in the detection of down curbs if, when confronted by a down curb (alleyways), he successfully anticipates, manually detects the curb with his cane, and appropriately responds by stopping. Falling off the curb, overstepping the curb, or using the cane as an orthopedic tool to regain balance does not merit the "yes" score and a "no" should be awarded.

2. Properly Aligns for Crossing -- A score of "yes" for properly aligning for a street crossing should be awarded for successful body alignment by the traveler prior to crossing the street with the aid of audible or tactual information. The traveler's alignment should be such that he could complete the crossing within the defined travel path if he maintained his line of travel. Score "yes" or "no" for each street encountered.

3. Starts Crossing at Appropriate Time -- A score of "yes" should be awarded if the traveler makes a prudent start at a street crossing as dictated by weather conditions, automobile traffic and the amount of traffic control. Starting long after the start of parallel traffic, crossing against a red light, or crossing when traffic pattern information is in doubt, qualifies for a "no" score.

4. Veers on Street Crossing -- is defined as a complete street crossing in which the traveler reaches the curb outside of the crosswalk or outside the defined travel path. Score "yes" or "no" for each crossing encountered, and in addition indicate the direction of the veer.

5. Needs Assistance to Complete Crossing -- is defined as assistance required by the traveler to complete his crossing in the event he becomes disoriented in the street, or places himself in a potentially hazardous situation. Score "yes" or "no" for each street crossing encountered.

E. Travel Path Position

1. Makes Cane Contact with Guidelines -- is defined as an occasion when unintentional cane contact is made with the travel boundary. At breaks, or openings in the boundary line (e.g., at driveways or entrances to stores), if the cane extends beyond the imaginary boundary line across the opening, a cane contact with the guideline should be scored. Scoring will be done by recording the number of incidents in the appropriate space in addition to an indication of the side on which the contact is made.

2. Veers off Travel Path -- are defined as occasions when the traveler moves off the travel path with both feet. Record the number of incidents in the appropriate space and indicate the direction of the veer.

TABLE A29

ORIENTATION & MOBILITY SUBTASK CHECKLIST DATA SHEET

PRELIMINARY C-4 LASER CANE EVALUATION, 1971-72

DATE _____ BLOCKS IN RUN _____

STUDENT ___1___2___3___4___5___6___7___8 NUMBER OF STREET CROSSINGS_____

RUN ___A___ LASER CANE FAMILIAR

___B___ LONG CANE FAMILIAR

___C___ LASER CANE UNFAMILIAR

___D___ LONG CANE UNFAMILIAR

CONTINUITY OF TRAVEL

1. Number of Hesitations

	1	2	3	4	5	6	7	8	TOTAL
BLOCKS									
STREETS									

2. Number of Stops

	1	2	3	4	5	6	7	8	TOTAL
BLOCKS									
STREETS									

OBSTACLE NEGOTIATION

1. Number of Attempted Circumventions without Contact

		1	2	3	4	5	6	7	8	TOTAL
BLOCKS	OBSTACLE									
	PEDESTRIAN									

TABLE A29 (cont'd)

STREETS		1	2	3	4	5	6	7	8	TOTAL
	OBSTACLE									
	PEDESTRIAN									

2. Number of Attempted Circumventions with Contact

		1	2	3	4	5	6	7	8	TOTAL
CANE CONTACT	OBSTACLE									
	PEDESTRIAN									
BODY CONTACT	OBSTACLE									
	PEDESTRIAN									
BOTH	OBSTACLE									
	PEDESTRIAN									

STREETS			1	2	3	4	5	6	7	8	TOTAL
	CANE CONTACT	OBSTACLE									
		PEDESTRIAN									
	BODY CONTACT	OBSTACLE									
		PEDESTRIAN									
	BOTH	OBSTACLE									
		PEDESTRIAN									

TABLE A29 (cont'd)

3. Number of Contacts Without Attempted Circumvention

			1	2	3	4	5	6	7	8	TOTAL
BLOCKS	CANE CONTACT	OBSTACLE									
		PEDESTRIAN									
	BODY CONTACT	OBSTACLE									
		PEDESTRIAN									
	BODY	OBSTACLE									
		PEDESTRIAN									

			1	2	3	4	5	6	7	8	TOTAL
STREETS	CANE CONTACT	OBSTACLE									
		PEDESTRIAN									
	BODY CONTACT	OBSTACLE									
		PEDESTRIAN									
	BOTH	OBSTACLE									
		PEDESTRIAN									

ORIENTATION

1. Number of Orientation Problems

	1	2	3	4	5	6	7	8	TOTAL
BLOCKS									
STREETS									

TABLE A29 (cont'd)

2. Number of Independent Recoveries from Orientation Problems

	1	2	3	4	5	6	7	8	TOTAL
BLOCKS									
STREETS									

3. Number of Times Assistance Given to Subject Involved in an Orientation Problems

	1	2	3	4	5	6	7	8	TOTAL
BLOCKS									
STREETS									

4. Number of Deviations from Prescribed Route

	1	2	3	4	5	6	7	8	TOTAL
BLOCKS									
STREETS									

STREET CROSSING

1. Detection of Down Curbs

	1	2	3	4	5	6	7	8	TOTAL
YES									
NO									

2. Proper Alignment for Crossing

	1	2	3	4	5	6	7	8	TOTAL
YES									
NO									

TABLE A29 (cont'd)

3. Starts Crossing at Appropriate Time

	1	2	3	4	5	6	7	8	TOTAL
YES									
NO									

4. Veers on Street Crossing

		1	2	3	4	5	6	7	8	TOTAL
YES	TOWARDS PARALLEL STREET									
	AWAY FROM PARALLEL STREET									
NO										

5. Needs Assistance to Complete Crossing

	1	2	3	4	5	6	7	8	TOTAL
YES									
NO									

TRAVEL PATH POSITION

1. Number of Cane Contacts with Guidelines

	1	2	3	4	5	6	7	8	TOTAL
TOWARDS PARALLEL STREET									
AWAY FROM PARALLEL STREET									

TABLE A29 (cont'd)

2. Number of Veers off Travel Path

	1	2	3	4	5	6	7	8	TOTAL
TOWARDS PARALLEL STREET									
AWAY FROM PARALLEL STREET									

TIME

1. Time Run Started _____
2. Time Run Ended _____
3. Total Travel Time _____

GENERAL TRAVEL INFORMATION

1. Pedestrian Traffic on Run ..... _____Heavy
   _____Medium
   _____Light

2. Automobile Traffic on Run ..... _____Heavy
   _____Medium
   _____Light

3. Weather Conditions During Run ..... _____Sunny
   _____Overcast
   _____Windy
   _____Rainy

4. Unusual Occurrences if any _____

_____

_____

_____

_____

CRITIQUE

There appeared to be general agreement among all 4 members of the O&M research staff that the content of the checklist did include most of the important areas of independent travel performance; however, it was obvious that some of the categories such as stops, hesitations, disorientation, etc., need even more rigid and meaningful definition. For the purpose of collecting and analyzing the data it would help in the future to reorganize the arrangement of the categories according to some selected interrelationships. It would also help to be more precise in defining the specific units or sections of the travel route that one is going to be concerned with when collecting data. For example, the question must be decided as to whether the boundary is to be on the right or the left side of the travel path, and when selected, what structure is to define that boundary? Also, if the route is described in terms of the number of blocks and the number of street crossings, the question of where a block begins and ends will have to be defined as well as how the number of blocks is going to be related to actual distance when blocks obviously vary in length. These are just a few specific examples of some of the details of definition that need to be worked out if the Subtask Checklist is to have broad application.

One final observation, but a very important one in terms of evaluation procedure, should be added. All of the O&M investigators had difficulty collecting meaningful objective data during on-the-spot observations. There are too many elements of performance to attend to and the judgments must be made too quickly for an observer to be effective in this situation. Because of this difficulty, the use of videotape proved to be a very effective tool in the collection of objective data. One area of weakness that was observed in using the videotape was in the scoring of doubtful physical contacts. It would also be very helpful if the quality of the audio channel on the videotape could be improved. It seems likely that more refined videotaping techniques and procedures could further improve the objective measurement of travel performance. The checklist which was used in the present evaluation could be scored effectively from videotape.

Appendix IV

TASK RATING FORM

INTRODUCTION

The Task Rating Form was constructed to provide a means of assessing complex aspects of performance in such a way that they could be compared under different conditions and when using different aids or devices. Once again the structure of the form can still be improved. Its details are reported here, partly in the interests of providing a thorough account of what procedures were followed and partly because they could provide a starting point for future mobility aid evaluations.

Appendix 4 is in three parts. Part one consists of the text of the instructions given to each of the raters indicating how they should complete the rating form. Part two consists of Table A30 which is a copy of the Task Rating Form, and part three summarizes the comments and criticisms provided by the O&M staff members who supervised the rating experiment.

INSTRUCTIONS GIVEN TO RATERS

As a rater you are about to view the first of four videotapes. Each videotape represents an individual traveling a route of approximately six blocks while crossing six streets. The four travelers will be utilizing the long cane or the laser cane in a familiar or unfamiliar area. Details about the route will be supplied prior to each viewing session. Before viewing the videotapes, the entire list of questions should be read carefully. At that time if any questions arise or further explanation is needed, please do not hesitate to ask for clarification. Rate each videotape as a separate performance. The method of rating you should use requires that you circle the vertical hash mark that best corresponds with your judgment on each question. Please respond to each question as best you can. As a point of reference in rating, a mark of "Excellent" should be understood as representing the very best caliber of performance you have observed at your center. A mark of "Average" would represent the performance norm for the population that has received training at your center. Thank you sincerely for your time and effort in assisting us with this project.

TABLE A30

ORIENTATION AND MOBILITY TASK RATING FORM

DATE _____

STUDENT ___1 ___2 ___3 ___4 ___5 ___6 ___7 ___8

RUN ____A-- Laser Cane Familiar

____B-- Long Cane Familiar

____C-- Laser Cane Unfamiliar

____D-- Long Cane Unfamiliar

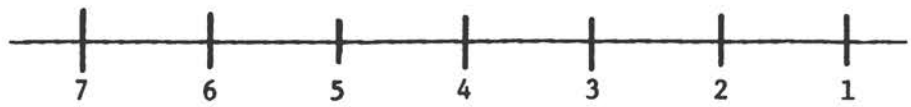
EVALUATOR _____

CLASS ONE QUESTIONS

Please rate each traveler on how well he does in each category.

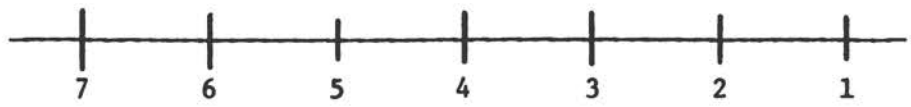
1. ---------- maintains his line of travel?

Excellent Average



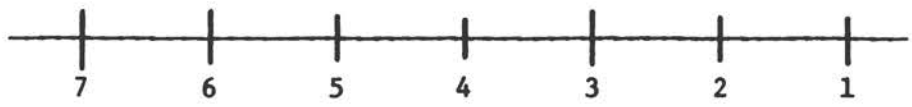
2. ---------- detects curbs?

Excellent Average



3. ---------- crosses streets?

Excellent Average



4. ---------- uses auditory information?

Excellent Average

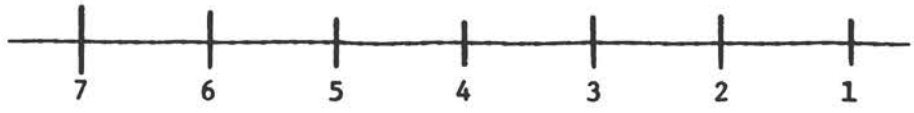
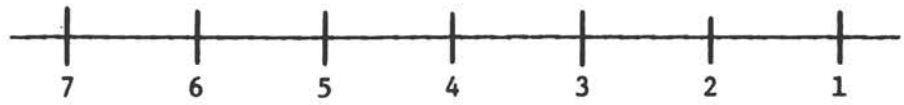


TABLE A30(cont'd)

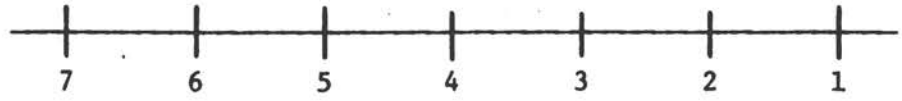
5. ---------- uses non-auditory information?

Excellent Average



6. ---------- uses information transmitted by the travel device?

Excellent Average



7. ---------- excecution of long cane technique?

Excellent Average

8. ---------- travels at appropriate speed?

Excellent Average

9. ---------- avoids cane contact with objects?

Excellent Average

10. ---------- avoids body contact with objects?

Excellent Average

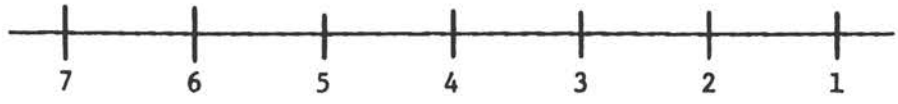
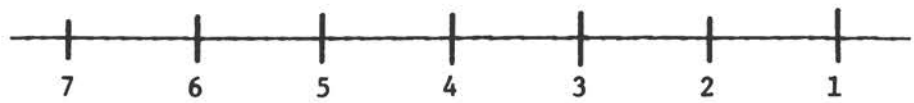


TABLE A30 (cont'd

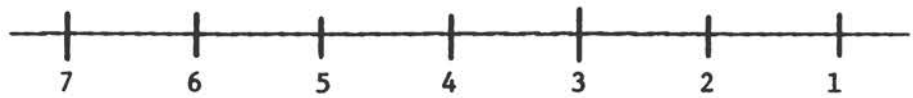
11. ---------- maintains orientation on prescribed route?

Excellent Average



12. ---------- solves orientation and mobility problems?

Excellent Average

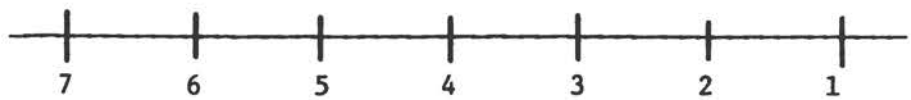


CLASS TWO QUESTIONS

Rate each traveler's total orientation and mobility performance in each of the following categories.

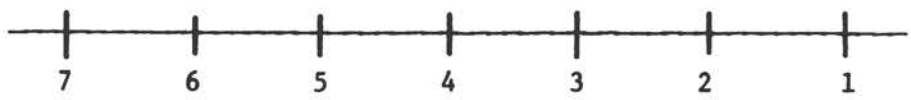
13. ---------- travels relaxed and confidently?

Excellent Average



14. ---------- travels such that he is aware and alert to informational changes?

Excellent Average



15. ---------- travels safely?

Excellent Average

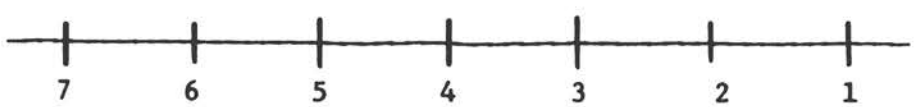


TABLE A30 (cont'd)

16. ---------- travels efficiently and smoothly?

Excellent Average

17. ---------- total orientation and mobility performance?

Excellent

COMMENTS: _____

18. Please assess the extent to which the videotape you have just seen permits you to give an accurate rating of mobility skill.

Accurate Inaccurate

CRITIQUE

In future studies where presumably a more random selection of travelers will be made, the rating scale should be labeled average at its midpoint. It is probable that a five point scale would be adequate. Also it should be emphasized to the raters that every question must be answered and that the answers must be located exactly on one of the hash marks. On both occasions when the rating scales have been used, there have been some unanswered questions and answers which appeared in the spaces between the hash marks.

Although in general the questions posed to the raters appeared to cover the major aspects of orientation and mobility, some of the questions could benefit from minor revisions in wording. Also, prior to rating the videotapes, the raters should view a calibrated performance in order to have a firm basis of comparison for their evaluation. Finally, the reliability of the raters might be tested by having them view several calibrated performances at various time intervals and noting their consistency of scoring. It is recommended that the details of such a consistency check should be developed with the assistance of a statistician.

Appendix V

RATER QUESTIONNAIRE

INTRODUCTION

The methods which were adopted for videotaping the cane journeys and the dimensions of mobility which were chosen for the attention of the raters, were all adopted after some preliminary experimentation carried out during the training phase. However, despite these efforts designed to refine techniques, it was recognized that numerous improvements could still be made and that it was likely that the sixteen raters would be able to contribute useful comments and suggestions for future use.

Accordingly, the rater questionnaire shown in Table A31 was prepared. The questions focussed on three principal topics; the adequacy of the videotapes for the purpose of assessing mobility performance, the relevance of the questions on the rating form to basic blind mobility skills and the rater's opinion of the utility of the laser cane. The raters' responses are listed in Table A32 and an analysis of these data is provided in the concluding section of this appendix.

UTILITY OF THE VIDEOTAPES

Fourteen out of the sixteen raters felt that the videotapes provided the needed information to rate overall travel performance (Q1) and specific travel skills (Q2) accurately most of the time, and these raters experienced no difficulty or little difficulty in using the tapes to judge performance (Q3). Of these 14 raters, ten felt that the videotape performances were at least as interesting as real life performances, while the rest felt they were less interesting (Q4).

Elements of videotaping which needed improvement were judged to be -

Attribute	Frequency of Comment
A. Quality of picture	1
B. Quality of sound	4
C. Angle of shooting	13
D. Length of videotapes	0
E. Areas used for routes	0
F. Distance of shooting from action	5
G. None of above	1

Thus most of the distress arose from not having a good view. The two raters who did not respond enthusiastically to questions 1, 2, and 3 provided most of the complaints and listed quality of picture and/or sound (Q5).

Fifteen of the sixteen raters felt that the videotapes were of either large (13) or moderate (2) value in evaluating mobility aids. The remaining rater

TABLE A31

PRELIMINARY C-4 LASER CANE EVALUATION

Evaluator _____

Center _____

Date _____

INSTRUCTIONS

We would appreciate your answering a few questions about the videotapes and the rating form in order that we can better assess the potential of these evaluation techniques. Also included are some questions concerning the Laser Cane and your impression of it. You may need a copy of the rating form to refer to in answering several of the questions. The last page has space for any comment that you may wish to add. Again, thank you for your time and assistance in this project.

VIDEOTAPES

1. _____ To what extent did the videotapes provide you the needed information to accurately rate overall travel performance?

   A. all the time
   B. most of the time
   C. about half of the time
   D. some of the time
   E. little, if any of the time

2. _____ To what extent did the videotapes provide you the needed information to accurately rate specific travel skills?

   A. all the time
   B. most of the time
   C. about half the time
   D. some of the time
   E. little, if any of the time

TABLE A31 (cont'd)

3. _____ Did you experience any difficulty using the videotapes to judge the travelers' performances?

A. no, not at all
B. yes, a little
C. yes, a moderate amount
D. yes, a great deal

4. _____ In comparison to real life observations of travel performance to what extent did the videotapes hold your interest?

A. a great deal more
B. slightly more
C. about the same
D. slightly less
E. a great deal less

5. _____ Which element or elements of videotaping, if any, needed major improvement?

A. quality of picture
B. quality of sound
C. angle of shooting
D. length of videotapes
E. areas used for mobility routes
F. distance of shooting from action
G. none of the above

6. _____ In your opinion what is the value of using videotapes as a practical tool in evaluating mobility devices?

A. large value
B. moderate value
C. small value
D. no value

7. _____ What is the value of using videotapes as a practical tool in evaluating travel performance?

A. large value
B. moderate value
C. small value
D. no value

TABLE A31 (cont'd)

8. _____ In general did you experience any difficulty using the rating form to judge the travelers' performance?

A. no, not at all
B. yes, a little
C. yes, a moderate amount
D. yes, a great deal

9. _____ To what extent did the rating form contain the major components of travel performance?

A. all of the major components
B. most of the major components
C. about half of the major components
D. some of the major components
E. little, if any of the major components

If your answer to the above question was C, D, or E, please suggest an improvement to the form _____

_____

_____

_____

10. _____ How satisfied were you that the 7-point scale in the rating form allowed you to accurately rate the questions?

A. very satisified
B. satisfied
C. dissatisfied
D. very dissatisfied

11. _____ Which question or questions, if any, did you find difficult to answer?

A. question number --1--2--3--4--5--6--7
--8--9--10--11--12--13--14--15--16--17

B. none

TABLE A31 (cont'd)

12. _____ Do you feel the rating form has practical value in evaluating mobility performance?

A. no, not at all
B. yes, a little
C. yes, a moderate amount
D. yes, a great deal

LASER CANE

13. _____ From your viewing of the Laser Cane runs, to what extent was the information provided by the device of practical value to the traveler?

A. large value
B. moderate value
C. small value
D. no value

14. _____ What effect did the Laser Cane have on improving the quality of the travelers' mobility performances?

A. large improvement
B. moderate improvement
C. small improvement
D. no improvement

15. _____ To what degree of practical application do you feel the Laser Cane has for the totally blind population served by your Center?

A. large application
B. moderate application
C. small application
D. no application

16. _____ Please indicate which particular feature of the Laser Cane impressed you the most? the least?

the most _____

_____

_____

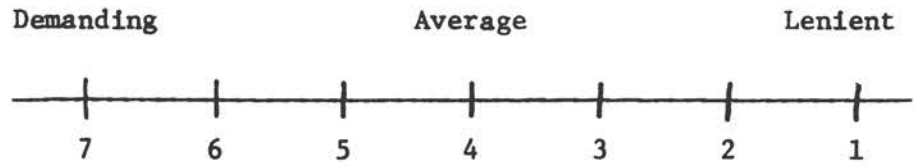
TABLE A31 (cont'd)

the least _____

_____

_____

17. _____ In comparison with the Orientation and Mobility Standards of your Center (which are indicated on the scale below as "average") please rate your standard of judgment.



COMMENTS: _____

TABLE A32

DATA FROM RATER QUESTIONNAIRE

HINES RATERS

Questions	H1	H2	H3	H4	H5	H6	H7	H8
1	B	B	B	B	B	B	B	A
2	B	B	B	B	B	B	B	A
3	B	B	B	A	A	B	A	A
4	B	A	B	C	A	D	C	B
5	C,B	C,F	C	C	C	C	C	C
6	A	A	A	A	A	A	A	B
7	A	A	A	A	A	A	A	B
8	B	A	A	A	B	B	A	A
9	B	B	B	B	B	B	A	B
10	A	A	B	B	A	B	B	A
11	6,7,14	B	B	9,10,12,14	B	4	B	B
12	D	D	D	D	C	D	D	D
13	C	B	A	B	A	A	A	B
14	C	B	A	B	B	A	B	B
15	C	C	A	C	B	A	B	B
16			SEE TABLE A33					
17	6	7	7	7	6	6	4	6

TABLE A32

DATA FROM RATER QUESTIONNAIRE

PALO ALTO RATERS

Questions	P1	P2	P3	P4	P5	P6	P7	P8
1	B	B	C	B	B	B	B	D
2	B	B	D	B	B	B	B	D
3	B	B	C	A	A	B	B	C
4	D	C	D	D	A	D	C	E
5	C	F	B C F	G	C F	B C	C	A B F
6	A	A	B	A	A	A	A	C
7	A	B	B	A	A	B	A	B
8	B	A	B	B	B	B	B	B
9	B	B	B	A	A	B	A	B
10	B	B	C	C	B	C	B	B
11	11 14	B	4,6,11,12 14,15,17		5	14 4,5,9,10	B	4,5,11 12,14
12	C	D	B	B	C	B	C	C
13	B	C	C	C	B	B	A	B
14	B	C		C	B	B	B	D
15	B	C	C	C	C	C		C
16				SEE TABLE A33				
17		7	6	6	1	6	6	4

TABLE A33

DATA FROM RATER QUESTIONNAIRE

Question 16	MOST:	LEAST:
Rater 1	Tactile stimulator	Effects of water causing signals
2	Picking up obstructions	Cost and maintenance of device
3	Picking up overhead obstacles	Picking up straight ahead obstacles
4	Detecting obstacles	Small margin of error and sounds seem to create tension
5	No body contact	Sounds seem to irritate at times
6	Cane contact was not necessary to avoid obstacles	Users hand position greatly determines the information he receives
7	Safety factor in traveling	No comment
8	Auditory information supplied	No comment
9	Use of building lines, etc.	Curb detection and signals from water puddles
10	Information from forward and upper beams seem the most valuable when interpreted properly	Cane is bulky and too much useless information
11	The overhead channel when used well	Down channel
12		
13	Ability to detect overhead obstacles	Too much noise; inaccurate signals
14	Detects overhead and straight out	Very cumbersome and seems to give signals when nothing is present
15	Allowing individual to project and avoid objects with cane	Is cane structure itself It could be streamline
16	Overhead warning	False signals on water

had complained of the quality of the sound and picture provided by the tapes he saw and was generally unreceptive. He felt that videotapes were of small value (Q6). All the raters felt that videotapes had at least moderate value in evaluating travel performance (Q7).

Thus most of the raters generally approved the use of videotapes but felt that they did not get as good a view of the traveler as they would have liked.

EFFICIENCY OF THE RATING FORM

Six raters had no difficulty and the remaining 10 met little difficulty in using the rating form to judge each traveler's performance (Q8). Twelve raters felt that the rating form covered most of the major components of travel and the remaining four felt it covered all of them (Q9). Thus all the raters felt the form was relatively simple to use and fairly complete. (We should note, however, that any other response on Q9 - that at most about half the major components of travel were covered - would have elicited a request for suggested improvements.)

The seven-point scale was very satisfactory to four raters, all at Hines hospital. It was felt to be just satisfactory to nine raters, including the remaining four from Hines, and three felt it was unsatisfactory (Q10).

The rating form questions which gave difficulty were:

Question	Frequency of difficulty
R 4 - Use of auditory information	4
R 5 - Use of nonauditory information	3
R 6 - Use of information transmitted by travel device	2
R 7 - Execution of long cane technique	1
R 9 - Avoiding cane contact with objects	2
R10 - Avoiding body contact with objects	2
R11 - Maintaining orientation on prescribed route	3
R12 - Solving orientation and mobility problems	3
R14 - Awareness and alertness to informational changes	6
R15 - Travels safely	1
R17 - Total orientation and mobility performance	1

It is interesting to note that of those four raters who earlier (in Q5) had complained about the quality of sound in the videotapes, two had difficulty with R6, two with R5, and three with R4. Every rater who had difficulty with more than one question included R14 in his list. Thus the consistency of the raters' opinions is upheld.

Seven raters claimed to have had no difficulty with any question and one did not respond. The Palo Alto raters had more difficulties with the rating form than the Hines raters (Q11).

Seven out of eight Hines raters thought the rating form had a great deal of practical value in evaluating mobility and the remaining rater thought that it had moderate value. Of the Palo Alto raters, only one thought that the rating form had a great deal of value and this rater was the only one at Palo Alto who had responded to Q8 that he had no difficulty using the rating form. The remaining Palo Alto raters thought the form had moderate (4) or little (3) value (Q12).

Thus the Hines raters were less critical of the rating form than the Palo Alto raters. Nevertheless, the Palo Alto raters tended to rate more leniently and one may speculate on their attitude toward the rating procedure in the light of their criticism.

VALUE OF THE LASER CANE

Only four raters, all at Hines, thought that the information provided by the laser cane was of great practical value to the traveler. The rest thought the value was moderate (7) or small (5); but none thought there was no value (Q13).

Two raters, both at Hines and both giving a top rating on the previous question, thought that the laser cane effected a great improvement in the traveler's mobility performance. Most of the raters (9) thought the improvement moderate, however, while three thought it small. One rater thought there was no improvement and another did not respond (Q14).

The same two raters who, in Q14, saw the cane effecting a large improvement in mobility performance, thought the cane had great application for the totally blind population served by their center. Of the rest, nine (six at Palo Alto) thought the application would be small, four thought it would be moderate and one did not respond, but none thought that there would be no application (Q15).

Thus the Hines raters seem optimistic about the potential of the laser cane as a mobility aid, and the Palo Alto raters seem less so.

The raters were asked (Q16) which particular features of the laser cane they liked most and which least. The overwhelming response in favor of the laser cane concerned its ability to detect obstacles, particularly overhead obstacles, thus avoiding body contact and making cane contact unnecessary. Other features mentioned were the tactile stimulator, auditory information, safety - actually a reference to the avoidance of body contact - and the use of building lines to maintain line of travel. Drawbacks included spurious signals caused by reflections from rain water, irritating sound, sensitivity to hand position, poor curb detection, bulk, and inaccurate signals. One rater did not like the down channel and another did not like the ability to pick up obstacles straight ahead. Three raters had no comment.

RATER'S RATING OF HIMSELF

A final question on this form asked the raters to rate their standards of judgment on a scale from one (lenient) through four (average) to seven (demanding). The intent was to shed some light and possibly help in the analysis of the field-trial data. However, the analysis of the data automatically adjusts for differences between raters and, in any case, one rater did not respond. We therefore have the standards of each rater rated by himself and estimated from the field-trial data. How well do these ratings agree?

Each group of raters (Hines and Palo Alto) was ranked according to the self-ratings and according to the within-location rater effects estimated in the analysis of variance of the field trial data for:

a) the average of rating-form questions R1 - R12 and

b) R17, overall performance rating (Table 11, page 47).

Since one of the Palo Alto raters did not rate himself, the ranks of the self-ratings were rescaled for the Palo Alto group. The results are summarized in the plots of Figure A6, which suggest a low positive correlation. We may conclude that, at best, a rater has a vague idea of his standards relative to those of his peers, assuming that the ratings are accurate and consistent and reflect only the degree of proficiency displayed in each performance.

QUANTITATIVE SUMMARY

The results of most of the questionnaire are described quantitatively in Table A34. The responses have been scored on a scale from one (least enthusiastic) to four (most enthusiastic). Where more than four choices existed, two responses at the low end were combined. The exceptions are question 11, where those raising no objections were given a score of four and those with four or more scored zero, and Q17 where the self-rating is given on a scale from 1 to 17.

It does not need a detailed statistical analysis to see that certain raters (e.g., raters H-3, H-5 and H-8) are consistently more positive in their responses than the rest, while others are considerably more negative or cautious (e.g., raters P-3 and P-8). Hines raters seem more enthusiastic in general. However, the field-trial data shows that the Palo Alto raters tended to give high ratings, i.e., to be more lenient than the Hines raters. Statistical tests (t test, run test) on the self-rating show there are no grounds for believing that Palo Alto raters as a group believe themselves to be more lenient than the Hines raters do. This suggest that the discrepancy is attributable to the predisposition of the raters, their interaction as a group and their enthusiasm and desire to participate. It would seem desirable, therefore, to have ratings performed by personnel who are totally independent of the training staff and to take precautions against members of the rater-groups comparing notes and being influenced by one another while the work is in progress.

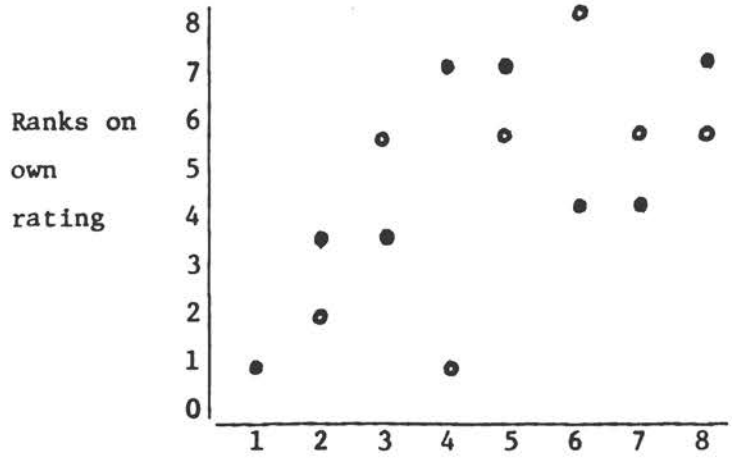
TABLE A34

RATER QUESTIONNAIRE

		Hines								Palo Alto								Distribution				
	Questions	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	4	3	2	1	
Videotapes	1	3	3	3	3	3	3	3	4	3	3	2	3	3	3	3	1	1	13	1	1	
	2	3	3	3	3	3	3	3	4	3	3	1	3	3	3	3	1	1	13	0	2	
	3	3	3	3	4	4	3	4	4	3	3	2	4	4	3	3	2	6	8	2	0	
	4	3	4	3	2	4	1	2	3	1	2	1	1	4	1	2	1	3	3	9	1	
	6	4	4	4	4	4	4	4	3	4	4	3	4	4	4	4	1	13	2	0	1	
	7	4	4	4	4	4	4	4	3	4	3	3	4	4	3	4	3	11	5	0	0	
Rating Form	8	3	4	4	4	3	3	4	4	3	4	3	3	3	3	3	3	6	10	0	0	
	9	3	3	3	3	3	3	4	3	3	3	3	4	4	3	4	3	4	12	0	0	
	10	4	4	3	3	4	3	3	4	3	3	2	2	3	2	3	3	4	9	3	0	
	11	1	4	4	0	4	3	4	4	2	4	0	-	3	0	4	0	7	2	1	1	4
	12	4	4	4	4	3	4	4	4	3	4	2	2	3	2	3	3	8	5	3	0	
Laser Cane	13	2	3	4	3	4	4	4	3	3	2	2	2	3	3	2	3	4	7	5	0	
	14	2	3	4	3	3	4	3	3	3	2	-	2	3	3	3	1	2	9	3	1	
	15	2	2	4	2	3	4	3	3	3	2	2	2	2	2	-	2	2	4	9	0	
	Self Rating 17	6	7	7	7	6	6	4	6	-	7	6	6	1	6	6	4					

RANKS OF RATERS OWN RATING PLOTTED AGAINST:

(a) RANKS OF RATER EFFECTS OF AVERAGE OVER QUESTIONS 1 - 12



(b) RANKS OF RATER EFFECTS OF QUESTION 17 (Overall performance)

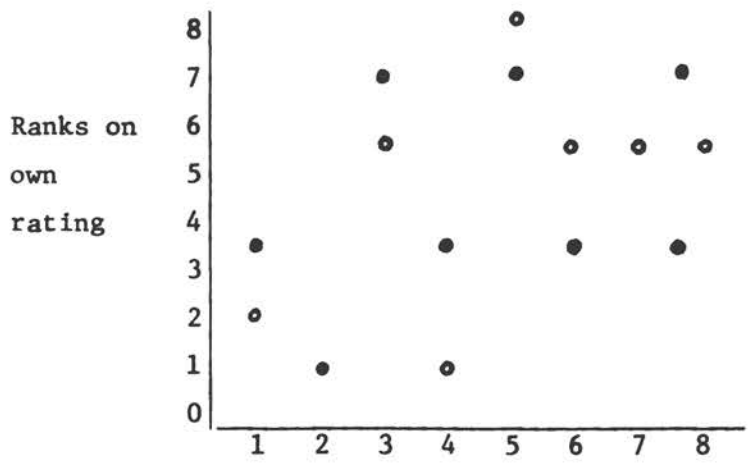


Fig. A6

Appendix VI

SUBJECT QUESTIONNAIRE

INTRODUCTION

A summary of the replies received in response to the subject questionnaire is given in Chapter 6 of this report. This appendix contains a detailed list of the questions, the replies to the "bonus question" and some critical comments on the composition of the questionnaire.

QUESTIONS

1. Is the process of learning to use the laser cane, in your view, very easy, fairly easy, difficult, very difficult?

2. How would you rate your confidence in the device, very high, high, low, very low?

3. Do you find the device comfortable to use? Please explain.

4. When using the laser cane, how, in your opinion, does it compare with long cane in the following areas?

   a) Weight
   b) Balance
   c) Touch
   d) Position at which the device is held.

5. Is the device reasonably durable?

6. Is the device reasonably maintenance-free?

7. Do you feel relaxed using the laser cane?

8. As relaxed as when using your long cane or collapsible cane?

9. Are the audible signals easily interpreted?

10. Do you have any difficulty telling the difference between the audible signals of the laser cane? If so, which one(s) confuse you?

11. Can you readily feel the tactile stimulator? If not, does it require undue concentration?

12. Which signal, audible or tactile, do you prefer to use for the Middle Channel? If you have preferences, under what circumstances do they apply?

13. Does your index finger ever become fatigued or numb to the tactile stimulator? If so, under what circumstances?

14. What channel do you use the most? The least?

15. Are there any occasions on which you do not respond to the signals of the laser cane? If so, under what circumstances do you not respond?

16. With reference to Q15, what objects do you fail to respond to?

17. In which situations do you feel the cane is most useful?

18. For what particular purpose is each channel most useful?

19. With reference to Q18, for what objects are each of the three channels most useful?

20. Do you feel that the range at which it is possible for you to detect objects with each channel is adequate?

21. Do you find the laser cane more useful in a familiar environment or in an unfamiliar one?

22. What general differences in technique or utilization do you note with the device in familiar and unfamiliar environments?

23. Does the device provide more aid to you in orientation or in the recognition of landmarks in familiar areas than the long cane?

24. Does the device aid you in orientation or in the recognition of useful landmarks in unfamiliar areas; how does this capability compare with that provided by your long cane in unfamiliar areas?

25. Does the laser cane or its signals create any confusion in orientation procedures or hinder use of environmental information?

26. Does the laser cane give reliable and useful direct travel path information?

27. Does the laser cane appear, at times, to be giving inexplicable signals?

28. Can you readily react to the tactile and/or audible signals of the device?

29. Can you readily determine the direction and width of objects with the laser cane while traveling at your normal gift?

30. Can you roughly estimate your distance from a detected object soon enough to take the proper action?

31. Do you feel your line of travel has improved using the laser cane in comparison with your usual line of travel when using your long cane?

32. Do you feel your speed of travel has been changed by using the laser cane as compared to your usual rate using the long cane?

33. Do you feel that, compared to your long cane, the laser cane provides you with any added information or a state of well-being that enables you to perform differently when traveling?

34. Are you relaxed while using the laser cane and its signals?

35. Does the laser cane or its signals cause you to become uncomfortable when you are around people? Do you feel the same or differently with the long cane?

36. Is the frequency or range of your travel influenced in any way when the laser cane is available?

37. Do you make any modifications of your conventional long cane technique when using the laser cane?

38. What improvements or modifications, if any, would you like to see incorporated in the present laser cane?

39. What additional information would you like to add to this interview?

40. Would you like to continue to use the laser cane? Can you give a rough percentage estimate of the extent to which you would like to use the laser cane in the future?

BONUS QUESTIONS

1. How many breakdowns do you feel would be tolerable for a mobility device per year?

Subject H1	No more than five per year
Subject H2	Six per year
Subject H3	Three to four per year
Subject H4	About two per year
Subject P1	Maximum of three
Subject P2	Two or three per year
Subject P3	Two breakdowns per year
Subject P4	No reply

2. How much would you spend per year for repairs and maintenance?

Subject H1	$100 per year
Subject H2	$100 per year
Subject H3	Between $50 and $100 per year
Subject H4	$50 per year
Subject P1	$100 per year
Subject P2	Between $80 and $100 per year
Subject P3	Between $75 and $100 per year
Subject P4	No reply

3. How long should it take to repair a mobility device, including shipping time?

Subject H1	No longer than two weeks
Subject H2	No longer than one week
Subject H3	No longer than 10 days or two weeks
Subject H4	No longer than 1 1/2 or two weeks
Subject P1	Two weeks
Subject P2	No reply
Subject P3	A maximum of three weeks
Subject P4	No reply

4. If you had to purchase your own laser cane, what would be the maximum amount of money you would pay for it?

Subject H1	No more than $7,500
Subject H2	No more than $1,200
Subject H3	No more than $100
Subject H4	No more than $500

The opinions of the Palo Alto subjects on this subject were not solicited.

CRITIQUE

In reviewing the results of the follow-up questionnaire, there was general agreement among the investigators that it successfully served the purpose of providing a general insight into the subjects' experiences with the laser cane. In retrospect the questionnaire thus appeared to have encompassed most of the information which the investigators had hoped to obtain. Also of interest was the fact that despite the inevitable differences between the Hines and Palo Alto subjects, both in their training and travel environments, and also performance differences between the canes that the subjects used, there was, nevertheless, substantial agreement among the subjects in their responses to the questionnaire. However, as one would expect in the initial application of this type of research instrument, there were some evident problem areas. Listed below are some general comments concerning suggested improvements and modifications of the questionnaire.

1. The categorization and sequential ordering of the questions needs to be improved. Questions dealing with the same general topic should be grouped together and ordered in some logical sequence from general to progressively more specific questions.

2. All questions should be stated in such a way that they would require a uniform type of response such as yes-no or multiple choice, etc. This would permit quantified scoring of responses and lend itself to statistical analysis and comparisons with data from other research instruments which might be employed.

3. Most of the questions were asked too many times - some questions as many as 4 or 5 times. The subjects quickly became familiar with the contents of the questionnaire and at times seemed to view it with rather amused indulgence. Perhaps it would be better in the future to formally administer the questionnaire only twice, once at the end of training and once at the end of the follow-up period. Obviously, certain questions would be more appropriate after some practical experience rather than immediately after training and this should be considered during any analysis of the data. Also, this suggestion should not exclude the benefit of maintaining contact with the subjects at interim periods during the follow-up and perhaps informally asking a few specific questions of particular relevance.

4. The telephone presentation of a lengthy formal questionnaire proved to be an awkward and unsatisfactory procedure.

5. There were several groups of questions which elicited redundant responses from the subjects. Some of these questions need to be deleted or restated and combined with other questions.

6. There are some questions which need to be revised because they were too awkward and lengthy or the terminology was unclear and confusing.

7. Some questions were really combinations of two questions. These should be divided into separate and distinct questions. As mentioned in suggestion #2, they should be reworded so that they require a specified type of response without the need of any qualification or explanation.

8. In the follow-up evaluation of a travel device, there seems to be some advantage in combining the use of a questionnaire which yields quantifiable responses with the application of an informal interview. This interview could contain very general questions which would serve to stimulate discussion and would define broad areas of inquiry. The informality would allow interaction between the subjects and the investigator and would provide for elaboration and explanation of questions and responses. This type of interview provides the investigator with a better picture of the subject's personal experiences, his home environment and his life style. While this type of interview is potentially more informative, it is also more open to bias and subjective interpretation. Therefore it would seem most beneficial to compare and contrast this type of informal interview with the more rigidly designed objective questionnaire and thus achieve a complementary balance between the two approaches.

SUPPLEMENT

Final Report on a Preliminary Evaluation of the C-4 Laser Cane

Results Obtained from a Replication

of the Rating Experiment

Introduction

The original rating data (RD1) were inconclusive and shed no definitive light on the existence of any differences in performance between subjects using the laser cane and the same subjects using the long cane.

Specifically, the analysis of the data pointed to the following weaknesses:

1) The original raters had been drawn from the same two centers where the subject training had been carried out, and they appeared to be biased in favor of "their own" subjects.

2) The raters proved to lack consistency, may not have been sufficiently prepared to carry out their task and may not have fully understood the rating procedure.

3) The raters had shown little agreement as to what constituted an "average performance".

It appeared that these faults could be avoided by obtaining new raters unconnected with the original training centers, by instructing them more carefully, and by providing a benchmark performance against which they could compare each of the eight cane travelers. By adopting these precautionary measures, it was hoped that the variability could be reduced to a point where distinctions would emerge.

The essential design of the new experiment remained the same as before. The particular combinations of tapes shown to each rater (and, of course, their order of presentation) were changed. This was done to avoid the possi bility (probably remote) that a particular combination of tapes shown in a particular order would create a bias of its own. An additional videotape of a ninth traveler, depicting an "average" long cane performance, was used to establish standards for the raters' scoring.

On this occasion sixteen raters were drawn from two different institutions. Eight of the raters were mobility instructors employed at the Carrol Rehabilitation Center in Newton, Massachusetts (referred to as Group A), while the remainder were mobility instructors from the Veterans Administration Hospital at West Haven, Connecticut (Group B). The raw data are shown in Table S1.

The rater preparation involved direct discussions with several panel members which were supplemented by telephone conversations. In addition,

TABLE S1

	SUBJECT H1				SUBJECT H2			
ORDER OF RUNS	3	1	4	2	2	4	1	3
	LONG F	LASER F	LONG UNF	LASER UNF	LONG F	LASER F	LONG UNF	LASER UNF
	A-8 B-2	A-1 B-1	A-7 B-8	A-6 B-4	A-5 B-3	A-8 B-7	A-2 B-2	A-7 B-1
RATING QUESTION								
1	7 - 6	7 - 6	6 - 4	7 - 5	7 - 4	7 - 3	7 - 6	7 - 4
2	7 - 4	7 - 6	5 - 4	7 - 4	5 - 3	7 - 3	7 - 4	6 - 2
3	6 - 2	6 - 5	6 - 4	7 - 3	7 - 2	7 - 3	6 - 2	6 - 3
4	6 - 3	7 - 6	6 - 4	7 - 4	2 - 6	7 - 3	6 - 3	6 - 3
5	7 - 2	7 - 6	6 - 4	7 - 3	6 - 3	7 - 2	7 - 2	6 - 5
6	7 - 3	7 - 5	6 - 5	4 - 4	5 - 3	7 - 3	7 - 3	6 - 4
7	7 - 5	5 - 5	7 - 4	4 - 3	7 - 3	7 - 3	5 - 5	5 - 4
8	5 - 2	5 - 5	6 - 5	4 - 4	7 - 3	7 - 3	7 - 2	5 - 5
9	6 - 2	7 - 6	6 - 5	6 - 4	7 - 4	7 - 4	7 - 2	6 - 5
10	7 - 3	7 - 5	6 - 4	4 - 5	7 - 4	7 - 4	7 - 3	7 - 6
11	6 - 6	7 - 6	5 - 3	4 - 4	7 - 5	7 - 3	6 - 6	7 - 6
12	7 - 5	7 - 6	6 - 5	4 - 4	6 - 3	7 - 2	7 - 5	6 - 6
13	7 - 5	6 - 4	7 - 4	2 - 4	7 - 5	7 - 4	7 - 5	6 - 5
14	7 - 3	7 - 5	6 - 5	5 - 3	3 - 4	7 - 4	7 - 3	6 - 4
15	7 - 5	5 - 5	6 - 5	7 - 4	6 - 2	7 - 4	6 - 5	6 - 5
16	6 - 5	6 - 5	6 - 4	4 - 4	7 - 5	7 - 4	5 - 5	6 - 5
17	7 - 6	7 - 5	6 - 4	5 - 4	5 - 5	7 - 3	6 - 6	6 - 4
18	4 - 4	5 - 4	5 - 5	5 - 3	4 - 3	5 - 1	1 - 4	5 - 5

TABLE S1 (cont'd)

	SUBJECT H3				SUBJECT H4			
ORDER OF RUNS	1	2	3	4	4	3	2	1
	LONG F	LASER F	LONG UNF	LASER UNF	LONG F	LASER F	LONG UNF	LASER UNF
	A-3 B-4	A-4 B-5	A-1 B-7	A-5 B-6	A-6 B-5	A-2 B-8	A-3 B-6	A-4 B-3
Rating Question								
1	4 - 4	3 - 2	7 - 3	6 - 3	7 - 3	7 - 5	6 - 4	6 - 2*
2	4 - 4	3 - 4	7 - 4	1 - 2	7 - 3	5 - 5	4 - 3	3 - 2
3	3 - 3	3 - 4	6 - 2	2 - 1	7 - 2	6 - 5	5 - 3	5 - 2
4	3 - 4	2 - 2	7 - 1	3 - 2	7 - 3	7 - 6	5 - 4	5 - 4
5	3 - 3	3 - 2	7 - 3	7 - 2	2 - 3	2 - 4	5 - 4	5 - 3
6	3 - 4	2 - 2	7 - 2	5 - 1	7 - 3	7 - 6	5 - 3	6 - 5
7	3 - 4	3 - 2	7 - 3	6 - 2	7 - 2	6 - 5	5 - 2	5 - 3
8	3 - 4	3 - 3	7 - 4	5 - 3	7 - 3	7 - 5	6 - 4	5 - 4
9	3 - 3	2 - 3	7 - 4	2 - 2	2 - 2	7 - 5	5 - 2	4 - 4
10	3 - 2	2 - 4	7 - 4	2 - 2	3 - 2	7 - 6	5 - 4	5 - 5
11	2 - 4	2 - 2	7 - 3	6 - 6	7 - 4	7 - 6	6 - 5	6 - 3
12	2 - 3	2 - 2	7 - 3	5 - 3	7 - 2	2 - 6	6 - 4	6 - 3
13	2 - 4	2 - 4	7 - 2	5 - 2	7 - 4	3 - 4	5 - 4	5 - 3
14	2 - 3	1 - 2	7 - 2	3 - 2	7 - 3	7 - 6	6 - 3	6 - 4
15	2 - 3	3 - 3	7 - 2	5 - 3	7 - 3	6 - 6	6 - 4	5 - 2
16	2 - 4	2 - 4	7 - 2	4 - 2	7 - 3	3 - 6	6 - 3	5 - 3
17	2 - 3	2 - 3	7 - 3	5 - 2	7 - 3	5 - 6	6 - 3	6 - 4
18	3 - 1	4 - 2	6 - 1	4 - 2	7 - 2	2 - 5	4 - 4	5 - 3

TABLE S1 (cont'd)

	SUBJECT P1				SUBJECT P2			
ORDER OF RUNS	2	1	4	3	3	4	1	2
	LONG F	LASER F	LONG UNF	LASER UNF	LONG F	LASER F	LONG UNF	LASER UNF
	A-1 B-8	A-5 B-6	A-4 B-4	A-3 B-5	A-4 B-6	A-3 B-3	A-6 B-5	A-2 B-7
RATING QUESTION								
1	7 - 6	4 - 5	6 - 5	5 - 2	2 - 6	4 - 5	4 - 5	7 - 2
2	7 - 6	6 - 6	6 - 2	6 - 2	3 - 7	4 - 3	7 - 5	7 - 3
3	7 - 6	3 - 5	6 - 4	4 - 2	3 - 6	5 - 5	7 - 5	7 - 3
4	7 - 6	1 - 5	6 - 4	5 - 2	4 - 6	5 - 6	4 - 6	7 - 3
5	7 - 5	5 - 4	6 - 4	5 - 2	3 - 6	4 - 3	4 - 5	7 - 2
6	7 - 5	1 - 4	6 - 3	6 - 2	4 - 6	5 - 7	4 - 5	7 - 1
7	7 - 6	6 - 4	6 - 3	6 - 2	3 - 5	3 - 4	5 - 4	6 - 2
8	7 - 5	6 - 5	5 - 3	6 - 3	4 - 6	5 - 7	4 - 5	7 - 3
9	7 - 5	1 - 4	5 - 2	6 - 2	4 - 5	5 - 7	2 - 4	7 - 3
10	7 - 4	2 - 5	5 - 2	6 - 2	4 - 6	5 - 7	3 - 3	7 - 3
11	7 - 7	1 - 3	6 - 5	6 - 3	7	4 - 4	7 - 5	7 - 3
12	7 - 7	3 - 3	7 - 4	6 - 2	4 - 7	4 - 3	7 - 6	7 - 2
13	7 - 6	7 - 5	6 - 4	7 - 4	4 - 6	4 - 5	7 - 5	7 - 2
14	7 - 6	2 - 4	6 - 3	7 - 3	4 - 6	5 - 7	7 - 5	7 - 2
15	7 - 7	5 - 5	6 - 3	5 - 2	4 - 5	5 - 6	5 - 5	7 - 2
16	7 - 6	1 - 5	5 - 4	6 - 2	5 - 6	5 - 6	5 - 5	6 - 2
17	7 - 6	3 - 4	6 - 4	6 - 2	4 - 6	4	7 - 5	7 - 2
18	6 - 6	3 - 4	5 - 5	4 - 2	4 - 5	4 - 3	7 - 3	3 - 1

TABLE S1 (cont'd)

	SUBJECT P3				SUBJECT P4			
ORDER OF RUNS	1	3	2	4	4	2	3	1
	LONG F	LASER F	LONG UNF	LASER UNF	LONG F	LASER F	LONG UNF	LASER UNF
	A-7 B-7	A-6 B-4	A-8 B-1	A-1 B-2	A-2 B-1	A-7 B-2	A-5 B-3	A-8 B-8
RATING QUESTION								
1	4 - 1	7 - 3	7 - 3	7 - 5	7 - 5	6 - 6	4 - 5	6 - 6
2	5 - 3	7 - 4	6 - 5	7 - 7	7 - 4	5 - 6	7 - 5	6 - 4
3	4 - 1	6 - 2	3 - 3	6 - 6	6 - 4	4 - 5	3 - 5	4 - 4
4	3 - 3	6 - 3	4 - 3	7 - 7	6 - 5	5 - 6	3 - 5	5 - 4
5	4 - 2	4 - 3	5 - 3	7 - 6	7 - 6	6 - 6	6 - 6	4 - 2
6	5 - 3	5 - 4	6 - 3	7 - 5	7 - 5	4 - 6	6 - 6	4 - 3
7	4 - 1	7 - 3	6 - 4	7 - 6	7 - 3	6 - 6	4 - 6	7 - 4
8	5 - 3	6 - 4	7 - 5	7 - 7	7 - 3	6 - 5	7 - 6	7 - 6
9	5 - 3	7 - 4	6 - 3	7 - 5	7 - 4	4 - 4	4 - 4	5 - 2
10	4 - 3	7 - 4	6 - 4	7 - 7	7 - 4	5 - 6	7 - 5	4 - 2
11	4 - 2	7 - 3	4 - 4	7 - 7	7 - 5	6 - 6	7 - 6	3 - 1
12	3 - 5	7 - 4	5 - 4	7 - 7	7 - 4	5 - 7	7 - 6	4 - 3
13	5 - 5	7 - 4	7 - 4	7 - 7	6 - 5	6 - 6	6 - 7	6 - 5
14	4 - 4	7 - 3	6 - 3	7 - 7	7 - 5	6 - 7	5 - 7	6 - 4
15	4 - 3	7 - 3	6 - 3	7 - 7	7 - 4	5 - 6	5 - 7	5 - 4
16	4 - 3	7 - 3	6 - 4	7 - 7	7 - 5	5 - 6	3 - 7	5 - 2
17	4 - 3	7 - 4	6 - 4	7 - 7	7 - 5	5 - 6	5 - 6	5 - 4
18	5 - 1	7 - 4	4 - 5	6 - 6	5 - 5	4 - 5	2 - 5	4 - 4

each rater was encouraged to familiarize himself thoroughly with the rating form in advance of the viewing session. The text of the instructions supplied to each rater with spare rating forms ran as follows.

Instructions

The enclosed forms have been designed to measure the mobility performances of blind travelers who use different kinds of aids. A few weeks after receiving these copies you will be asked to view five videotape recordings of blind travelers and to rate their performances in a number of categories. In the meantime it is strongly recommended that you examine the form carefully and practice its use by rating the performances of some of your best clients.

The method that you should use to record your rating is to circle the vertical hash mark that best corresponds to your judgment on each question. Please provide an answer to every question. As a point of reference in rating, a mark of "Excellent" should represent the very best caliber of performance you have observed and when you are rating your own clients; the mark of "Average" should be taken as the performance norm for the population that has received training at your center. Later, when the videotaped journeys are screened, a special tape will be shown which will depict a performance level which, for the purpose of rating the other videotapes, you should regard as the "Average" performance. It is very important that all your judgments are made in relation to the performances of this "Average traveler".

You will provide ratings on four videotapes. Each tape represents an individual traveling a route of approximately six blocks while crossing six streets. The four travelers will be utilizing the long cane or the laser cane in either a familiar or unfamiliar area. Before viewing each tape you will be informed of the traveling conditions.

Once again you are urged to make use of these spare forms before the videotape rating sessions begin. Any questions about the form or the rating procedure which arise from your preliminary experiences should be addressed to Mr. Ekstrom who will be visiting your center for this purpose just prior to the viewing sessions.

Thank you sincerely for your time and conscientious effort in this project.

Results

Despite these instructions, the data which were produced lacked two entries. Suitable values were estimated for the missing data (as was necessary in the previous analysis) and the analysis was performed by the same program as before.

The results of the analysis are summarized in Tables S2 and S3. They are, in general, as unremarkable as those which emerged from the analysis of RD1.

TABLE S2
CLASS ONE QUESTIONS

Estimates		1 Line of Travel	2 Curbs	3 Cross Streets	4 Auditory Information	5 Nonauditory Information	6 Information from Device	7 Long Cane Technique	8 Appropriate Speed	9 Avoids Cane Contact	10 Avoids Body Contact	11 Maintains Orientation On Prescribed Route	12 Solves O&M Problems	Ave. 1 - 12
Mean		5.03	4.84	4.34	4.62	4.48	4.67	4.64	5.00	4.44	4.72	5.03	4.89	4.73
Subject Location	α_1	.13	-.41	-.16	-.13	-.17	-.08	-.14	-.38	-.03	-.06	-.09	-.23	-.13
Times	τ_1	-.22	.09	-.28	-.31	-.36	-.36	-.26	-.25	-.56	-.78	-.91	-.33	-.38
	τ_2	.09	.03	.16	-.06	.14	-.48	-.14	-.06	.06	.09	-.09	-.20	-.04
	τ_3	-.03	.21	-.16	-.06	-.05	.39	.23	.12	.44	.78	.66	.42	.25
	τ_4	.16	-.34	.28	.44	.27	.45	.17	.18	.06	-.09	.34	.11	.17
Treatments	κ_1	-.03	.09	-.03	0.0	-.17	.14	-.01	-.38	-.13	-.34	.22	.05	-.05
	κ_2	-.03	.22	.28	.19	-.23	.02	.05	.13	.38	.47	-.41	-.52	.04
	κ_3	.09	.22	.03	-.19	.33	.14	.11	.19	-.19	-.03	.28	.67	.14
	κ_4	-.03	-.53	-.28	0.0	.04	-.30	-.14	.06	-.06	-.09	-.09	-.20	-.13
Rater Location	θ_1	.84	.81	.84	.5	.86	.80	.95	.78	.75	.66	.56	.64	.75
Subjects b(1)	1	.84	1.06	.69	.88	.94	.53	.50	-.13	.84	.47	0.0	.84	.62
	2	.47	.19	.31	0.0	.44	.16	.37	-.25	.84	.97	.75	.59	.44
	3	-1.16	-.81	-1.19	-1.50	-.56	-1.34	-.75	.13	-1.16	-1.41	-1.13	-1.28	-1.08
	4	-.16	-.44	.19	.62	-.81	.66	-.13	.50	-.53	-.03	.38	-.15	.01
(2)	1	.09	-.13	.13	-.25	.09	-.50	.22	-.38	-.47	-.66	-.19	-.25	-.19
	2	-.53	-.38	.63	.38	-.41	.13	-.78	-.25	.16	-.03	.19	-.13	-.09
	3	-.28	.25	-.63	-.25	-.41	0.0	-.03	.13	.53	.47	-.19	.13	-.02
	4	.71	.25	-.13	.13	.72	.38	.59	.50	-.21	.22	.19	.25	.30
Subj. X Rater $(\alpha\theta)_{11}$		.31*	.06	.47°	.38*	.27	.30	.11	.16	.09	.06	.06	.14	.20
Treatment Contrasts														
(Laser-Long) Fam.		0.0	.13	.31	.19	-.06	-.13	.06	.50	.50	.81	-.63	-.56	.09
(Laser-Long) Unf.		-.13	-.75	-.31	.19	-.25	-.44	-.25	-.13	.13	-.06	-.38	-.88	-.27
Laser-Long		-.13	-.63	0.0	.38	-.31	-.56	-.19	.38	.63	.75	-1.00	-1.44	-.18
Unf. - Fam.		.13	-.63	-.50	-.38	.81	-.31	-.06	.50	-.50	-.25	.38	.94	.01
Type X Fam.		-.13	-.88	-.63	0.0	-.19	-.31	-.31	-.63	-.38	-.87	.25	-.31	-.36
Time Contrasts														
Linear		1.00	-1.13	1.38	2.25	1.69	3.31	1.69	1.50	2.25	2.75	4.5	1.94	1.92
Quadratic		-.13	-.50	0.0	.25	-.19	.19	-.19	-.13	-1.00	-1.75	-1.13	-.44	-.42

TABLE 32 (cont'd)

ANOVA		CLASS ONE QUESTIONS												
							F							
Source	df	1	2	3	4	5	6	7	8	9	10	11	12	Ave.
Subject Loc.	(1, 6)	.24	3.45	.41	.20	.49	.10	.48	5.68*	.01	.05	.20	.91	.43
Time	(3, 36)	.22	.38	.49	.67	.51	2.14	.47	.32	1.31	3.58°	2.52*	.62	.92
Treatment	(3, 36)	.03	.83	.38	.16	.46	.38	.09	.54	.49	1.01	.55	1.39	.16
Rater Location	(1,36)	23.00°°	17.07°°	20.20°°	6.81°	20.46°°	22.57°°	29.20°°	20.23°°	17.18°°	14.94°°	6.93°°	9.02°°	26.65°°
Subj. w. Loc.	(6,36)	2.14*	1.24	1.67	2.09*	1.68	2.18*	1.33	.82	2.30*	2.77°	.96	1.32	1.85
SL X Time	(3,36)	2.50*			2.30*		3.57°	2.23*		3.13**	4.49°°	2.20		2.56
SL X Tr	(3,36)									2.24*				
SL X RL	(1,36)	3.16*		6.23°	3.83*		3.13*							
Time X RL	(3,36)													
Tr X RL	(3,36)						2.41*							
Error M.S.	σ_2^2(36)	1.98	2.48	2.26	2.35	2.31	1.80	1.99	1.93	2.10	1.85	2.92	2.91	1.35
Subj.Variance	σ_b^2	.28	.07	.28	.32	.20	.27	.08	0.0	.34	.41	0.0	.12	.14
Mult.Corr R^2		.60	.52	.57	.54	.58	.66	.59	.52	.62	.66	.47	.49	.61
Rater M.S.		2.57	2.75	2.61	3.41	1.93	2.10	1.90	2.02	2.30	1.85	3.53	2.37	1.53
Res. M.S.		1.61	2.29	2.03	1.68	2.55	1.61	2.05	1.87	1.97	1.84	2.53	3.26	1.23
F(14,22) approx.		1.60	1.20	1.28	2.03*	.75	1.31	.93	1.08	1.17	1.00	1.40	.73	1.24
	R^2	.80	.73	.76	.80	.71	.81	.75	.71	.78	.79	.72	.65	.79
EMS Comparison with first data set:	σ_1^2	2.29	1.69	2.43	2.10	2.70	2.44	1.57	1.43	2.22	2.12	2.18	1.47	1.27
$F(36,36) = \sigma_1^2/\sigma_2^{2+}$		1.16	.68	1.08	.89	.86	1.36	.79	.74	1.06	1.15	.75	4.93**	.94

NOTE: F values less than 2.0 for interactions are omitted.
+ 2 tailed test.

Significance levels attained:
* 10%; ** 5%; ° 2 1/2%; °° 1%

TABLE S3
CLASS TWO QUESTIONS

		13	14	15	16	17	18
		Relaxed & Confident	Sensitivity to Informational Changes	Travels Safely	Travels Efficiently	Total Performance	Videotape Rating
Mean		5.11	4.87	4.91	4.75	4.94	3.98
Subject Loc.	α_1	- .48	- .41	- .16	- .15	- .16	- .30
Times	τ_1	- .05	- .31	- .59	- .68	- .31	- .42
	τ_2	- .23	- .44	- .03	- .06	- .19	- .05
	τ_3	.14	.38	.21	.18	.31	.08
	τ_4	.14	.38	.41	.44	.19	.39
Treatments	κ_1	.20	- .19	- .16	.38	.06	.08
	κ_2	- .23	.13	.16	-0.06	- .19	- .11
	κ_3	.33	.19	.16	.06	.31	.14
	κ_4	- .30	- .13	- .16	- .38	- .19	- .11
Rater Loc.	θ_1	.64	.75	.75	.47	.65	.45
Subject b(1)	1	.25	.65	.75	.41	.72	.69
	2	1.13	.28	.38	.91	.47	- .19
	3	-1.13	-1.72	-1.25	-1.22	-1.41	- .81
	4	- .25	.78	.13	- .09	.22	.31
b(2)	1	.16	- .53	- .06	- .41	- .34	.09
	2	- .59	.09	- .19	.09	- .09	- .53
	3	.16	- .16	- .06	.22	.16	.47
	4	.28	.59	.31	.09	.28	- .03
Subj. X Rater Loc.	$(\alpha\theta)_{11}$	.05	.22	.19	.13	.13	.17
Treat. Contrasts							
(Laser-Long) Fam		- .44	.31	.31	- .44	- .25	- .19
(Laser-Long) Unf		- .63	- .31	- .31	- .44	- .50	- .25
Laser-Long		-1.06	0.0	0.0	- .88	- .75	- .44
Unf. - Fam.		.06	.13	0.0	- .63	.25	.06
Type X Fam		- .19	- .63	- .63	0.0	- .25	- .06
Time Contrasts							
Lin		.94	2.88	3.25	3.5	2.00	2.56
Quad		.19	.13	- .38	- .5	.13	- .06

TABLE S3 (cont'd)

CLASS TWO QUESTIONS

ANOVA	F					
Source	13	14	15	16	17	18
Subject Loc.	3.59	1.67	.48	.43	.39	2.38
Time	.27	1.36	1.53	1.55	.75	.66
Treatment	.83	.24	.26	.64	.49	.10
Rater Location	13.94°°	16.14°°	18.19°°	5.83°°	14.61°°	4.83**
Subjects w Loc.	2.22	2.83	1.63	1.50	2.11*	.87
SL X Time		2.06				
SL X Tr						
SL X RL						
Time X RL						
Error HS σ^2	1.88	2.23	1.98	2.41	1.89	2.72
Subj.variance σ_b^2	.28	.51	.16	.15	.26	0.0
Mult. Corr. R^2	.56	.62	.55	.48	.55	.35
Rater H.S.	1.52	2.82	2.29	2.35	2.51	4.98
Res. H.S.	2.11	1.86	1.78	2.45	1.49	1.28
F(14,22) approx.	.72	1.51	1.29	.96	1.68	3.88°°
R^2						
EMS comparison with first data set: σ_1^2	1.55	1.75	2.36	1.15	1.69	1.17
	.82	.79	.93	.48**	.89	.43°°

In fact, close inspection shows almost no consistency between the two sets of data.

We note, for example, that the "Subject Location" α_1, which was positive for questions 1-17 in the RD1, is nearly always negative in the new data (RD2), but no value is significant for either data set. Item 8 in RD2 reaches a 10% significance level but this may be due to chance.

The difference between Rater Locations, θ_1, is always "highly significant." However, this should not cause any excitement. Similarly, it is quite often the case that the "Subjects within Locations" effect is significant--indicating that subjects differ from each other. The significance levels achieved for this effect are somewhat lower in RD2 than in RD1.

The Subject Location x Rater Location interaction is small in RD2 compared to RD1.

The Time effect appears significant--at 2 1/2% for Item 10 (Avoids Body Contact) and 10% for Item 11 (Maintains Orientation) but the significance is not isolated in the linear or quadratic contrasts. However, we suspect it is "close to" linear.

The Subject Location x Time interaction shows some significance, which is hard to account for. One wonders whether the observer teams who made the videotapes (and are confounded with subject location) did not undergo some change of technique as the recording proceeded.

The estimates of the separate Time and Treatment effects (τ's and κ's) are not consistent from RD1 and RD2. The subject effects (b's) are also of dubious consistency, with the possible exceptions of H2 and H3.

One set of estimates which does remain consistent from RD1 and RD2 is the Error Mean Square--the estimate of the underlying variance which limits the sensitivity of the analysis. Only items 12 (Solves Orientation and Mobility Problems), 16 (Travels Efficiently) and 18 (Quality of Tape) are "significantly different." In these cases, the Error Mean Square is larger in RD2. The multiple correlation coefficient, R^2, is about the same in RD2 as it is in RD1, and adjusting for raters as in RD1 brings about the same improvement in fit with no dramatic reduction in the Error Mean Square.

Conclusions

We must therefore conclude that there are more sources of variation at work than we can account for. Despite the effort to standardize the subjective ratings, no improvement is apparent in the data--the Error Mean Square is not reduced, and the Main Effects, if any, are relatively too small to be detected by this rating method. It would seem that almost any subjective rating technique would suffer from this problem unless, perhaps, a much larger number of

raters and/or subjects could be found.* In most cases, however, such a procedure would be impractical.

Therefore, to assess small differences in travel performance we would recommend concentration on the development and refinement of objective measures.

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*It is a legitimate question to ask why the two data sets, RD1 and RD2, were not combined and then analyzed. One of the reasons was practical--the statistician had no access to a computer on which to prepare a new program. The other reason is more fundamental--the two ratings were essentially different experiments, being separated in time and in the receptiveness and preparation of the raters. Thus there is no a priori justification for combining the data sets.

Results Obtained from the Rater Questionnaire

Introduction

Members of both groups of raters were asked to complete the rater questionnaire described in Appendix 5. However, raters A-8 and B-6 did not return their forms, so only data from seven raters in each group are available.

Utility of the Videotapes

Of the fourteen raters, eight (seven in Group A and one in Group B) felt that the videotapes provided the needed information to rate overall travel performance accurately most of the time (Q1), while seven (five in Group A and two in Group B) felt the information to rate specific travel skills was provided most of the time (Q2). Six raters (four in Group A and two in Group B) experienced only little difficulty in using the tapes to judge performance, while the remaining eight had at least moderate difficulty (Q3). Only five raters felt the videotape performances were at least as interesting as real life performances, while the rest felt they were less interesting (Q4).

Elements of videotaping which needed improvement were judged to be:

Attribute		Frequency of Comment	
		RD2	RD1
A	Quality of picture	4	1
B	Quality of sound	3	4
C	Angle of shooting	12	13
D	Length of videotape	1	0
E	Area used for routes	5	0
F	Distance of shooting from action	3	5
G	None of above	0	1

Most of the dissatisfaction seems to be caused by the angle of shooting. This is consistent with the opinions of the raters of RD1 (Q5).

Eleven of the fourteen raters felt that the videotaping technique was of large (3) or moderate (8) value in evaluating mobility aids. Three raters felt that the videotapes were of small value (Q6). All the raters in Group A and four in Group B (eleven in all) thought that the videotapes had at least a moderate value in evaluating travel performance (Q1).

The raters' reception of the video recordings was mixed although the data show that Group A is more positive than Group B. Both groups are not as receptive as the original sixteen raters of RD1.

TABLE S4

DATA FROM RATER QUESTIONNAIRE

CARROLL CENTER

Questions	A1	A2	A3	A4	A5	A6	A7	A8
1	B	B	B	B	B	A	B	-
2	B	D	B	B	B	D	B	-
3	B	D	B	B	C	B	C	-
4	D	D	D	D	D	C	C	-
5	C	A,C,E,F	A,C,E	C*	C,E	A,E	A,B,C	-
6	B	B	A	B	C	A	B	-
7	B	B	A	B	A	B	B	-
8	B	B	B	B	D	B	A	-
9	B	C*	B*	B*	D	A	B	-
10	B	C	B	C	C	B	B	-
11	B	5,6,9,11	17	9,10,11	9,10	5,6,8,9,14	4,5,6	-
12	C	B	D	B	C	C	B	-
13	C	C	A	B	C	C	B	-
14	C	C	B	*	C	D	B	-
15	B	C	C	B	C	C	A	-
16	-							
17	-	5*	5*	*	7*	4	6*	

*Additional comments were volunteered

TABLE S4 (cont'd)

DATA FROM RATER QUESTIONNAIRE

EASTERN BLINDNESS REHABILITATION CENTER (EBRC)

V. A. WEST HAVEN

Questions	B1	B2	B3	B4	B5	B6	B7	B8
1	D	D	D	D	E	-	B	C
2	C	B	D	D	D	-	B	D
3	C	C	B	D	D	-	B	C
4	C	E	B	D	D	-	E	C
5	C	B,C	C,D,F	C,F	C	-	B,E	C
6	C	B	B*	B*	C	-	B	A
7	B	C	B*	C	C	-	B	A
8	B	B	B	C	C	-	D	A
9	B	B	B*	B	D*	-	B*	B
10	B	B	C*	B	B	-	D	B
11	4,5,14	12,14	3,8*	4,6,14	3,4,12,17	-	4,5,11 2,15,17	11,17*
12	C	B	B*	B	B	-	B	C
13	C	B	B	C	-	-	C*	C
14	*	B	C	C	-	-	D*	B
15	C	C	C*	C	C	-	D*	C
16								
17	5	2*	5	6*	6*	-	-	6*

*Additional comments were volunteered.

Efficiency of the Rating Form

Ten out of fourteen raters had little or no trouble using the rating form to judge the travelers' performance (Q8). Eleven raters felt the rating form covered most, or all, of the major components of travel. Of the three who were dissatisfied with the coverage, none actually suggested an improvement although a variety of comments was offered, with one rater noting that not all components on the form could be observed in the video image (Q9).

The seven-point scale was satisfactory to nine raters (Q10).

The rating form questions which gave difficulty were:

Question	Frequency of difficulty			
	Group A	Group B	Total RD2	RD1
R3 Crosses streets	0	2	2	0
R4 Use of auditory information	1	4	5	4
R5 " " nonauditory information	3	2	5	3
R6 " " information from device	3	1	4	2
R7 Long cane technique	0	1	1	1
R8 Appropriate speed	1	1	2	0
R9 Avoiding cane contact	4	0	4	2
R10 Avoiding body contact	2	0	2	2
R11 Maintaining orientation	2	3	5	3
R12 Solving O&M problems	0	2	2	3
R13 Relaxed and confident	0	1	1	0
R14 Awareness and alertness to information change	1	3	4	6
R15 Travels safely	0	0	0	1
R17 Total O&M performance	1	2	3	1

The sparsity and interdependence of the data make them difficult to judge objectively; but it would seem that the majority of the raters' problems occurred with roughly the same questions as bothered the original raters: R4, R5, R6, R9, R11 and R14. One rater claimed to have had no difficulties. The sorts of consistency noted in the earlier report on the rater questionnaire did not surface in this case (Q11).

Six of the raters thought the rating form had at least moderate value (only one, in Group A, thought it had a great deal of value), and eight thought it of little value in evaluating mobility performance (Q12).

Thus the two groups were somewhat critical of the rating form, and certainly more critical than the original raters.

Value of the Laser Cane

Only one rater, in Group A, thought the information provided by the laser cane was of great practical value to the traveler. Four raters thought it of moderate value; but most (8) thought it of small value. One rater did not respond (Q13). However, four raters thought the laser cane effected a moderate improvement in the travelers' mobility performance (but only two of these, both in Group A, opted for "moderate" or "large" response to Q13), five thought the improvement was small and two thought there was no improvement. Three of the fourteen raters did not respond, one of them commenting that "it depended on the traveler" and another, more cogently, that having "viewed four travelers in isolation for only one try [he was] unable to properly judge improvement" (this observation was also made by one of the respondents) (Q14).

Three raters, all in Group A, thought the cane had a large (1) or moderate (2) application for the totally blind population served by their center. Of the rest, ten raters thought the application would be small and one thought there would be no application unless one used "just the upper beam for overhead objects" (Q15).

Group A seemed slightly more optimistic about the potential of the laser cane as a mobility aid than Group B, but neither group appeared wildly enthusiastic.

The raters were asked (Q16) which particular features of the laser cane they liked most and which least. As with the original set of raters, by far the most favorable feature was the ability to detect obstacles, particularly overhead obstacles. Other features mentioned were the uses for trailing the shoreline, for maintaining or recovering the line of travel and for aligning with pedestrian traffic in street crossings. Unfavorable features were inaccurate signals, too many signals in congested situations, and the lower channel in general. The lower channel was criticized particularly for poor curb detection and for its generation of inaccurate or uninformative signals. These comments are consistent with the opinions of the original raters. One rater offered the opinion that the delay in audio-feedback from the upper channel caused collisions with overhead obstacles to occur despite the warning. One rater did not like the forward channel and one thought the device too expensive to be practical. One rater did not comment at all.

Rater's Rating of Himself

These data were not analyzed because there were only eleven responses obtained and because the quality of the data obtained from the previous raters proved to be so poor.