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ABSTRACT

Behavioral and engineering tests were conducted in the field and laboratory to assess effectiveness and usefulness of the Vibralert, an electronic device for maintaining contact with deaf and deaf-blind children and adults. The vibrating portable signal system was used by 24 deaf and hearing parents to maintain contact with their deaf children at play outside and inside the home for a 2-month period. Findings showed that the majority of the parents and children liked and used the system, and that one third of the test group indicated willingness to buy the system despite problems encountered which corroborated test results. The tests revealed major weaknesses in the system such as restricted range of less than 75 feet, sensitivity to moisture, erratic performance, and difficult maintenance of battery charge. Similar testing was conducted with deaf-blind adults in domestic and industrial settings using the Vibralert and another similar device, the MIT TAC-COM. The investigations showed that the Vibralert was preferred over the MIT TAC-COM in both conditions and that complaints were similar to complaints expressed in the previous field test. (MC)

Electronic Communication with Deaf and Deaf-Blind Persons

A Joint Research Effort with

National Center for Deaf-Blind Youths and Adults

DEAFNESS RESEARCH & TRAINING CENTER

New York University School of Education

A FIELD EVALUATION OF DEVICES FOR MAINTAINING CONTACT WITH MOBILE DEAF AND DEAF-BLIND CHILDREN:

ELECTRONIC COMMUNICATION WITH DEAF AND DEAF-BLIND PERSONS

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A Joint Research Effort of
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PREFACE

Persons who are deaf and persons who are deaf-blind have a number of communication problems in common. Recognizing this fact, the National Center for Deaf-Blind Youths and Adults has greatly valued the opportunity to work cooperatively with the New York University Deafness Research & Training Center to resolve some of the problems that concern both of the centers.

We embarked on the joint venture described in the following pages because of our common interest in the particular problem of calling or paging a deaf or deaf-blind person from a distance. Through our cooperation in this area, we have been able to maximize the utilization of available manpower by eliminating duplication of efforts and, thus, minimizing cost.

We greatly appreciate the training in the use of the sign language that the NYU Deafness Research & Training Center has provided for many of the staff of the National Center; and we equally appreciate the interest which a number of the staff of the Deafness Research & Training Center have shown in the special problems of individuals who are both deaf and blind.

The pooling of scientific resources involved in this study represents cooperation in a new area between the Deafness Research & Training Center and the National Center. The successful outcome of this cooperation leads us to look forward to future joint ventures between our two centers to enhance our ability to solve problems related to deafness, deaf-blindness, and blindness.

Peter J. Salmon, LL.D

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INTRODUCTION

This research has significance beyond its immediate objective of testing a radio-activated signaling device. The project is a cooperative effort of two federally funded, national organizations, the National Center for Deaf-Blind Youth and Adults and the New York University Deafness Research & Training Center. Recognizing a common problem, the two centers joined forces to more economically study a system potentially valuable to each of the populations they are established to serve.

Once out of sight of another person, the deaf and deaf-blind individuals are equally lacking in a means of being contacted by that person. The deaf child outside at play is "deaf and blind" to his mother at home. Even at home, if he is in a different room from his mother, the deaf child is out of contact with her. The deaf-blind person, of course, ordinarily responds to neither voice nor visual signal, so those wishing to alert him must touch him.

In all these instances and more, a remotely activated tactile signaling device appeared to be worthwhile. Whether it would prove to be so in practice was the initial research question. The second was how valuable would it be. Less importantly, the research also evaluated a system presently being marketed by Bell & Howell. By testing off-the-shelf units, the investigation was expected to provide information that would be helpful in detecting limitations imposed by equipment design and quality of manufacturing. The main target of the research, however, was testing the communication principles exemplified under field conditions.

The original impetus for this study came from Dr. Thomas Fay, then Associate Director of the Deafness Research and Training Center and now Director, Speech and Hearing Clinic, Columbia Presbyterian Medical Center. Dr. Fay convened the meeting which brought together representatives of the two centers with Mr. Dwight Ritter, of Bell & Howell, in August, 1971. It was at that meeting that Dr. Eugene Zumwalt, then Director of Research for the National Center, and Dr. William Schiff, then Director of Research for the Deafness Center, agreed to jointly pursue evaluation of the signaling system. In 1972, Dr. Zumwalt was replaced by Dr. Frederick Kruger, who completed the research and prepared the chapter on use by deaf-blind adults.

In September, 1971, a proposal for the study was submitted to the Bureau of Education for the Handicapped, U.S. Office of Education. Funding was subsequently awarded for the period March to August, 1972. Dr. Toby S. Dresner was employed to construct the interviews, monitor the equipment placed in the field, and conduct the interviews. Over-all direction of the project continued to be the responsibility of Dr. Schiff.

The report presented here is, as indicated on the title page, the work of many people. Drs. Dresner and Schiff prepared the substantive portions describing the research with deaf children. Mr. Peter Soltesz wrote the technical description of the equipment. Dr. Krueger contributed the section on research with deaf-blind persons. Because of time pressures, none of the authors had a full opportunity to review the edited version. Therefore, while they deserve full credit for the virtues of this document, they should not be held responsible for any errors it contains.

Jerome D. Schein, Ph.D.
Editor

25 May 1973

Chapter I

SUMMARY

Behavioral and engineering tests were conducted in the field and laboratory in order to assess the effectiveness and usefulness of an electronic device---the Bell & Howell Vibralert---for maintaining contact with deaf and deaf-blind persons. Deaf and hearing parents of deaf youngsters used the vibrating portable signal system to maintain contact at a distance with their deaf children. For two-month trial periods the devices were provided to 24 families who used them in a variety of indoor and outdoor settings, primarily for summoning the children home or to prearranged places. Approximately 75% to 90% of the parents and 86% to 92% of the children (deaf and hearing, respectively) reported that they liked and used the system, in spite of problems encountered with it.

Behavioral and engineering tests revealed major weaknesses in the system, including extremely restricted range (less than 75 feet indoors or outdoors in most cases), sensitivity to moisture, erratic performance, and difficult maintenance of battery charge. But the facts that a majority of parents and their children affirmed the usefulness of the device and that one third indicated they were willing to purchase it despite the problems experienced with it clearly support the value of maintaining such electronic contact.

Similar testing was done with deaf-blind adults, using the Vibralert in the domestic setting and both the MIT TAC-COM and the Vibralert in the industrial setting. The Vibralert was found useful in both conditions and was preferred over the MIT TAC-COM in the workshop. The preference for the Vibralert in the industrial condition was slight and was based on relatively minor points. Furthermore the Vibralert aroused essentially the same complaints about its performance as in the field tests with deaf children.

The findings also delineate the areas of needed improvement in the particular equipment tested and specify how an optimally useful system could be developed. With the suggested modifications, such a system should find wide acceptance among the deaf and deaf-blind populations.

Chapter II

FIELD TEST WITH DEAF CHILDREN

Statement of Problem

Several electronic systems have been developed recently for signal communication at a distance with persons having severe sensory impairment. By means of vibrations generated by a portable radio transmitter and sent to portable receivers, deaf, blind, and deaf-blind people may be signaled individually. With such devices, parents or school staff can signal a child to go to a prearranged place. The units are also designed to operate as vibrating doorbells or intercom signal devices.

The present study provided field testing and engineering testing of one of these devices, the Bell & Howell Vibralert, in order to establish its practical value with potential consumer populations---families having deaf or deaf-blind[1] youngsters. The study sought to determine how well the equipment operated under everyday conditions, how useful parents found it, and how effective it could be predicted to be over a longer period of use than it was given during the experiments.[2]

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[1]Because the uses of the devices and methodologies required for deaf and deaf-blind populations are quite different, the findings with deaf-blind individuals are reported separately.

[2]An additional aim of the present investigation was to evaluate the acceptance potential and effectiveness of the Bell & Howell Vibralert Dial-A-Comm system (Model 356C). At the time the research proposal was submitted, the Dial-A-Comm was reportedly being installed in at least one residential school for deaf children. When the grant was received, the same report was given us by a company representative. Arrangements were made to test the multiple-receiver version of Dial-A-Comm at the American School for the Deaf, Hartford, Connecticut, as soon as the installation was completed. By the end of the grant period (August 31, 1972), the installation had still not been made and there were no other such units in operation in the country. Therefore, this projected phase of the research could not be completed. However, a group signalling arrangement, MIT TAC-COM, was tested with deaf-blind adults (see Chapter IV).

Table I

Distribution of Subjects in Field Test of Vibralert System, by Age, Sex, and Hearing of Parents: Deaf Sample, 1972

Children's Sex and Age (in Years)	Parents' Hearing	
	Deaf	Hearing
All	12	12
Male	6	6
10-12	3	3
13-15	3	3
Female	6	6
10-12	3	3
13-15	3	3

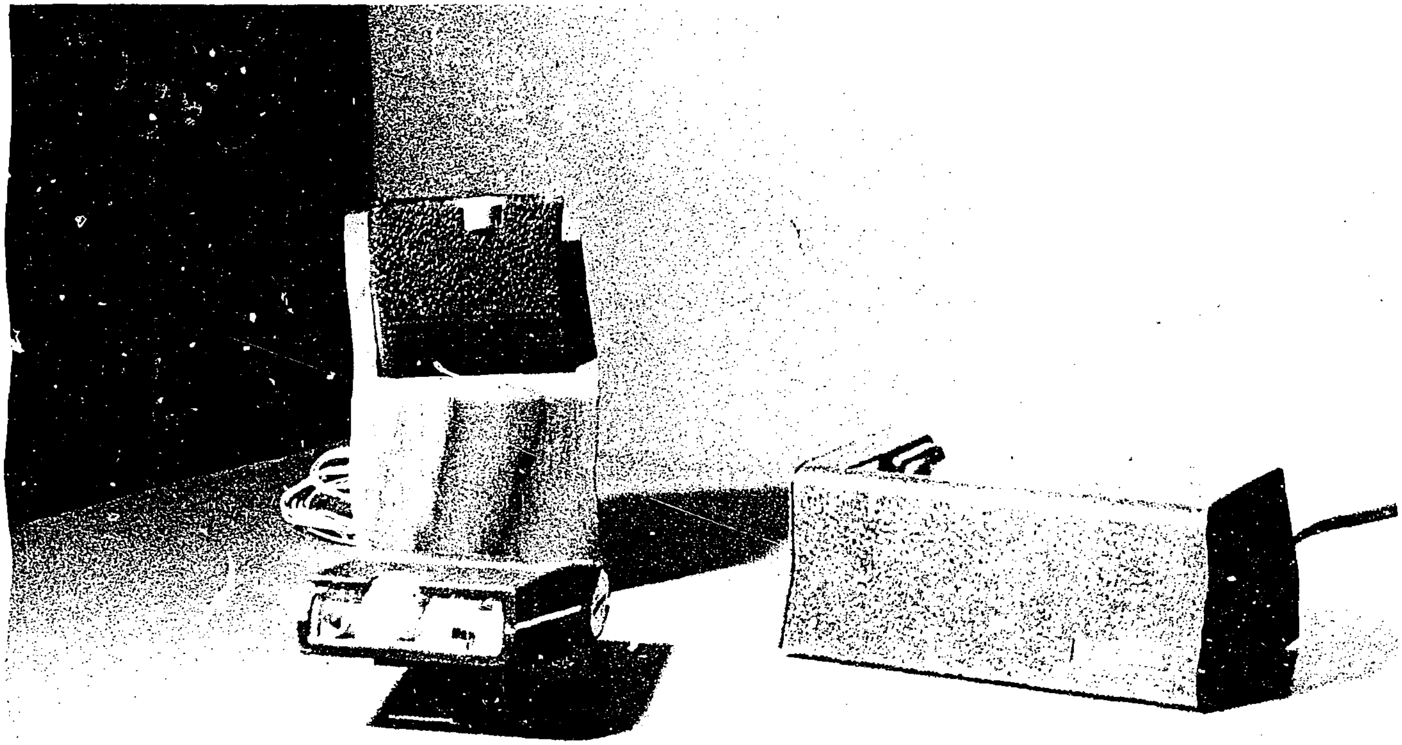

Figure 1.

Vibralert transceiver tilted to show its width.
Battery charger and transmitter in background.

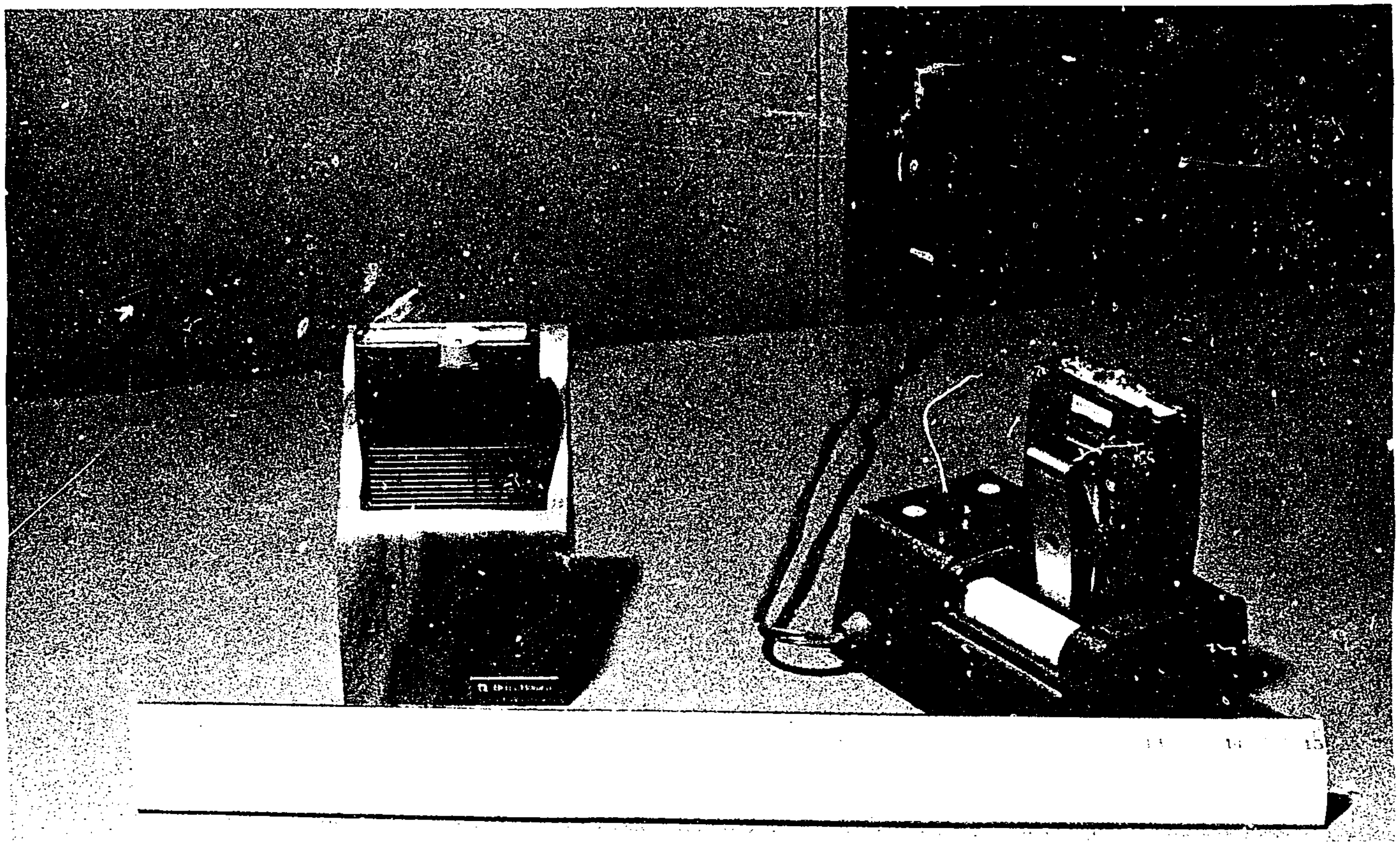

Figure 2.

Vibralert transceiver, transmitter
and battery charger.

Procedure. The initial interview schedules were constructed to determine the uses of the transmitter, the child's responses to the vibrator, preferences for the device, and its mechanical functioning.

To be certain that all questions could be understood and clear responses obtained, the initial schedules were administered to a deaf parent and child (not included in the regular sample) after they had tried the Vibralert for a brief period of time. As a result of this pretest the schedules were altered and alternate forms for each question were provided. The parent-interview schedule was structured as follows:

Questions 1 and 2 were asked simply to find out where the parents kept the transmitter and whether that was the most convenient location. Questions 3-17 ascertained the use of the transmitter and the child's responses. Questions 18-24 inquired about preferences for the instrument over the usual method of calling the child. Questions 25-27 concerned the mechanical functioning of the units. Questions 28 and 29 were asked to see if there were special applications of the instrument. Question 30 determined the vulnerability of the instrument to mishandling. Question 31 was an over-all evaluation of the device. Questions 32 and 38 were requests for ways to improve the device. Questions 33-37, which were asked only at the second interview, were attempts to determine the marketing possibilities of the instruments.

The child-interview schedules followed a similar pattern, and also served as a check on the use and response to the equipment. All of the interviews were conducted in the homes, by one of two field interviewers, either orally or manually depending on the individual's preference.

At the first session interviewers demonstrated the units and explained their operation. The battery recharging and/or changing procedures were likewise demonstrated. Initially all families were provided with disposable batteries. Of the 14 children in the spring sample, 11 were subsequently provided with rechargers and rechargeable batteries. The parents were asked to use the transmitter whenever they wanted to "call" their children. The children were asked to "go and find your parent" whenever they felt the vibration. The only other specific request made of the parents was to try to estimate the range of the instrument by using it over a distance and noting down the time the transmitter button was pushed and the time the vibration was felt.

Results of Field Trials

An inspection of the data showed that, in most instances, differences between responses were not significantly associated with time of year (spring vs. summer) or age or sex of child. Where these factors appear relevant they are discussed below. However, responses to a number of questions did vary by parents' hearing ability. Accordingly, parental hearing occupied the major portion of the analysis.

No parents reported complete indifference to the unit (Table 2). All 24 families said they used it during the preceding month. Deaf parents indicated less use than hearing parents. However, this apparently greater use by hearing parents became less obvious after suitable probing (Table 3). Both subgroups of parents signalled their children about equally often at meal times. When otherwise occupied, deaf parents used the Vibralert less often than hearing parents. Inside the house, both rated use of the instrument similarly; but when the child was outdoors, hearing parents more often reported routine use. The latter finding may reflect the deaf parents' unwillingness to rely on a device which worked intermittently, if at all, under conditions of extended range.

In the first month, all parents used the transmitters. The hearing parents used them more consistently than the deaf parents and the children of hearing parents responded more consistently. The initial enthusiasm for the instruments abated considerably due to the malfunctioning of nearly all of the transmitters. Even prior to the first interview, nearly all of the parents phoned in with complaints. The major defect was the restricted range of the transmitter (see Table 4). The reports of the restricted range varied considerably. Some of the units were not functioning at all beyond the confines of the house or apartment, and even then, some were not functioning beyond 10-20 feet and, furthermore, were functioning erratically, even within this restricted range. Others were functioning at a greater range but none drew a response, initially, beyond one-half. Nonetheless, only two of the families withdrew their participation prior to the first interview.

More of the hearing parents demonstrated a preference for using the transmitter beyond their usual method of locating the child personally. To some extent the deaf parents indicated that they might have preferred the transmitter, if they were really sure that it was working. Preference for the instrument also had something to do with the children's major complaint: the size, bulk, and general lack of comfort involved in wearing the Vibralert. Two of the parents reported that they would have preferred the transmitter if their children were more comfortable wearing the vibrators.

Table 2.

Responses by Hearing Ability of the Parents to the Question "Did you use the transmitter in the last month?"

Responses	Hearing Ability of Parents	
	Deaf	Hearing
Most of the time	2	5
Some of the time	10	7

By the end of the second month, four of the deaf parents had already given up the instrument. Erratic functioning was the major reason, aside from the restricted range. The child's lack of interest in the device was also a factor in its rejection; the novelty had worn off and the children were "bored" with it. All but two of the families reported that they used the transmitter less in the second month.

Only two of the hearing parents said they would spend a week's salary[3] to purchase the device if it were marketed. None of the deaf parents felt the device would be worth that price.

All of the parents and children made suggestions on changing the Vibralert. Some indicated that if these changes were instituted they might indeed want to own one. The major alterations were increased range and smaller size. Many indicated that the device might be useful for younger deaf children. Many of the parents of adolescents indicated that their children were too independent to be summoned in this fashion and ought to be responsible enough to know when to come home and what time dinner was served.

The summer sample generally gave more positive overall evaluations of the instrument than the spring sample. Similar difficulties were encountered---limited range and erratic functioning. However, several of the instruments functioned very well. Most families took vacations for parts of the summer and took the units with them. In Miami Beach the range was reported as 11 blocks; a similar range was reported for the New Jersey shore. For the Lake George, New York, area the range was about 400 feet. The response "one mile" given by one parent exceeds the manufacturer's own claims and should, in the context of the inquiry, be interpreted to mean "a long way from home."

While the instrument was used to a somewhat greater extent in the summer, the children had more difficulty finding a suitable place to wear the vibrators. With fewer belts and pockets on summer clothing, short tops and bathing suit bands were less comfortable alternatives. The children reported that having to remember not to jump in the water with the vibrator on was decidedly bothersome. Unlike the spring sample, only one deaf parent preferred to find her child herself rather than

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[3]Although exact salary figures were not obtained, all installations were in low to moderate-income-level homes.

Table 3.

Responses by Hearing Ability of Parents to the Questions
(a) "Did you use the transmitter to call X for meals?"
(b) "Did you use the transmitter when you were busy (cooking, talking on the phone, or taking care of other children)?"
(c) "Did you use the transmitter when X was inside the (house, apartment, or apartment building)?" (d) "Did you use the transmitter when X was outside the (house, apartment, or apartment building)?"

	Hearing ability of Parents	
Response/Question	Deaf	Hearing
Meals		
most of the time	7	5
some of the time	3	6
no	2	1
Busy		
most of the time	4	5
some of the time	4	6
no	4	1
Inside		
most of the time	6	7
some of the time	4	5
no	2	0
Outside		
most of the time	3	7
some of the time	8	5
no	1	0

bothering with the transmitter, while three of the hearing parents found it more convenient to locate their children themselves rather than using the transmitter. Most parents peported using the transmitter somewhat less in the second month than in the first month, but none of the units was stored away. Only one child in the summer sample preferred his mother coming to look for him over being summoned by the vibrator. More families in the summer sample would be willing to buy the units, though none would pay more than two week's salary.

The suggestions for improving the device paralleled the spring sample: it should be made smaller and lighter, have a greater range and be capable of two-way transmission. In the special circumstances category, the units were used as waking devices by two parents, and for one family the unit was especially useful as a caller between hospital staff and elderly or convalescing patients.

Boys responded somewhat better to the instruments, though this may be due to the greater availability of belts and pants pockets as comfortable repositories for the vibrators, or possibly to boys' somewhat greater independence necessitating more calling of boys than of girls. More boys preferred being paged by the vibrator than having their parent physically locate them, though most of the children preferred not to be summoned at all. Most of the parents felt that their children should be responsible enough not to be summoned for chores or meal times. The parents of girls preferred to locate their children themselves, but this also may be due to the girls remaining more often in the confines of the house or apartment where relatively little effort is required in finding them. Also, in homes where a sibling was handy, most of the parents preferred to send a personal messenger, feeling more secure that the message was delivered.

There were no appreciable differences in questionnaire responses or other indications of preferences for the device according to age. The speculation is that there would have been greater differences if much younger children constituted the younger sample. Many parents indicated that they really would have liked to have such an instrument available when their children were very young.

The data for the deaf versus hearing parents demonstrated less use in the deaf community and less response from the children of deaf parents. The device appears to the deaf community as one more mechanization. With hearing aids, doorbell-signalling devices, light couplings for TTYs, waking devices, etc., this paging system is, for some, neither revolutionary enough, functional enough, nor critical enough to warrant its use.

Table 4.

Responses by Hearing Status of Parents to the Question, "What was the furthest you tried to call X?"

Responses	Hearing Status of Parents: Deaf	Hearing
Less than 1 block	5	4
1 block	4	2
2 blocks	1	1
3-7 blocks	2	2
1 mile	0	1
could not determine	0	2

By and large, the parents complained that the instruments had a restricted range and functioned erratically. Additional problems were encountered with battery-cap screws that either fell out or did not fit tightly enough to sustain contact with the battery. Too few hours of power from the batteries or rechargeable batteries that could not sustain recharging or got overcharged were also encountered (see chapter III, "Engineering and Performance Tests".)

In summary, while the family units have some utility as a summoner of deaf children, they are not acceptable instruments in their present condition. With increased range, less bulk, and fewer malfunctions, they might well prove to be useful, since the principle of maintaining contact was endorsed by approximately 75% (deaf sample) to approximately 90% (hearing sample) of users completing the trial period. Those discontinuing use of the Vibralert or responding that they disliked it appeared to be rejecting the equipment, rather than the underlying idea. Further testing with better designed instruments should add to the vigorous support already obtained in these limited field tests.

Chapter III

ENGINEERING AND PERFORMANCE TESTS

Ten Bell and Howell Model DB150 transmitter-receiver (Vibralert) pairs, called "Deaf-Blind Vibralert System", were received, along with non-rechargeable batteries. Twelve rechargers and 12 doorbell units were also received. Rechargeable batteries were purchased from an independent supplier. Figures 1 and 2 picture the units.

Condition of Equipment Upon Receipt.

All units were inspected upon receipt. Four of the 12 rechargers had loose parts inside, which were found upon disassembly to be transformer-mounting screws. A fifth unit had a faulty fuse. All units---including those mentioned above---showed no evidence of damage in shipment and had both quality control and inspection stamps on them. All units were tested for intra-room (10 feet) operation after correcting the above defects, and all batteries were tested for full capacity. With the exception of the loose parts and faulty fuse, all units cperated properly.

The Transmitter.

A 1.7-6 pF trimmer capacitor (C316) used to tune the LC antenna circuit loosens with vibration or shock. A 1 Meg-Ω resistor (R106) in series with a grounding switch, S101 (pushbutton), is used to induce transmission. Looking into the pushbutton switch terminals, the impedence is extremely high (2 megΩ) and allows false triggering of the transmitter by accidental tactual control of trigger terminals. A (6T*) timing circuit controls the two-tone encoder (9T). The encoder's output is then sent to a crystal controlled oscillator-modulator (3T) and final RF output transistor feeding an LC antenna circuit.

The transmitter battery is Mallory TR 118, rated at 350 mAH, 11.20V. During transmission, the current drain is 5-7 mA for 2 seconds. Transmitter battery cap presently opens on a 17 degree turn and falls off very easily. The angle should be changed to a minimum of 90 degrees, preferably to 180 degrees.

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*T = Transistor

The Receiver.

There is a loopstick antenna feeding into a crystal-controlled RF mixer and amplifier (4T), then fed into a highly selective IF amplifier, a (10T) tone decoder and (7T) control amplifier which turns on an eccentrically loaded motor to give a vibrating effect.

The C-101, a 5-15 pF antenna trimmer capacitor gets misaligned if the receiver is dropped or shaken severely. When the receiver is turned on and the voltage is low, 2.8-3.2V, the motor turns on indicating that the unit is working. However, the RF amplifier seems to be in the cut-off region. Thus, there is a false confidence induced into the user, who will assume that the unit is working when, in fact, it will not receive any transmitted signal.

The receiver starts vibrating at 2.8-3.0V. The standby current of the units was measured at 3 to 6 mA, depending on the unit and voltage, with the average at 4.5 mA. When receiving, the average current drain is 30 mA, with peak pulses from 35-70 mA for approximately 10 to 15 seconds. One cycle contains 9 to 16 pulses for 10 to 14 seconds, which yield 1 to 1.2 pulses per second. Battery was Mallory TR 133/RCA VS 133.

Batteries and Rechargers.

Two types of rechargeable batteries were tested; a standard unit supplied by Bell and Howell at 4.2V, 250 mA hours, and a Gould No. 225 BLH at 3.6V, nominal 225 mA hours.

The recharger has a short circuit current of 15 mA and and open circuit voltage of 12V.

Using a 225 mAH battery with an average standby load of 4.5mA, the battery should last for 50 hours on standby. At maximum load, which is 30 mA for 10 seconds repeated every 30 seconds, the battery will last for 22.5 hours. The primary cell TR 133, rated at 1,000 mAH with a standby load of 4.5 mA, should last 222 hours. At maximum loading, the battery should last 100 hours. The charge rate for the Gould rechargeable battery is 25 mA for 14 hours, trickle rate of 2 mA. The rechargeable battery keeps charge from -40° to 140° F. Battery should retain 75% of its charge for one month. It is charged at 1.5V per cell. The nominal charged-cell voltage is 1.33V.

The mercury battery has the reverse polarity shape of the Nicads and alkaline betteries. It is suggested that the rechargeable battery should be marked in a unique manner so as to reduce or eliminate the confusion.

It is suggested that transmitter mounting hardware, be glued in or made an integral part of the recharging unit. The project engineer was forced to go through all 12 units to tighten mountings.

Perhaps a minor but significant point was a blown fuse in the recharger. The engineer thought that it would be a simple matter to change a fuse, until he actually tried to remove it. The sleeve-type, inline fuse holder was forced onto the fuse, and the position of the fuse was such that manual dexterity and miniature fingers were a definite necessity. In attempts to remove the fuse holder, the wire terminal broke. Any person trying to change fuses would have the same problem. It is recommended that the manufacturer use standard clip-type fuse holders which allow for easy removal and insertion of fuses.

Due to poor design in the recharger, the following were obtained on the rechargeable batteries: On the 10 Gould batteries, 50 to 100 recharges; on two Bell & Howell batteries, 40 to 70 recharges.

People tended to forget to recharge batteries or overcharged them by leaving batteries in the rechargers, or left the units on, running down the batteries. The sensitivity and the range of the units are somewhat dependent on voltage normally and critically dependent on voltage when the battery approaches its discharged state.

<u>The Doorbell Converter.</u>

Doorbell triggering unit was tested to 45 Volts input, both AC and DC. It was found that input to the transmitter was Zener regulated to 17.5 Volts. The converter may be connected across the doorbell itself or across the doorbell button or switch. In the former case, pushing the doorbell yields a positive-going voltage to trigger the transmitter. In the latter case, a negative-going voltage step is generated by the converter to trigger the transmitter. It was found that when the converter is connected to the doorbell switch a power failure would cause triggering of the transmitter.

<u>Moisture and Immersion Tests.</u>

Both receiver and transmitter were tested in kitchens by several persons (users and the engineer). When the units were brought in close proximity (3 to 4 feet) to boiling water, the transmitter stopped functioning.

Further tests were made such as dropping units into a bathtub water at 120 degrees (as children may) for a maximum of 5 seconds. Receivers started to operate erratically and did not stop vibrating after the initial period. The receiver was thoroughly cleaned and dried, but it never operated normally thereafter.

Further, it was found that any water spray or water droplets, as from condensation, caused transmitter to malfunction. Again, the transmitter was submerged into 120 degree water for 5 seconds. After thoroughly drying the transmitter by blowing with a fan, it was found that a high frequency signal (8000 Hz) and low frequency (300 and 500 Hz) were alternatingly emanating from reed filters. The transmitter never operated normally thereafter. Placing a transmitter unit in an ordinary refrigerator (simulating cold, humid winter weather) similarly prevented normal operation.

It is clear that the units (especially and most importantly, the receivers) are highly sensitive to humidity and water immersion. Since the instrument cases are not watertight, even bringing a cold receiver into a warm, moist home or classroom might result in erratic functioning or malfunctioning.

Drop Tests

Units were dropped from varying heights onto two surfaces: linoleum and concrete. The results are summarized in Table 5. In general, the drop tests showed an unusually rugged case, capable of withstanding fairly severe abuse. The transmitter was unaffected by drops up to 10 feet onto linoleum and 6 feet onto concrete. The receiver suffered only minor damage, not likely to affect immediate functioning of the unit.

Range Tests

Range tests were conducted before severe tests. Five units were tested for range in various settings. One unit was tested in a steel-and-concrete building at New York University (Courant Institute). The maximum range was 27 feet, (3 floors vertically). in a nearby masonry-and-frame building, the maximum vertical range was 60 feet (6 floors vertically). Three of the units were tested in both city and suburban settings (Flushing, Bronx, Manahattan, Croton-on-Hudson, New York; Candlewood Lake, Connecticut). All units had a range of 100 feet or less. One unit's range was limited to 50 feet. A fourth unit only worked for 25 feet. New batteries for all units were installed, but the results were identical.

Receiver sensitivity is also affected by other companies using the same frequency, such as Motorola Page-Boy. In this case, the transmitter RF is the same (151.625 MHz) except for the encoding. This tends to cut the sensitivity enough to interfere with normal operation of the units.

In summary, the useful range of these units appears severely limited---the majority of tests, indoors or outdoors, horizontal or vertical, showed maximum range to be 75 feet or less. By comparison, walkie-talkies with 100 mW input power having a range of 1/4 mile sell for as low as $25 a pair. Similar transmitters

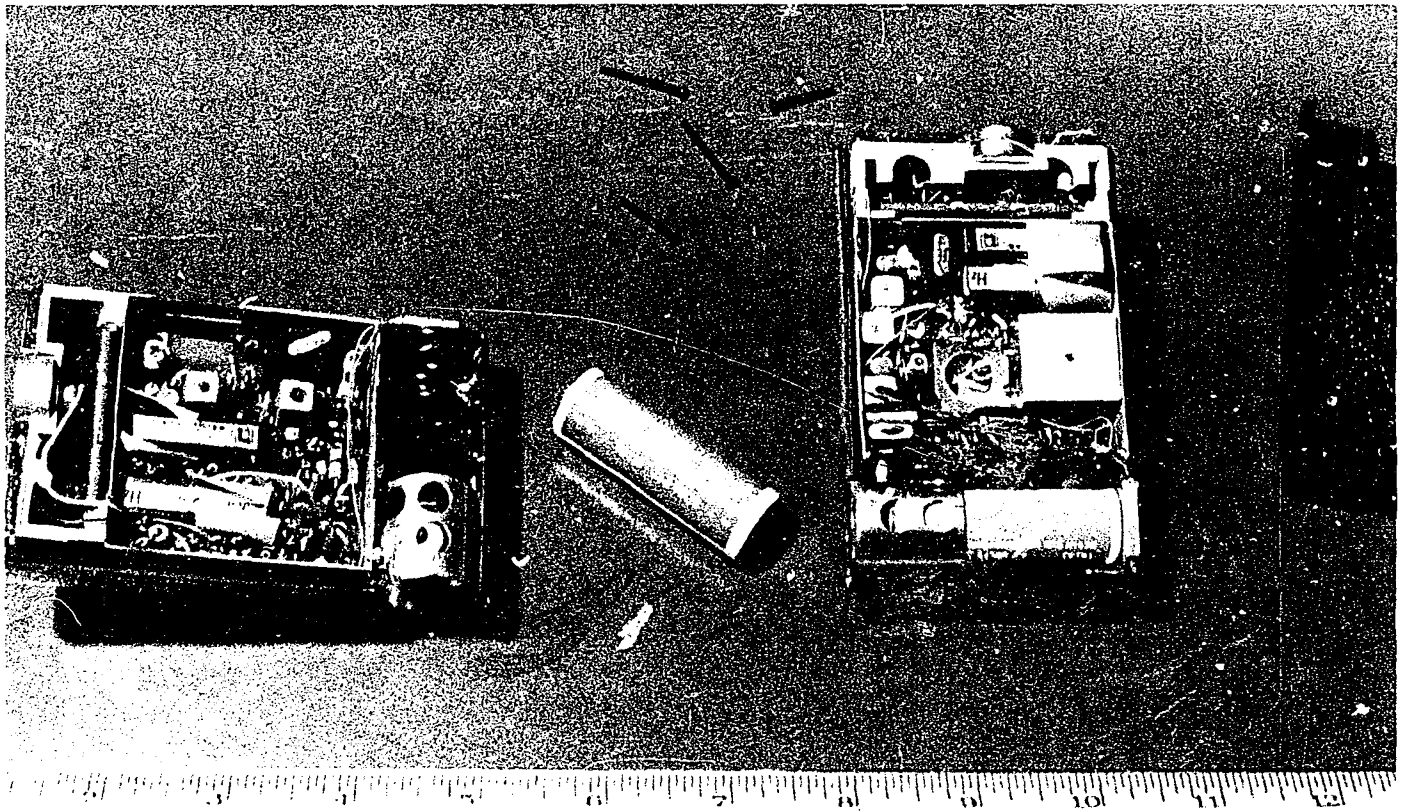

Figure 3.

Vibralert transceiver and transmitter shown
with covers removed to expose interiors.

Table 5.

Results of Drop Tests of Vibralert Instrument in the Laboratory

Testing conditions	Results for Receiver	Results for Transmitter
Onto linoleum floor		
From 1'	undamaged	undamaged
2'	slight misalignment of trimmer capacitors	undamaged
6'	undamaged	undamaged
10'	undamaged	undamaged
Onto concrete floor		
From 1'	undamaged	undamaged
2'	undamaged	undamaged
6'	hairline crack on corner of case; trimmer capacitor and reed filters loosened	undamaged

with inputs of 1 to 5 watts in the Citizens band start from $50 to $150 per unit with their range extending from 1.5 to 5 miles. Although these latter units are transceivers, speakers could be replaced by the vibrator. A two-way unit having a range of up to 2 miles, could be manufactured for $100 to $150 a set.

The FCC presently allows the use of Citizens-band radio and garage-door openers of less than 100 mW input power to operate continuously. Certainly the deaf and the deaf-blind might be allowed to have a frequency band, specifically allocated to them, with no limitation on duty cycle. It would also be advantageous for them to be allowed more input power for extended range.

General and Specific Engineering Recommendations.

1. All users should be supplied with a set of instructions and a complete equivalent-substitution table for the batteries.

2. The transmitter, especially for deaf persons, should have an RF output monitor, since there is no way for the deaf person to hear the little tone the transmitter makes when transmitting. This monitor should give visual indication, such as an LED or small lamp, indicating the fact that not only is the battery good, but also the transmitter is actually transmitting a signal.

3. The transmitter has two trigger points on the bottom to be used with a doorbell or other triggering device. The impedance hooking into these two terminals is very high---2 MegOhms. The average range for humans between two fingers was 200K-500K Ω. Thus, any accidental contact with these terminals will trigger a "false" signal. It is recommended that this impedance be reduced to 100 K Ω or less.

4. Polarity markers on rechargers, receivers and transmitters should be raised sufficiently so that a blind person can easily determine which side is the positive terminal.

5. Since these receivers were modified from a tone/vibrate to vibration-only units and the same case has been used, it is recommended that the opening for the nonexistent speaker be sealed to make it dustproof and waterproof. Watertight cases would be even better.

6. The receiver unit starts vibrating at 2.8-3.0 volts; however, it does not receive until the voltage is about 3.2 Volts. It is recommended that units be so modified that when the receiver cannot receive it does not vibrate.

7. Recharger should have an indicator (i.e., meter) to show the charge of the battery. Presently, a red light stays on regardless of battery condition. Further, to prevent overcharging, it should have an automatic cutout when the battery is fully charged.

8. Rechargeable batteries can be recharged 200 to 500 times before termination of their service. The charging rates for the battery should be closely observed for maximum utilization of battery service. The possibility of a fast-recharge system should be investigated.

9. Transmitter should have more input power and radiate more efficiently. An external collapsible or rubberized whip antenna, similar to the one presently used by Motorola in the New York City Police Department walkie-talkies, should be investigated.

10. The circuit for both the receiver and the transmitter are too elaborate for this kind of a system. A simple but reliable circuit is called for. Not only would this help in trouble-shooting and repairing units, but would drastically reduce costs.

11. The possibility of decreasing receiver's and increasing transmitter's size should be looked into for one-way transmission. The receiver could be reduced in size by the use of integrated circuits.

12. The limitations of the 30-second duty cycle, in which the transmitter is not allowed to operate, should be dispensed with. This would allow for codes to be used to increase the message-sending capacity of the system. In a two-way device the receiver of a call could confirm receipt, for example, eliminating a major source of lack of confidence---information as to whether the message was received.

13. Most users complained of the large protruding clip on both the receiver and the transmitter, making it difficult to wear them without a belt.

14. The reed filters (relays) should be mounted more securely, or eliminated completely.

15. Quality control (vide ante) should be improved generally to avoid initial disappointment by users.

Chapter IV

FIELD TESTING WITH DEAF-BLIND INDIVIDUALS

The National Center for Deaf-Blind Youths and Adults conducted two studies in cooperation with the New York University Deafness Research & Training Center. The first study was initiated as a several month project to compare and evaluate the Bell & Howell Vibralert and the TAC-COM[1] as beginning-and end-of-work-period alerts. Both of these devices operate independent of interconnecting wires and provide a signal through a vibrating device when keyed on by a remote transmitter. The second study was initiated in order to directly evaluate the usefulness of the Bell & Howell Vibralert to the deaf-blind individual(s) at home; i.e., as a doorbell signal, etc.

Both studies indicated that the Vibralert was able to function as a signaling device over a restricted range. It was valued by the users in spite of problems which were encountered as the Vibralerts were used over an extended period.

With modification and/or redesign, a wireless signaling system appears to be of significant value to the deaf-blind individual. The present studies were initiated to determine the extent to which deaf-blind individuals preferred a wireless vibratory paging device to other signaling methods.

<u>Report on Study 1</u>

Eight subjects (trainees at the National Center headquarters in Garden City Park) participated in the several month's evaluation of both the Bell & Howell Vibralert and the MIT TAC-COM as beginning-and-end-of-work-period alerts. These subjects were selected because they did not have sufficient functional hearing to perceive the class bells. Of the eight, three subjects used both the Bell & Howell and the MIT devices. This arrangement was due to the fact that these

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[1]The TAC-COM is a wireless signaling device which makes use of a perimeter induction loop to radiate signals to the receiver. The vibrator in the receiver is actuated as long as the transmitted signal is present. Coded signals can be sent. The Bell & Howell Vibralert makes use of VHF radio frequency transmission of its signal. Once the receiver is activated, the vibrator pulses on and off until the subject deactivates it. Because of the 30-second delay imposed between possible transmissions, no coded signals can be sent. For a report on the TAC-COM, see "Development and Demonstration of Communication Systems for the Blind and Deaf/Blind", Final Report of Project No. 14-P-55016/1-03, Social and Rehabilitation Service, February 26, 1973.

three subjects were the only ones of the eight who had sufficient communications skills to compare the two instruments.

Each male subject carried one device, generally wearing it on his belt or in a shirt or pants pocket. The female subjects had to clip the units to collars, belts or hold them in their hands because of a lack of pockets. The subjects were told of the significance of the units and demonstrations were given to familiarize them with the controls and operating characteristics of each device. (The major difference between the signals of the two devices was that the TAC-COM provided a steady vibration which continued until transmission was terminated while the Vibralert provided a pulsing vibration which the subject could terminate once he had responded to the signal).

Transmitters for both devices were electrically connected to a Simplex, 8500 series, electric time clock. Control contacts within the clock were set to activate the transmitter at 10 minutes before the hour and on the hour.

In general, the Bell & Howell Vibralert was preferred over the TAC-COM. The sample was quite small, however, and many of the positive aspects of the Vibralert were mechanical (e.g., stronger clip, lighter weight, vibration not as intense, and signal could be terminated by recipient without deactivating unit). It was agreed by all subjects that a wireless signaling device was of value to them.

Report on Study 2

This second study was an attempt to determine the nature and extent of utilization of the Vibralert by deaf-blind individuals in their homes. To do this, letters were sent to a number of deaf-blind individuals in several states requesting cooperation in field testing of the Vibralert as a door-bell signaling device. By the end of April, 1972, three responses were received. The first, a woman in Wilmington, Delaware, rejected the plan, writing that she did not need such a device, since she always knew in advance when her family or friends would visit her. The second respondent (AA), from Grand Rapids, Michigan, expressed an eagerness to try the device. The third respondent (BB), from Denver, Colorado, also volunteered, with the understanding that all installation expenses were to be paid by the National Center.

Because of the distances involved, we were unable to personally interview our subjects, and all communication was by mail. The subjects did, however, send in progress reports. One of the subjects (AA) was able to use our braille instructions to install the unit himself! He immediately wrote to us of his excitement in being able to page his wife or be paged by her (they are both deaf-blind) and requested another Vibralert so that each could signal the other with the centrally located transmitter. Because of her blindness, he explained, it was sometimes difficult for his wife to locate him in the apartment. With the Vibralert she is able to call him to dinner, etc., even if he is in another room. The most recent report from AA (8/10/72) indicates that he and his wife are happily using the two-receiver system and find it of significant value in alerting each other, as well as responding to the doorbell. To date, they have not reported using the system outside their home.

The second subject (BB) reports that his biggest concern is placing too much trust in the Vibralert and then having it quit because of a discharged battery. He places it in the recharger while he is out at work, but uses it continuously during weekends. Even with his hesitation to trust the system, BB values the device and reports that he sleeps with the Vibralert under his pillow so that he can be awakened at night by the doorbell.

This brief field evaluation has already indicated clearly that a wireless signaling device such as the Vibralert can be of significant value to deaf-blind adults. There are quite a few technical problems to be overcome before the Bell & Howell Vibralert can be of full practical use.

Comments and recommendations

1. When the Bell & Howell Vibralert is used by a deaf-blind individual as a doorbell indicator or internal signaling device, the required range is so small that lack of signal did not appear as a problem.

2. It is suggested that the battery supply on the receiver be fail-safe; i.e., when the battery voltage becomes too low for proper service, the vibrator should turn on and remain on until the power switch is turned off and the battery replaced.

3. With respect to the transmitter battery, it is suggested that the Mallory TR 118 be replaced by a Gould rechargeable battery (such as the 10.8V/50BL) which could be constantly trickle charged while the transmitter is in the wall fixture and which should yield at least several full days' signaling capability when carried around.

4. Both transmitter and receiver battery chargers should have internal voltage sensing to switch from full charge (i.e., 10-hour rate) to trickle charge (100-hour rate) when the battery is fully charged.

5. Because of the desire to make the Vibralert as useful and reliable as possible to the deaf-blind individual, the unit should be packaged so as to be convenient to carry or wear. Specifically, it should be miniaturized so that it could be worn as a "mod" bracelet or hung from the neck by a cord or chain.

6. It is essential that future units be totally waterproof so that the Vibralert can be used at all times (as, for example, when washing dishes, bathing, or swimming). Only in this way can the deaf-blind user gain confidence in their use.

7. It is further recommended that the tuning fork filter be replaced by solid state filters; such as, Signetics #566 and #567 integrated-circuit tone encoders and tone decoders.

8. The 30 second time-out restriction is a major complaint. If it were eliminated, signals could be established between users and/or between different devices so as to broaden the capability of the individual in discriminating between a doorbell, a telephone ring, or the spouse's call to come to a particular room in the house.

9. A spare, fully charged receiver battery should be available at all times in the recharger rack.

Other suggestions already have been presented in the engineering report (vide ante.) These recommendations arise specifically from our experience with deaf-blind adults.

Conclusions

All of the users felt a wireless signaling device was of value In the first study reported, it meant signals could be received without requiring physical contact with the instructor. The signals provided a time indicator. For the people in the second study, it has meant increased mobility and security within the home, particularly in the case of AA and his wife, both of whom are deaf and blind.

Chapter V

OVERALL EVALUATION OF VIBRALERT SYSTEM

As noted in the conclusions to Chapters II and IV, both the deaf and deaf-blind users agree that the electronic signaling device is valuable---in principle. The ability to contact a deaf or deaf-blind person at a distance has many advantages, both for deaf children and deaf-blind adults.

Deaf children at play can be contacted by their parents with virtually no inconvenience to either; the parents need only activate the vibrators by pushing a button. Compared to the necessity to physically move to a position where the child's eye can be caught or he can be touched, the use of electronic signaling represents a marked improvement. It is not difficult, furthermore, to envision circumstances in which the Vibralert could be more than a convenience: it could save the child from serious danger. This idea apparently occurred to participants who thought the device would be even more helpful with younger children.

Parents invented many specialized uses. The Vibralert, placed under the child's pillow, can function as an alarm clock. A bed-ridden deaf child can reverse the intended procedure, signaling his mother when he needs her. The possibilities are numerous.

For the deaf-blind person, the Vibralert can act in place of the doorbell to advise when a visitor has arrived. The deaf-blind couple who tested the system found it was a means for contacting each other---a problem for them, even when they are in the same apartment. The TAC-COM system tried in the work situation also proved of value. It signaled starting time, lunch time, coffee breaks, and quitting time. The system could also be modified to advise the deaf-blind person that he is wanted in the office, etc.

Of course, the two systems tested were found to have flaws. Carelessness in manufacture and design were evidenced. Both the National Center and the Deafness Center technicians produced long lists of recommended changes in the equipment (vide infra). Most of their recommendations can be accomplished at small cost. The effect of the changes insofar as instrumental utility is concerned would be correspondingly great.

To the deaf and deaf-blind persons, miniaturization appears highly desirable. Children and adolescents, especially, would better accept the receiver were it fashioned like a Dick Tracy wristwatch or a lavaliere. Summertime use particularly demands a less bulky instrument, because the users' fewer, lighter clothes offer reduced carrying capacity. Belts and harnesses to hold the receivers could be tried, but they are frequently uncomfortable in hot weather.

Increased effective range was another requested improvement in the Vibralert. No technical barriers prevent this condition being met. Along with it must go greater reliability. Confidence in the system is a requisite for its wider acceptance.

In spite of the Vibralerts' limited performance, the majority of families liked it. Ninety percent of hearing parents, 75 percent of deaf parents, and 89 percent of the deaf children so stated. What is more, a third of each parent group expressed a willingness to purchase the system, if it sold for as much as a week's salary (approximately $100 to $200). Fifteen percent would spend two weeks' salary for the system; none would give a month's salary.

An instrument that combined the modifications suggested---smaller, lighter, waterproof, more powerful, more reliable---would probably meet wide acceptance from deaf and deaf-blind groups. Hearing parents seemed more accepting of the signaling system than deaf parents, principally because of negative attitudes toward dependence on an electro-mechanical device. The modifications suggested should overcome the relatively small resistance shown by some deaf parents and children.

Less crucial would be changes directed toward increasing communication. By eliminating the 30-second time-out feature, the Vibralert could be used to send a code---morse or a simple, ad hoc series of pulses. Thus, a child could easily learn that one pulse means "dinnertime," two pulses mean "you have a visitor," etc. Two-way communication with the Vibralert system is also possible, if the parties at each end had both a transmitter and a receiver. Obviously, in its present form, the equipment does not lend itself to such use. The suggested changes, however, would make this service feasible.

Aside from the assessment of on-the-shelf equipment, this project has tested the concept of electronic signaling. The results vigorously support the idea, despite inadequacies in the equipment. In view of the potential uncovered by the studies reported herein, encouragement should be given manufacturers to complete the developmental steps needed to make a system that meets the recommendations put forth by engineers, parents, and children.