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MASTER OF FINE ARTS

COMMUNICATION DEVICES FOR
THE HEARING IMPAIRED

by

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Have you ever walked alone in a dark street? Have you ever been unable to hear clearly because you have a cold and temporarily lost your hearing? If you have had these experiences, you can imagine how lonely and afraid hearing-impaired people can be. Their loneliness is due to the fact that they couldn't communicate very well with hearing people. Their fear is due to the fact that they can not receive any warning signals, such as sirens from ambulances or fire trucks. They worry that someone or something will suddenly come out behind them and hurt them.

I think that everyone has had similar experiences during their lifetime. Sometimes these experiences are just like a nightmare and influence your whole life. When I was little, I had a very close friend who lived next door. We always went to school together, played together, and even fought together. He always helped me because he was stronger than I. When someone insulted me, he always stood by my side. But one day, he got a high fever and then he lost his hearing. He couldn't go to school with me because he was totally deaf. In my memory, he was always laughing and got along with all of his friends, but now he had lost his smiling face and left us. He became angry and upset very easily. Finally he went to a school for the deaf and my family moved out of that town, so we lost contact. But one day when I was walking in the street, I noticed that someone was watching me strangely and waved his only arm to me. I got a shock when I found this man was my old neighbor and best friend. On a piece of paper, he wrote down that he at first really wanted to avoid meeting me because in his heart he was disturbed and thought I would look down on him, but finally he decided to see me and told me his sad story.

He had lost his arm in an old factory when an accidental fire caused strong acid to come out of a machine's pipe and burn his left arm badly. When he picked up the phone and shouted for help, he didn't know that the phone had a busy signal, so no one knew what had happened to him. Finally when he reached the hospital, the doctors found that his arm was burned so seriously, it had to be amputated immediately. When I heard this story, I could not help shaking. He said

at that moment he thought of killing himself, but he could not leave his parents alone. Now he had become healthy and had started a small business to sell clothes and toys. He knew his life was terrible, but he said he would keep going and fight back.

Motivated by this unforgettable experience, I decided to design a system of products that could assist hearing impaired people in their daily lives. The initial idea for this thesis project was to provide three allied products. The first one was a warning device that could respond to emergency signals. The second one was a telecommunications device that could assist the hearing impaired to communicate with hearing people. The third one was a translating device that would provide a readout of the spoken words.

II. Project Research

Designers often make mistakes when designing products for the handicapped by considering only their physical impairments. While attempting to solve the problems related to the physical handicaps, designers often overlook other considerations, such as the disabled individual's psychological condition.

In relation to this, I have found published information that will provide appropriate design direction and criteria and favorably influence my design of products.

First at all, I would like to use published information to understand the definition of the hearing impairment, how many people in the U.S. have hearing trouble, what is the cause, and what is the psychological consequence for the hearing-impaired. Then, I would like to find out the products that have been sold and designed for the hearing-impaired.

Therefore, the first step for me was to find out and to understand what it means to be hearing-impaired. We all know that we make contact with our environment through five senses. Any sensory impairment affects one of the important ways in which we can receive information from the external environment. Then, the hearing impairment can be defined as "any loss of hearing varying from slight to profound, affecting, according to its time of onset and severity, the ability of an individual to make normal contact with his or her environment."[1] The second step for me was to find out how many people in the U.S. have hearing trouble and what is the cause. The term 'hearing-impaired' covers a wide spectrum of people, including the deaf and deafened, the partially hearing and the hard of hearing. According to a 1991 survey by the National Center for Health Statistics(NCHS), about 20 million Americans have trouble with their hearing. Much of the rapid increase in hearing prob-

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[1]Lysons, Kenneth, Hearing Impairment , p. 2. Cambridge, Woodhead-Faulkner, 1984

lems are due to the aging of the U.S. population, so the increase should continue as the population continues to age. In addition, many experts also blame environmental noise, which is present today at much higher levels than in past years. Years of exposure to loud noise from machinery, power tools, music, appliances, and even hair dryers can damage a person's hearing permanently.

The next step for me was to find out what the psychological consequence for the hearing-impaired were. There is an immense amount of literature relating to the psychological consequences of hearing impairment. In evaluating statements relating to the psychology of hearing loss, four facts must be remembered.

1. While generalizations regarding the effects of hearing loss can be made, every hearing-impaired person must be regarded as an individual and not a stereotype.
2. The type of test administered, as well as the knowledge of hearing impairment and ability of the investigator to communicate with the deaf, should be considered when evaluating the results of intelligence and personality studies relating to hearing-impaired persons, particularly the pre-lingually deaf.
3. The response to hearing loss of any individual will be influenced by many variables relating to the impairment, especially the age of onset and its severity, together with personal, educational and social factors.
4. There are profound differences in the responses of the pre-lingually deaf, the traumatically deafened and the hard of hearing.[2]

Because the hearing impairment is hidden in the beginning and may go through the stages of slight, moderate and severe, both hard of hearing children and adults may have to deal with misunderstanding

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[2]Lysons, Kenneth, Ibid., p. 48.

from their families, teachers, or co-workers. Children may be accused of slowness or lack of concentration, adults of being unfriendly or withdrawn. While the intelligence of the child will be unaffected, educational progress may be slowed down.

Psychological reactions to progressive hearing impairment include anxiety, anger, apathy, dependency, exaggeration of symptoms, frustration, self-centeredness and submissiveness. The hearing-impaired person may resort to such defense mechanisms as denial of the impairment, withdrawal from society, over-compensation and self-reflection.[3] An individual's basic personality will strongly influence these reactions. In the case of seniors, a common reaction is denial of the problem. Many older individuals believe that using assistive technology might highlight their problem, or they may not wish to recognize that they are getting older. As a result, it is important to answer this question: why would someone with a hearing loss choose not to use a simple device that might correct the problem?

Hearing aids come in a variety of types and sizes (Fig. 1). The following products have been sold and designed for the hearing-impaired:

1. The body hearing aid may be necessary for a person with severe hearing loss.
2. The behind-the ear model is still worn by many people, even some with severe hearing loss.
3. The in-the-ear (ITE) aid is presently the most popular style worn, and can help a person who has a moderately severe hearing loss.
4. The canal model is the smallest hearing aid now available. It can help people who have relatively mild degrees of hearing impairment.
5. The eyeglass hearing aid, no longer a popular style, is

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[3]Lysons, Kenneth, Ibid., p. 52.

still available.[4]

There are more than 1,200 types of hearing aids on the market today. Advances in technology are bringing constant improvement.

The following products are Assistive Listening Devices, and are recommended for specific listening tasks when the use of the hearing aid alone is not enough. They can be used in addition to, or in place of, a hearing aid. Examples of these devices include:

1. amplified telephone receivers (Fig. 2)
2. light-activated doorbells and smoke alarms
3. vibrating alarm clocks
4. miniature amplified communicators for face-to-face con-versation (Fig. 3)
5. special telephone ringers
6. infrared amplifiers for use with TV sound
7. FM amplifiers for the most severe hearing losses [5]

The type and number of aids or assistive listening devices will depend on the amount of hearing loss and the needs of each person. What is good for one individual may not necessarily help another.

Hearing loss can have a profound impact on a person's attitudes and consumer behavior. The rapid growth in hearing problems makes it important for industrial designers to be sensitive to the wants and needs of this hearing-impaired group. The challenge of serving hearing-impaired customers is to make products accessible without making customers feel "hearing-impaired."

Many of these products look uncomfortable to wear or use, and many consumers fear the stigma of disability that may come with the use of such products.

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[4] The Lighthouse Inc., <u>Sound & Sight, Your Second Fifty Years</u>, p. 10.
[5] The Lighthouse Inc., Ibid., p. 10.

Interviewing Users

The first section provided some valuable information from published sources, but I have found these kinds of data too limited to cover the full range of problems that people with hearing impairments have to deal with. Therefore, I decided to use the interview method to collect more information. My hope was that this would round-out my research. At the same time, this method allowed me to communicate face-to-face with the hearing-impaired, and to let them know that I would do my best to design a series of thoughtful products that could assist them in their daily lives.

The form of interview I decided to use was the standardized schedule interview, in which the questions are prepared in advance and are asked of all respondents in exactly the same way. [6]

The following are the schedule interview questions that I used in my interviews:

1. Do you use hearing aids?
2. Have you ever been bothered by hearing aids? Why?
3. Do you have a TDD (Telecommunications Device for the Deaf)?
4. Do you have any trouble using TDD? Why?
5. Do you have a closed-captioned television?
6. How did you feel about closed-captioned television?
7. Do you have any trouble receiving emergency signals such as fire alarm, fire engine horn, or ambulance siren?
8. Would you like to share with me the most frustrating thing in your life that has been caused by being hearing-impaired.

I interviewed 30 people (12 females and 18 males) who were hearing-impaired college students from 18 to 25 years of age.

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[6]Richardson, Stephen A., Barbara Snell Dohrenwend, and David Klein, Interviewing, Its Form And Function, p. 35. New York, Basic Books, 1965.

In answer to the first question, 12 people used hearing aids, and 18 people didn't.

In answer to the second question, nearly all respondents had been bothered by hearing aids for a long time. Some of them believed that using hearing aids only drew attention to their problem without working very well. In the summer time especially, it was a painful experience to wear hearing aids because it caused excessive sweating in the ear. Hearing aids can sometimes heat up so much that they even burned the ear.

In answer to the third question, many people did have a TDD in their home, but when they left the house it became very difficult for them to locate a TDD to use.

In response to the fourth question, most did not have any problems operating the TDD. One person, however, mentioned that the key pad was quite easy to break and not very comfortable to type on.

In response to the fifth question, all had the closed-captioned TV, since according to law all TVs must be able to support closed-captions.

From the sixth question, all respondents enjoyed the closed-captioned function on TV and they hoped one day to have it at the movie theater.

In answer to the seventh question, all mentioned the fire alarm as a problem. They felt it was impossible for them to receive the fire alarm when they were asleep.

From the responses to question 8, I could better understand the suffering and concerns that many with hearing impairments experienced.

One respondent had a bad experience when her flight home for Christmas was delayed, and the airport's text telephone (TDD) was broken. "I asked the stewardess to call my parents for me. She refused

because it would cost too much money." At the airport, other airline staff also refused to help. The respondent ended up staying the night in a hotel that didn't have a vibration or light alarm to wake her, so she missed a connecting flight the next morning. "I am fed up with places that don't have any equipment," she said.

"I wouldn't change my deafness at all," said another respondent, but he would like to see "more consideration for those of us who rely on visual communication instead of voice communication." Like many customers, he chooses his favorite restaurants as much for the service as the food. "Last month, I went to a restaurant that used beepers to call the people who were sitting and waiting. The beepers vibrated when our table was ready. That was wonderful! I wish there were a lot more restaurants that used that system." Although he didn't describe a frustration experience, he did observe a helpful innovation.

"It gets very frustrating. There seems to be a stigma attached to hearing aids, and getting used to one can be difficult," said a third respondent. Cost is also a factor, she said. "Hearing aids can cost up to $800 each, and most insurance plans don't cover them. People aren't sure they are worth it. Often they don't realize what a difference they could make."

The same respondent also had a bad experience with hearing aids. "Sometimes hearing aids really aren't worth it. I once had an old model hearing aid which was equipped with only one kind of adjustment - volume control so if you can't hear a companion's voice in a restaurant and decide to turn up the volume, the result will be louder noise from knives and forks, music, and neighboring tables. Ringing, buzzing, and feedback are common problems."

These responses provided a great deal of insight. If the first respondent could carry her own TDD, she could simply plug into the pay phone when she needed to call. But, this kind of TDD must be very light to carry and easy to store. In addition, she might wear some kind of device that could help her to receive the emergency signals from a fire

alarm and also double as an alarm clock. Had she owned such a device, she would have made it home in time for Christmas.

The second respondent mentioned the beeper that told him when his table was ready. By extending this concept, one could design a device to give him even more information from a phone ring, door bell, or a pager.

The third respondent's experience suggested a device that could help her to direct conversation to someone with greater precision, eliminating or reducing distracting sounds.

I had a wonderful experience interviewing these people. They provided me with much valuable information.

Questionnaire

The previous section, interviewing users, provided some valuable information from the hearing-impaired, but did not provide information in a quantified or systematic manner. Therefore, I could not identify data indicating specific problems. For example, females were much more likely than males to criticize the hearing aides. This may have been just a coincidence, or there may have been a key reason behind it, perhaps having something to do with comfort level or how women were concerned about their appearance. However, I didn't have solid evidence to prove such a connection between sex and preference.

I decided to use questionnaires to determine information more precisely and, hopefully, provide specific data leading to further understanding. Interview respondents can provide solid general information, but a questionnaire would allow me to be more precise.

For the next step, I designed a questionnaire. According to Anderson and Berdie, "A good starting point is to decide upon goals for your study. If you not sure where you are going, you are liable to end up someplace else."[7]

I thought carefully about the kind of information I wished to gather. Knowing who should be asked to complete the survey form was the first factor to determine. What was their occupation, sex, and age? This information would give me some basic data about the respondents. The second thing to learn was the personal experiences of the respondents, such as whether they used hearing aides, practiced sign language, etc. Third, I wanted to understand their attitudes about this project. For example, would the respondent want to own such a device? Fourth, I wanted to know their preferences as to types of warning or

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[7]Berdie, Douglas R. and John F. Anderson, <u>Questionnaires: Design and Use</u>, p. 14. Metucher, N.J., Scarecrow Press, 1974

emergency signals, such as vibration or flashing lights. Fifth, I wanted to obtain comments or suggestions about this project. I used these five groups of information when I created the questionnaire (Appendix 1).

F i n d i n g s

I sent 300 questionnaires to the Rochester School for the Deaf and the National Technical Institute for the Deaf. Of the 63 responses I received, 54 were students and 9 were faculty members. By gender, the breakdown was 31 female and 32 male. Most respondents were fairly young (10-20 years old). Based on this feedback (Appendix 1), I expected to design a product that would work not only for the younger generation, but also for those who were older.

I discovered that nearly half of all female respondents did not express a desire to own this device (Fig. 5). Based on interviews, I believe they were most likely worried about drawing attention to themselves by wearing it. This was evidence that I needed to take psychological conditions into stronger consideration. Male respondents seemed to be much more willing to wear this kind of product. More female respondents than male respondents criticized the shape of the hearing aids. An explanation might be that the females were more prone to care about their appearance than males.

I found out that most of the respondents with hearing impairments used hearing aids, practiced sign language, and practiced lip-reading (Fig. 6 to 8). I concluded that most of them were doing their best to adjust to, and even overcome their disability. I did find intriguing the fact that male respondents were far less interested in learning to lip-read.

I found that the respondents generally preferred captioning to having an interpreter (Fig. 9). This seemed to express their desire to become independent. They do not want to depend on an interpreter and thereby highlight their disability. This finding strongly encouraged me to design a product that could support the captioning system. This would allow the user to receive information easily without having constantly to sit in the front.

Concerning how respondents would like to carry this device (Fig. 10), most preferred to carry such a device on the wrist, though the waist and pocket were also popular. This finding once again reminded me to focus on psychological considerations. People want to be able to wear this device in a convenient and inconspicuous manner, like wearing a watch on their wrist, a pager on their waist, or a key-ring in their pocket. Respondents emphatically did not want to carry any device that might emphasize their disability in public, no matter how excellent it functioned, or how it was shaped.

I found that most of the respondents did not want to pay more than $200 dollars to own such a device (Fig. 11). Perhaps this was because most respondents were students, unable to afford too much money to purchase this product. But, I was encouraged that one respondent was willing to pay more than $400 dollars.

I learned that respondents tended to prefer vibration warning signals over flashing lights, though a significant share wanted both (Fig. 12). I believe this is more evidence that the hearing impaired care deeply about maintaining their privacy. They wanted this device to be covered by clothes or even hidden in some way that would allow them to sense a signal by vibration.

From question 12 (Fig. 13), I discovered that the use of this device to identify telephone rings was the most popular feature, followed closely by identifying fire alarms. This showed me two things that I needed to consider. First, that people with hearing disabilities like using the telephone to communicate just as everyone else. One respondent even mentioned that using TDD or TTY was the most convenient way to communicate with hearing people since most hearing people do not know how to sign. Secondly, most of the hearing-impaired do not feel very secure when sleeping alone, since they cannot notice the traditional audible, fire alarm.

From question 13, I received four comments.

1. "I would like to use this device in any place that I want to, such as in the dorm, in the classes, in the office or even during a trip."

2. "I would like to see this device combine all the warning signals together, such as a telephone ring, fire alarm, and alarm clock."

3. "The communication device should be general. The main communication device I would love to use would combine features of the phone with TDD or TTY."

4. "I am not sure I understand this product's functions. Can you draw a picture to show me what kind of device that we are talking about?"

Question 14 was a chance for the respondents' comments.

1. "It would be nice for this device to be really small so it would be portable. Also it could be attached to something we wear, such as a watch, necklace, or glasses."

2. "I hope you can create a visual communication device in the future, for example, to see face to face on a TV screen and use sign language to each other, instead of using a telephone."

3. "Small is better and easier to handle, and why not add it to a ring or bracelet?"

From the entire response of this section, I received much additional information.

Some respondents to my questionnaire were unsure about the kind of device I was trying to design for them. Therefore, I decided to design six models and use them in a focus group test. One important feature of a focus group is that it provides large amounts of data in a respondent's own words. Important connections and a deeper level of meaning also result from this face to face contact. A contemporary 8 to 12 member group is directed by a moderator that encourages conversation and keeps the discussion on the chosen topic. The best focus groups are small enough to permit a genuine discussion among its members.[8]

The various models I devised can be worn on the wrist, waist, or in a pocket. One model (Fig. 14), was worn as a watch, with microphones on the top and bottom designed as red triangles - to pick up emergency signals. The watch also had yellow rectangles on the top and bottom representing flashing lights to indicate emergency signals. Two black circles located on the back of this device represented a vibration warning device. Users switched freely between flashing lights and vibration warning signals.

The second model (Fig. 15), was a pager-shaped device, to be carried on the waist. A red oval on the right represented a microphone for picking up certain types of sound frequencies that constitute emergencies. A yellow triangle represented a flashing light to signal such events. A brown square represented a liquid crystal display to let wearers know when someone is trying to contact them by phone or TTY. Two black circles on the back represented a vibration warning device. Again, users could use flashing lights or the vibration warning signal as they wish.

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[8]Stewart David W. & Shamdasani Prem N. , FOCUS GROUP Theory and Practice, p. 10. Newbury Park, Calif. : Sage Publications, 1990.

Another model (Fig. 16), was a key ring-shaped device to be carried in someone's pocket. Because its position would be close to the body, a user should have no problems sensing vibration warning signals. A red oval represented a microphone for emergency signals and a blue square simulated a car door remote control. A yellow square represented a warning flashing light for emergency signals. Two black circles in the back represented the vibrator. As with the previous device, the user could use either flashing lights or vibration warning signals.

Another model (Fig. 17) was pen-shaped. Like the key ring-shaped device, it could be carried in a pocket, close to the body, allowing the user to feel vibration warning signals. This device would also employ flashing lights when not in contact with the body. The microphone, indicated by a red button, would be at the top. A yellow triangle represented a flashing light, and the black circle at the bottom represented a vibrator.

The fifth model (Fig. 19) was shaped like a notebook, and would be placed in a pocket, a book bag, or a purse. It had red buttons on the both ends, serving as microphones to receive verbal speech and translate it into captions. It would be unable, however, to pick up emergency signals. If a user wanted to pick up warning signals, this device should be combined with another, such as models one to four. When this "notebook" opened, the user easily recognized the brown square as a liquid crystal display and a black square as a keyboard.

The last model (Fig. 20 to 21) was also notebook-shaped and would be put into a coat pocket, book bag, or purse. Two red buttons represented microphones for picking up verbal speech and emergency signals. The yellow triangle on top, represented a warning flashing light to indicate emergency signals. The vibration feature would be installed inside the body at the bottom. In this device, the vibration or flashing light method could be used separately or at the same time. When this device was open, the user could see the easily recognizable liquid crystal display and keyboard. At either end, units would detach to allow for telephone hookup. The keyboard, too, could be detached, and the user could send typed signals via radio waves.

Focus group testing clarified design problems and gave potential users an opportunity to handle the products. It allowed the hearing-impaired to study the models and respond to the questions about them. As I mentioned before, an important feature of focus groups is their ability to provide large amounts of data in a respondent's own words. A modern focus group consists of 8 to 12 members and a moderator that encourages conversation and keeps the discussion on a chosen topic.

Additionally, I wanted to supplement the information derived from the questionnaire and findings. With 8 members from each category, including male and female teenagers, college students, and older adults, I was able to test a range of concepts.

Each focus group session included an introduction, warm-up, questions, and close.

INTRODUCTION

1. The moderator introduced himself to the group.

   a. The moderator indicated the session's goals, explaining that this meeting would be of great help the graduate student who was in the process of designing a new product for the hearing impaired. He also explained that his role was to guide and interpret the process, ensuring that everyone in the room had the opportunity to share his or her point of view about the topics being discussed.

   b. The moderator indicated that the session would probably take an hour to complete, but depended on the interest level generated in the discussion.

2. The moderator provided a broad statement of the objective of the group: to review an idea that might help hearing impaired people with emergency warnings as well as general communication.
3. The moderator indicated the video camera in the corner was to record the session.

4. The moderator mentioned that refreshments were available for the participants.

5. The moderator gave the participants some sense of the rules for group.

   a. Only one person should talk at a time.

   b. The participants should not have side conversations during the session.

WARM-UP

The object of the warm-up phase of the focus group was to help the participants feel comfortable with the group process so that they would participate actively.

   a. The moderator had people introduce themselves, primarily to get the participants communicating and to give the moderator and designer some basic information about the participants.

   b. The moderator made sure that everyone had a name tag positioned to face the moderator.

   c. The moderator introduced the study models and general topics of discussion using the designer's notes, pictures, and function descriptions of the study models. The participants also received notes and hand-outs (Appendix 2), and the moderator asked them to fill out the personal information in the appropriate section. This helped familiarize the participants with the study mod-

els and also assisted them in asking more specific questions later.[9]

QUESTIONS

1. Have you ever used a warning device before? If so, what kind?

2. Which of the six different products on the table is most convenient for you?

3. Why you think the shape of the product you chose is appropriate and comfortable?

4. Would you like to own it? How much would you be willing to pay for it?

5. Do you like combined functions such as warning and paging?

6. What other ideas do you have?

CLOSE

The subjects were invited to view the result of the project at my thesis exhibition.

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[9]Greenbaum Thomas L. , The Practical Handbook And Guide To Focus Group Research, p. 88. Lexington, Mass. : Lexington Books, 1988.

Findings

First Group Session (teenager group):

Product No. 1 (Watch-shaped device):

1. The participants wanted this product to have an alarm and be water proof.

2. Some suggested that this device not only display time, but also more clearly indicate various types of emergency situations by captioning, so they can know specifically what kind of emergency is transpiring.

Product No. 2 (Pager-shaped):

1. Some suggested that the vibration or flashing light might too easily be interpreted by others as excessive, or might alarm others unduly.

2. Others wanted this device not only to indicate when someone was calling them, but to specify the various types of emergencies in progress.

Product No. 3 (Key ring-shaped):

1. Lacking driving experience, they had no comments.

Product No. 4 (Pen-shaped):

1. They asked about what kind of power to supply this product, and suggested using AC, DC, or solar power.

2. One of participants worried the ink would leak and influence the warning function.

3. Another respondent noticed that if he wore a T-shirt, there would no place to clip this device.

Product No. 5 (Note book design):

1. Several suggested that this device not only translate spoken words into text, but that it also translate their typing into actual speech. This idea started when I showed them my electronic dictionary.

2. They wanted this device to have some kind of clip or holder for easy carrying.

3. Several communicated concerns about the price of such a product.

4. This idea was fairly popular, because the users might no longer need a pen and paper to communicate with hearing people.

5. Several asked about the type of power source that would support this product, and for how long?

Product No. 6 (Note book design):

1. Many participants worried that this product could get dirty easily, and hoped it would have a cover for protection.

2. Once again, they thought it would be a good idea to have some kind of clip or belt. They believed that they would want to carry this product around all day, since it has everything.

3. They suggested that this product be combined with the pager function, so that they wouldn't need to purchase another product to supplement it.

4. They worried that the keypad would be too small for typing.

Comments from Question No. 6:

1. There were concerns about the possible weight of products 5 and 6.

2. One suggested was that I design a device that combines with a bicycle helmet.

3. One person suggested that I combine this kind of warning device with a hearing aid.

4. One person suggested I combine it with clothing or jewelry, such as rings, necklaces, or even shoe laces.

5. Several noticed that on product 6, the phone might easily block the screen.

Second Group Session (Adult group):

Product No. 1 (Watch-shaped device):

1. They suggested I incorporate an alarm clock and have the product describe emergency situations.

Product No. 2 (Pager-shaped):

1. Others wanted the product to recognize and display different emergency situations.

Product No. 3 (Key ring-shaped):

1. Some focus groups members wanted the flashing light to be stronger, such as a strobe.

2. The participants worried that if this device were attached to a key in the ignition of a car, its location might be too low for a driver to notice the flashing light.

3. They wanted me to consider incorporating a self-defense function. One might push a button that would emit a flashing light or a loud sound.

Product No. 4 (Pen-shaped):

1. No comments.

Product No. 5 (Note book design):

1. They wanted me to think about using this product to connect to the radio to receive the weather forecast.

2. Others wanted me to think about using this product to translate TV and movies to captioned text.

Product No. 6 (Note book design):

1. They worried that the key pad would slide from the holding position too easily.

Open comments from Question No. 6:

1. They thought the warning device might connect to the bed.
2. Some members would like this device to improve the safety for hearing impaired working in a high risk environment.

3. Some expressed the interest in purchasing this kind of device for their children and, if possible, for it to include a self-defense system.

4. They wanted a control to switch between the vibration or flashing light.

5. Most agreed that the watch-shaped device was the best design.

6. One person suggested that he wouldn't want to wear this kind of device all day, and wanted it to be able to rest on a table or in his pocket.

7 Many hoped that this kind of warning device would connect to their house security.

8. They wanted me to make this device water proof, so that they could swim by themselves.

9. They thought perhaps the product could recognize that someone is knocking on their door.

Third Group Session (NTID Students):

Product No. 1 (Watch-shaped device):

1. Some suggested designing it in male and female styles.

Product No. 2 (Pager-shaped):

1. Many wanted the pager screen to not only display who is calling you, but also display the specific emergency situations.

2. Several thought this device might be dangerous for driving: a driver would need to pull it out to see what's going on.

Product No. 3 (Key ring-shaped):

1. General concern was expressed that the location might be too low for a driver to notice the flashing light. Perhaps it is possible to connect it to other flashing light devices.

Product No. 4 (Pen-shaped):

1. This will probably be easily lost.

Product No. 5 (Note book design):

1. They wanted this product to connect to the TV, or to be used in movie theaters

Product No. 6 (Note book design):

1. When an emergency situation occurs while you are on the telephone the light should flash, but the product should not vibrate, since you will be typing.

Open comments from Question No. 6:

1. Device number 5 or 6 might be connected to eyeglasses. These would pick up the sound and then display the captions on the glasses. This feature could be used for displaying captions from a movie without having them appear on the screen.

This chapter explains the product's safety, user-friendliness, and portability. It also describes the process of concept exploration, form exploration, the application of colors and graphics.

My research indicated a preference among deaf and hard-of-hearing individuals for three basic features in any product designed to assist their communication with the hearing world. First, a warning device that can signal users during emergency or urgent situations. Second, a communication feature that can assist them to communicate more effectively with hearing people, and can also support telecommunications functions. Third, a feature that can combine the functions of interpreter and note taker. I decided to include these three features in the design of the products.

Technological Applications

The following subsections introduce the various technologies to be used:

1. Voice and Frequency Recognition

Voice recognition is the conversion of spoken words into computer text. Speech is first digitized and then matched against a dictionary of coded wave forms. The matches are converted into text as if the words were typed on the keyboard. According to Raymond Kurzweil, a world renowned speech researcher, the great potential use to the handicapped for a voice recognition-based device would be in providing a visual readout of what people are saying. As a result, the hearing impaired would not only be better able to communicate with hearing people, but they would be able to receive greater amounts of information.

The technology that permits a device to receive and translate spoken words can also allow the reception of specific high frequencies, which can then be translated into the corresponding text. The implication was clear: the device would allow the user to detect various signals,

such as the warning of an emergency vehicle in the area, a fire alarm, or a ringing telephone. Both voice and emergency frequency recognition technology, then, would be fundamental to my project.

2. Speech Synthesis

"One of the most exciting applications of speech synthesis technology is to provide a voice prosthesis for the speech impaired."[1]

Speech synthesis occurs when typed text is translated to corresponding recorded words. Individuals whose speech is not sufficiently intelligible to allow effective communication with others are an obvious group that stands to gain by this technology. Several adequate text-to-speech software programs already exist today; these would be essential for the product.

3. Virtual Reality

Virtual reality is a type of human-computer interface. As computational power has increased, so has experimentation with interfaces that provide rich visual information. Looking forward, a major thrust may be discerned in the development of virtual and metaphoric realities that provide a more direct link between the user and the environment modeled by the computer system. Virtual realities will be created for those situations that provide some form of direct or indirect analog-digital-analog experience for users. Alternate, or virtual, reality would be created for those situations that would benefit the handicapped. This reality would contain a rich multi-sensory interaction, it could show data not ordinarily available to the handicapped senses.

As Sandra K. Helsel and Judith Paris Roth state: "Virtual reality suggests the possibility of see-through glasses and even contact

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[1]Newel, A. F., International Conference on Speech Input/Output: Technique and Applications. p. 3. London: The Institution, 1986.

lenses. With such small glasses, video cameras can see your face and provide a three-dimensional alter ego. In fact, the graphic reality and the real one can be merged so that teleparticipants can appear to be sitting on real chairs around you."[2]

The United States military already used this technology for several operational products including a flight simulator mask that allowed the pilot to receive and respond to different kinds of information. The military, of course, had no monopoly of uses for virtual reality. A new product, called "Virtual Vision Sport" glasses would allow the user to watch TV programs on a pair of eyeglasses: a compact TV tuner worn on the waist would send a virtual image to the glasses, which would then appear as a large TV screen focused 10 feet in front of the user. A person could watch TV and notice the real world around him; it could also serve as a camcorder feature that allows an individual to see the recording in progress, without peering through a tiny viewfinder.[3]

My product will adopt this technology: after translating spoken words it will project them as captions onto a Virtual Vision Glass, to be worn by the user.

The following devices introduce the technology applied.

Warning Device Technology

1. The product will use frequency recognition combined with a system of flashing lights or vibrations to alert the hearing impaired to a variety of situations that are otherwise easily unnoticed, such as an emergency vehicle in the area, a fire alarm, or a ringing telephone.

[2]Helsel, Sandra K and Roth, Judith Paris, Virtual Reality, Theory, Practice, and Promise, p. 24. Westport: Meckler, 1991.
[3]Jetcetera Magazine, p. 84.

Communication Device Technology

1. This device should combine the functions of a cellular phone and a portable TTY.

2. This device should assist the hearing impaired to communicate with hearing people more easily and directly.

Translation Device Technology

1. This device will combine the functions of interpreter and note taker.

2. The device will use voice recognition to translate spoken words from radio, television, movies, or people. It will then project these words onto a Virtual Vision Glass, thus acting as a personal interpreter.

Design Criteria

This section introduces the criteria used for all 3 devices.

1. They should be easy to operate.

2. They should allow the user to avoid stigma.

3. They should be durable.

4. They should be lightweight, to allow for easy and unobtrusive transport.

5. They should be easily maintained.

6. They should be made of recyclable material.

Concept Exploration

This section explains the three concepts I considered for the product format.

The first concept combined warning, communication, and translation functions within one unit. Similar in appearance to a lap-top or notebook computer, it offered portability and inconspicuousness. It also allowed me to overcome several key design problems I had been encountering. For example, its keypad was of an adequate size for typing, whereas the smaller products did not provide nearly as much typing space, making them somewhat uncomfortable in this respect. Moreover, the unit's 12 to 13 inches liquid crystal display meant that the user would have a clear view even when the device was connected to the phone set.

While this design had much to commend it, several problems remained. First was the danger of its being too complex for easy use. Moreover, because it contained several features, it might weigh too much. Perhaps even more serious, the product lacked a vibration warning function since, obviously, no one could wear this product next to his or her body.

The widespread use of notebook computers itself posed a problem for this concept: I could not really claim this to be a new product, at least from an industrial design standpoint. It posed no new form, but instead combined several functions into an already-existing form. I wanted to innovate, to design a new product form that could be used safely and easily.

The second concept used a modular system to overcome the disadvantages of weight, bulk, and complexity inherent in the first concept. Each module had its specific function, and could be added to the main unit, either by itself or with the other modules, as the user decided. A user could decide his or her specific need for a particular situation with-

out needing to carry the entire unit.

This feature definitely reduced the product's weight and volume. It also helped to clarify for the user just what the various product functions were. The warning device served solely as an alert during emergency situations; it did not mix with the communication or translation functions. If the user wished to communicate with someone, she or he would use the communication device. Besides being easy to store, this product showed much less likelihood for being lost, since each module easily connected to the other, thereby keeping the entire unit together.

This concept also had some disadvantages, however. The module system limited the possibilities of design, and made it less attractive when one or more of the modules were separated from the main unit. The continual joining and separation of the various modules also made it more prone to breakage. Finally, the process of attaching or detaching the various modules promised to be a confusing one for users.

The third concept separated the various functions into distinctive units. This allowed for excellent portability, ease of carrying, and permitted each device to be better suited to its proper position. For example, research analysis showed that the preferred position for the warning device was on the wrist; that the communication device be folded or rolled up for easy transport in a pocket, book bag or purse; and that the translation device be carried either on the waist using a clip, or placed in a pocket, bag or purse when not in use. Such an arrangement also reduced the likelihood that the user would draw attention to him/herself.

In addition, this concept allowed for a lower and more flexible selling price. Concepts one and two were designed for the user to purchase the unit in its entirety. Here, the user did not need to pay for three devices if only one or two were desired. One could buy a warning device only, or purchase the warning and communication devices together, where they could then function together. In such an instance, the warning device would not only respond to local emergency vehicles and fire alarms, but also to phone calls.

A possible drawback to this concept was the possibility that it

might attract attention and thereby emphasize the user's disability. The particular forms were out of the ordinary, and the possibility existed that it would cause the "labeling" problem for deaf and hard-of-hearing users.

I nevertheless chose this last design as the central concept for the project. Attaching the warning device to the wrist allowed the user to receive and respond to emergency situations or telephone calls easily and relatively conveniently, and also allowed for easy storage in one's pocket or bag when not in use. It retained a vibration function in addition to having flashing lights, so that the user could simply store the unit in his or her pocket for convenient carrying.

To conserve storage space when not in use, I decided that the unit would roll up rather than fold up. This also happened to allow for a more comfortable, full-size keyboard upon which to type, as well as a rollable, liquid crystal display for viewing. The user could therefore own a communication device combining TTY and cellular phone functions powerful enough to send and receive information from any location.

I designed the translation device to appear somewhat like a wallet, to be folded into a user's pocket or placed in a bag when not in use. When unfolded, the device contained two sections. One was a virtual vision glass for projecting captions, the other a compact disk for recording information.

Form Exploration

Arguments have existed regarding form and function throughout the history of industrial design. Does form follow function or the reverse? I believe that products should combine functional innovation with attractive appearance, and that the warning, communication and translation devices I am preparing should be as attractive as other consumer products on the market while still functioning effectively. An attractive design also helps to minimize the stigma of a user's handicap.

Many sketches were made mainly on the basis of these principles. No matter how many sketches that I had drawn, however, I was unable to arrive at the form that I felt was the right one. In particular, I wanted the devices to share a common, tasteful, design theme. In my many sketches, I explored forms from circles to squares and from free to relatively rigid. I tried to use architectural styles for inspiration. The Georgian Style, for example, is a symmetrical composition enriched with classical detail. Translating it into the design of my products, I arranged the microphones symmetrically, placing them on either end. Additionally, I designed various thin lines running through the products to represent the classical detail of enrichment in Georgian Style. I actually enjoyed translating the character and feel of architectural designs for my products. This not only allowed me to create an attractive form for my design devices, but also helped to give a better sense of the spirit of the specific products.

I still needed to determine which forms to work with. Therefore, I created a check-list with various criteria to help me evaluate each sketch:

Check List:

1. Does this form contain anything in it that might indicate the user's disability?

2. Is it warm and "friendly looking"?

3. Does this form convey simplicity and clarity?

4. Is it compatible with human factors?

5. Does this form provide optimal functional operation?

6. Does this form convey an overall sense of coherency?

From this check-list, I narrowed the possibilities to three groups. The first I called Streamline Moderne (see Fig. 22 to 26). This style was characterized by soft or rounded corners and smooth surfaces without extensive ornamentation.[4] The streamlined effect was emphasized by the use of a curved surface wrapping around the corners, which gave a warm and friendly look. It was also comfortable to hold in one's hand or carry in one's pocket.

I called the second group of sketches Late-Modern (see Fig. 27 to 31). The essence of this style was exaggeration, repetition and paradox.[5] This form made the devices quite attractive, and comparable in appearance to many other consumer products. While this style also contained the risk that it might highlight the user's disability, it remains true that many products for the handicapped are boring and tasteless in appearance.

The third group of sketches were the "Post-Modern" style (see Fig. 32 to 36). This style embraced a number of substyles or modes; its central principle was eclecticism, the choosing and using of features from other styles.[6] In this group of sketches, I combined the style from Miesian and Neo-Expressionism. From Miesian style, I carried the sense of regularity and symmetry to create a simplicity of form. From Neo-Expressionism, I chose the continuity of curve that conveys the sense of movement and dynamism to the form.

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[4]Blumenson, J. G. John, Identifying American Architecture, p. 79. New York: Norton, 1981
[5]Whiffen, Marcus, American Architecture since 1780, p. 285. Cambridge, Mass. · MIT Press, 1992.
[6]Whiffen, Marcus, Ibid., p. 293.

Since the warning device for the hearing impaired was designed for a person's wrist, I decided that a soft and flexible material was more suitable than a rigid one. In addition, I found that a liquid crystal display offered maximum flexibility for presenting a wide variety of images, and retained the advantage of almost instantaneous image recognition. Therefore, the final profile for the warning device was one which was quite similar in appearance to an electronic watch. Two liquid crystal displays on the device provided the graphic symbols to indicate emergency signals.

As I mentioned previously, I planned for the communication device to be able to be rolled and put into a pocket or bag when not in use. To find a proper diameter for carrying or holding, I referred to Woodson and Tillman's design handbook, and I found that a 2.5 inches diameter would work well between age 12 and adult.[7] The final profile for this device was similar to a scroll. The keyboard and LCD could be rolled up, and the whole unit could become a cylindrical form. The foldable translation device also had an optimal size of 2.5 inches in width, and 4 inches in height, a proper size for most people.

For the product exterior, I wanted a soft and flexible material that allowed for rolling or folding. I tested several in terms of strength, flexibility, and overall appearance. Neither nylon, cotton, leather, nor even wool, enhanced the form's character. Rubber, however, did. The combination of its flexibility, adaptability to low temperatures, waterproof nature, and durability made it the best choice.

For the main body, which would actually hold the electronic mechanism, I chose ABS (Acrylonitrile Butadiene Styrene). This material has been modified for strength and toughness greater than normal styrene.

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[7]Woodson, Wesley E. , Tillman Barry, Tillman Peggy, Human Factors Design Handbook, p. 570. New York: McGraw-Hill, 1987.

After the creation of three-dimensional models, the form of each device was carefully studied with reference to human factors. Experience has shown the three-dimensional form study to be very important, because it often reveals various design problems or benefits not easily shown in a sketch.

The right color should enhance the product's warm and friendly appearance without, of course, drawing excessive attention to itself and thereby highlighting a user's disability. This was somewhat of a challenge. Warm and friendly colors such as red can also be bright, splashy, and aggressive. They can draw attention to the user's disability.

I investigated the effect of various colors on people. According to Woodson, Tillman and Tillman's design handbook, black tends to give the sense of solidness, heaviness, comfort, and neutrality.[8] This is exactly the sense I wanted to convey for this product, in particular the feeling of comfort and of neutrality. Yet, while I was happy with the choice of black as the primary color for the product, I still wanted an accent color to avoid it appearing dull or vague. I decided to include small amounts of four accent colors: red, green, yellow and light gray to enliven the appearance. Each color also represented a specific function of the product. Red represented the microphone, yellow the warning light, green the communication device, while light gray highlighted the control bar and the interior of the translation device.

The colors I chose for the final products are:

1. Black - PANTONE Black 4 CV.

2. Red - PANTONE Red 032 CV.

3. Yellow - PANTONE Yellow 102 CV.

4. Green - PANTONE Green 354 CV.

5. Gray - PANTONE Cool Gray 1 CV.

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[8]Woodson, Wesley E. , Tillman Barry, Tillman Peggy, Ibid., p. 673.

Instead of using words to describe a situation, graphic images are sometimes more easily recognized and understood. For this reason, I decided to use graphic symbols, or icons to translate the various situations that a user might encounter. For example, a nearby fire engine would not only be indicated by a vibration or flashing light, but by an icon representing a fire engine.

Seven icons represent the various kinds of emergency situations (see Fig. 37). The fire engine icon has already been referred to. Additionally, there are icons representing an ambulance and police vehicle, a fire alarm, a ringing telephone, an alarm clock, and a door bell. Of course, each of these icons would be accompanied with vibration and flashing features.

I decided to apply the brand name of "MiniTok." MiniTok combined "Mini" (to emphasize portability) with "Tok" (for "Talk"). For the product labels and displays, I chose the Helvetica medium font for its simplicity, elegance and readability.

Safety Guard

The MiniTok System for the hearing impaired consists of three parts: the Safety Guard, the Communicator, and the Entertainer.

Safety Guard

Two flow charts (Fig. 38 and 39) provide an overview of how the Safety Guard functions and how each part fits within the overall scheme.

Fig.38 describes how the Safety Guard utilizes a highly sensitive microphone to pick up emergency signals. The Frequency Recognition feature then recognizes specific frequencies and displays them as specific icons on the LCD (Liquid Crystal Display) to notify the user. Each of these icons is accompanied by vibration and flashing light, if the user chooses to activate those features.

Fig.39 describes the expanded functions of the Safety Guard when used in conjunction with the Communicator. Essentially, the unit can function as a pager by displaying a telephone icon when an individual tries to contact the user. The user can then see the caller's telephone number by pushing the control bar on the Safety Guard, and can call back immediately or later by using the Communicator.

The Safety Guard Components:

The Microphone

The microphone on the Safety Guard is shaped like a round button, functioning primarily as a receiver. It was designed in order to eliminate or suppress unwanted background noise, making it easier to identify specific urgent frequencies such as ambulance or fire alarm.

The Warning Flash Bar

The Warning Flash Bar beside the microphone flashes intermittently when the Safety Guard receives an urgent frequency. It can be disabled if the user prefers to use the vibration warning signal. For safety concerns, either the flashing lights or vibration warning signal must function. If the user were to try to disable both, the Safety Guard system would reject the order. In the event that both warning signals are down, the system would automatically shut off all power.

The Warning Display

A warning display, which presents an icon for each urgent situation, is below the microphone and warning flash bar.

The Time Display

Below the warning display is a clock which gives the current time. It can serve as an alarm clock with its own icon, and can be used in conjunction with vibration or flashing lights.

The Control Bars

Flow Fig. 40, describes the functions of the control bar. There are two control bars below the time display: a Function Bar and a Setting Bar, which work together.

When the user presses the function bar, the first message, "Turn Off the Alarm?" is shown on the warning display. By pressing the function bar again, a second message "Are you sure?" is shown. Below the message is displayed "Yes or No" with "Yes" being highlighted. The user can then press the function bar to confirm that choice, or press the setting bar to switch the "Yes" status to "No," then press the function bar to confirm the choice.

The Safety Guard's best feature is its three-range warning. The first-range warning covers a radius of 100 feet, which gives a relatively slow, intermittent signal when an emergency vehicle activates it. When the vehicle reaches 50 feet, the warning signal speeds up. The user at this moment can decide whether or not to turn off the signal. The inner range of the Safety Guard is 20 feet, at which point the warning signal is at its most rapid. If the user wishes to choose other options, he or she can simply press the setting bar, allowing other functions to display.

Three flow charts (Fig. 41 to 43) provide an overview of how the Communicator functions and how each part fits within the overall scheme.

Fig. 41, describes the procedure by which a hearing person phones a hearing impaired individual who owns only the Communicator. When a hearing-impaired person receives a call from a hearing person, the Communicator activates the warning flashing lights to alert the user. The user activates the voice recognition feature of the Communicator, which translates spoken language to text, displayed on the Communicator's LCD. The user then uses the rollable keyboard to type a responding message, which the Communicator translates to artificial speech.

Fig. 42, describes the functions of the Safety Guard and Communicator when they are used together. In this case, the hearing person calls the paging center to deliver a short message, then leaves his or her phone number. The paging center sends the message to the user, who is alerted by the Safety Guard. The user reads the message and phone number on the warning display, and calls back by using the Communicator. The process is the same as the procedure depicted in Fig. 38.

Fig. 43 describes the process by which a hearing impaired person can speak directly with a hearing person without need of translation by an interpreter. The microphone picks up the hearing person's voice, which is then translated to text by the voice recognition feature, then displayed on the Communicator. A hearing-impaired person can then quickly type her or his response on the keyboard, which the Communicator then synthesizes into speech.

The Communicator Components:

The Microphones

The Communicator's microphones are located on both ends of the main unit (the cylinder part), shaped as two half-spheres. These microphones were designed to detect the human voice and eliminate or suppress unwanted background noise, in order to enhance the voice quality into the Communicator.

The Warning Flash Rings

The warning flash rings are attached to the bottom of the microphones, and are activated when the Communicator receives a phone call.

The Speaker

The speaker is below the warning flash rings and looks like a flat ring around the main unit (the cylinder part) with small holes in it. The function of the speaker is to speak for the hearing impaired when they need to communicate face to face with hearing people.

The Maintenance

A battery (AAA) is located in the shaft of the Communicator and is easily accessed by a twist-and-pull motion on the lower yellow flash ring. The electronics are also located here for easy maintenance, and the shaft itself can be easily replaced when necessary.

The LCD (Liquid Crystal Display)

The LCD is located above the keyboard, and combines seven, small LCD square screen into a single, large display. The feature allows 28 letters to be displayed on a single line, and can present 3 lines at once, giving the user a comfortable view of the message area. Pressing

the display function key allows the user to review past messages or conversations just ended. Therefore, the user need not lose or forget phone calls or conversations, as they are automatically recorded by the Communicator. The system automatically asks the user to delete a message when memory space is full. The user can review the displayed messages and decide which messages to delete and retain.

This system was designed to protect the speech rights of the hearing-impaired. By keeping a record of messages and conversations, it helps the user from being taken advantage of in oral communication with hearing individuals.

Seven small LCD units display the messages. I have confidence in the concept of a flexible screen, and believe that in the future it will be common to see rollable computers with comfortable 10" flexible screens with input determined by voice recognition or finger writing.

The Keyboard

The key configuration for this flexible keyboard follows the current one in use on the standard TTY keyboard. This arrangement gives the user a friendly and familiar feel. Most people dislike the experience of having to adapt to a new product that forces one to learn skills that are mundane. Therefore, on this flexible keyboard I added only four new function buttons. The first pair of buttons is located on the left side of the LCD: their function is to adjust the LCD's brightness. The other pair of buttons are located on the right side of the LCD: their function is to control the speaker volume.

Three flow charts (Fig. 44 to 46) describe the functions of the Entertainer.

Fig. 44 describes the process by which a hearing impaired student can attend a lecture or a seminar where spoken words are used. The user can take out the Entertainer and clip the Virtual Vision Glass to his or her eyeglass frame. If the user doesn't have an eyeglass frame, he or she can use the frame designed for the Virtual Vision Glass. The user can also leave the Virtual Vision Glass in the holding position without wearing it, and still see the projected captions. The microphone picks up the speaker's voice, which is then translated into text by the voice recognition feature, and projected onto the Virtual Vision Glass.

The Entertainer will also be able to record lecture information onto a compact disc. By playing back the information recorded to CD (compact disc), the user will be able to use the Virtual Vision Glass to review the lecture as many times as he or she wants. If the user prefers a large screen to review the lecture, the CD can simply be put into a computer's CD drive and the contents displayed on the computer monitor. The user could even use a software package to edit the notes.

Fig. 45 demonstrates another unique function of the Entertainer: it can become a traveling guide. When the user is driving into an unfamiliar area, he or she can insert a travel guide CD into the Entertainer, which would then project the map into the Virtual Vision Glass. This would obviate the need for constantly checking a map, and probably reduce the chance for an accident. Also, by pressing the Fast Forward or Rewind button, the user can obtain additional information available in travel guides, such as where to find a hotel, gas station, restaurant, etc.

Fig. 46 describes the Entertainer's most unique function, which is to translate voice from movies, TV, or radio into captions which are then

projected onto the Virtual Vision Glass. For example, if the user has a long driving trip, he or she can turn on the radio and read the weather report, traffic report, or even the daily news right from the Virtual Vision Glass. Also, the user could use the Entertainer to enjoy a movie, as it would provide captions on the Virtual Vision Glass. The user could then really enjoy a film on the big screen.

The Entertainer Components:

The Microphones

The microphones on the Entertainer are located on both ends of the cylinder part, and a AAA size battery is in the shaft of the cylinder. These microphones have been designed for the human voice while eliminating or suppressing unwanted background noise in order to enhance the voice quality from other mediums' broadcast.

The Projecting System

The Entertainer provides translation of spoken words, such as from radio, TV, movies, or live individuals, and uses the projecting system to show these words on the Virtual Vision Glass. There are two fan-shaped control buttons which can adjust the focus between the eyesight to the words and to get a clear view, since the eyesight of individuals differs widely. An eject button is located below the focus button, which releases the Virtual Vision Glass.

The Power Buttons

Two power buttons are located at the top right corner. There are two because when one system is down, the other can still continue to receive information for the hearing impaired. For example, if the user attends an important meeting he or she can take out the Entertainer and press both power buttons. However, if the user suddenly finds out that the recording system doesn't respond, and the meeting has already

begun, the Virtual Vision Glass could still transmit the information. The power button system, then is similar to a back-up function between a projecting and recording system. When one system was down, it does not affect the other system.

The Recording System

The Entertainer uses a CD which can hold up to approximately 1GB of memory. The buttons of the recording system are similar to that of contemporary tape recorders, in order to convey a sense of familiarity.

V. Conclusion

The sad story that I recounted in the Introduction led me to design the "MiniTok System" for the hearing-impaired.

The response of the hearing impaired to the products in my thesis has been positive. They agreed that providing the urgent frequency recognition in the Safety Guard would be a desirable way to alert users. They also believed that the Communicator's combination of TTY and cellular phone functions would be an appropriate way for hearing impaired people to communicate with the hearing, that the Entertainer's feature of projecting text to the virtual vision glass was excellent, and the ability to record the human voice into a compact disc would be another suitable way for the hearing-impaired to receive various kinds of information from different kinds of sources.

The regular and symmetrical form of the product was meant to convey a sense of simplicity, while the flexible rubber material wrapping around the products in this system was meant to provide a sense of warmth and friendliness. Since colors could have drawn excessive attention to the user's disability, black was chosen to convey a sense of comfort and neutrality. The colors red, green, yellow, and light gray were used to accent and enliven the overall appearance, however. Graphics included seven icons that represent the various kinds of emergency situations, and the logo of "MiniTok" conveyed the meaning of portability and communication.

I realize that a designer cannot arrive at a good design for the disabled without considering their psychological concerns as well as their physical ones. Accordingly, eliminating any unsuitable design that could indicate the user's disability was a major goal of this project. Furthermore, I have learned from this project that an awkward design can exacerbate the frustration and feeling of insufficiency which a handicap can cause in disabled people. Thus, a suitable size for carrying, a thoughtful function for operating, and a delightful form for appearance, all had to be closely examined through a series of research, sketch, and

modeling tests. Although I recognized the voice recognition and the roll-up keyboard and screen in this project might not necessarily be practical right now, the accelerating pace of developing technology will make the design of the MiniTok valid for the near future.

Appendix 1

Date: 09/12/94
From: Yu-Chun Hsu
Major: Industrial Design
To: Faculty & Students

Dear Faculty & Students:

I intend to develop a conceptual communication device as my thesis project. The device would improve communication between the hearing and individuals who are deaf, and would provide significant benefits for individuals who are deaf or hard of hearing. While its main function would be to translate verbal communication into a text, it would also include features that could aid users in emergency situations(i.e. warn drivers of an emergency vehicle in the area). Before I begin, I would like to have your input. Would you please answer this questionnaire:

1.
☐ Student.
☐ Faculty.

2. Sex.
☐ Female.
☐ Male.

3. Age.
☐ 10-20
☐ 20-30
☐ 30-40
☐ 40-50
☐ 50-60
☐ 60-80

4. Would you want to own such a communication device?

☐ Yes.
☐ No.

5. Do you use a hearing aid?

☐ Yes.
☐ No.

6. Do you use sign language?

☐ Yes.
☐ No.

7. Do you use lip-reading?

☐ Yes.
☐ No.

8. Which do you prefer? Captioning or an Interpreter?

☐ Captioning.
☐ Interpreter.

9. How would you like to carry this electronic communication device ?

☐ Around neck.
☐ On wrist.
☐ On waist.
☐ In pocket.
☐ In hand with handle or strap.
   Other. _____

10. How much would you be willing to pay for such a product?

   $_____

11. What kind of warning signal would you prefer to receive?

☐ Vibration.
☐ Flashing Light.
   Other. _____

12. What type of emergency situations should be included?
☐ Telephone.
☐ Fire alarm.
☐ Fire engine horn.
☐ Ambulance siren.
Other._____

13. What other uses might this device have that would be useful to you?

Please list them in this area.

14. If you have any other comments, please list them in this area.

* Please return this questionnaire to CIAS Support Dep.   Building 7A
Room 3441, c/o Jim Dron.
Thanks!

Appendix 2

Subject: Hand out for focus group.
Date: 12/7/94
Designer: Yu-Chun Hsu

A. Female ☐

   Male ☐

B. Age:

   10-20 ☐

   20-30 ☐

   30-40 ☐

   above 40 ☐

Answer 1.

☐

Answer 2.

No. 1 ☐

No. 2 ☐

No. 3 ☐

No. 4 ☐

No. 5 ☐

No. 6 ☐

Answer 3.

Why?

Answer 4.

Yes

No

How much?

Answer 5.

No. 1

No. 2

No. 3

No. 4

No. 5

No. 6

Answer 6.
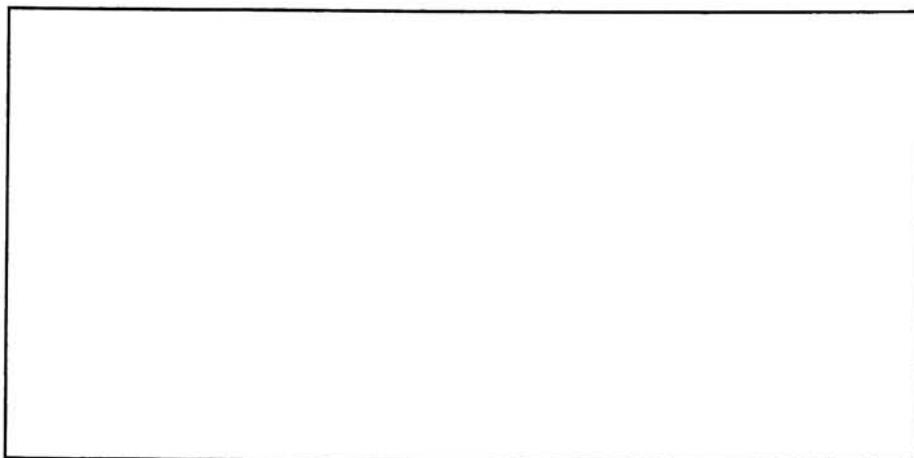
Fig. 1. Hearing aids
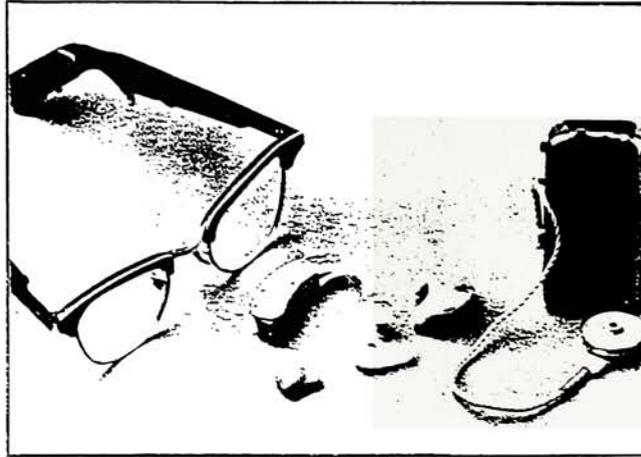
Fig. 2. Amplified telephone receivers
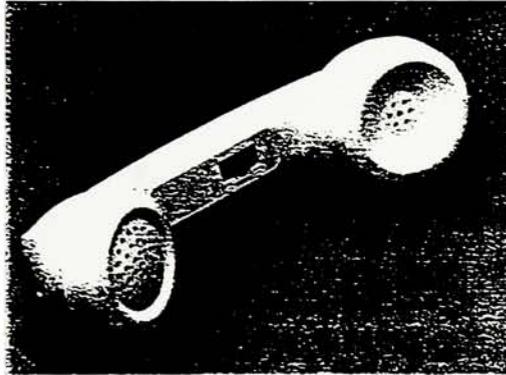
Fig. 3. Miniature amplified communicators

Fig. 4. Tabulation of Survey Results

Sample	Female	Male	Total
Student	26	28	54
Faculty	5	4	9

3. Age

	Female	Male	Total
10-20	14	15	29
20-30	9	10	19
30-40	3	3	6
40-50	3	1	4
50-60	2	3	5

4. Would you want to own such a communication device?

	Female	Male	Total
Yes	18	25	43
No	13	7	20

5. Do you use a hearing aid?

	Female	Male	Total
Yes	26	23	49
No	5	9	14

6. Do you use sign language?

	Female	Male	Total
Yes	24	29	53
No	7	3	10

7. Do you use lip-reading?

	Female	Male	Total
Yes	28	22	50
No	3	10	13

8. Which do you presently prefer?

	Female	Male	Total
Captioning	26	28	54
Interpreter	5	4	9

9. How would you like to carry this electronic communication device?

	Female	Male	Total
Around neck	0	3	3
On wrist	15	14	29
On waist	9	6	15
In pocket	7	8	15
In hand	0	1	1
Other	0	0	0

Sample	Female	Male	Total
10. How much would you be willing to pay for such a product?			
Free	0	0	0
5-100	16	12	28
100-200	7	10	17
200-300	6	6	12
300-400	2	3	5
400-500	0	1	1
11. What kind of warning signal would you prefer to receive?			
Vibration	18	16	34
Flashing Light	5	6	11
Both	8	10	18
12. What type of emergency situations should be included?			
Telephone	13	11	24
Fire alarm	10	12	22
Fire engine horn	5	4	9
Ambulance sirer	3	5	8
Other	0	0	0

Fig. 5. Percentage of respondents by gender who want to own the communication device

From Female Respondents.

Q 4. Would you want to own such a communication device?

41.9% Said **No**

Number of Respondents: 31

58.1% Said **Yes**

From Male Respondents.

Q 4. Would you want to own such a communication device?

21.9% Said **No**

Number of Respondents: 32

78.1% Said **Yes**
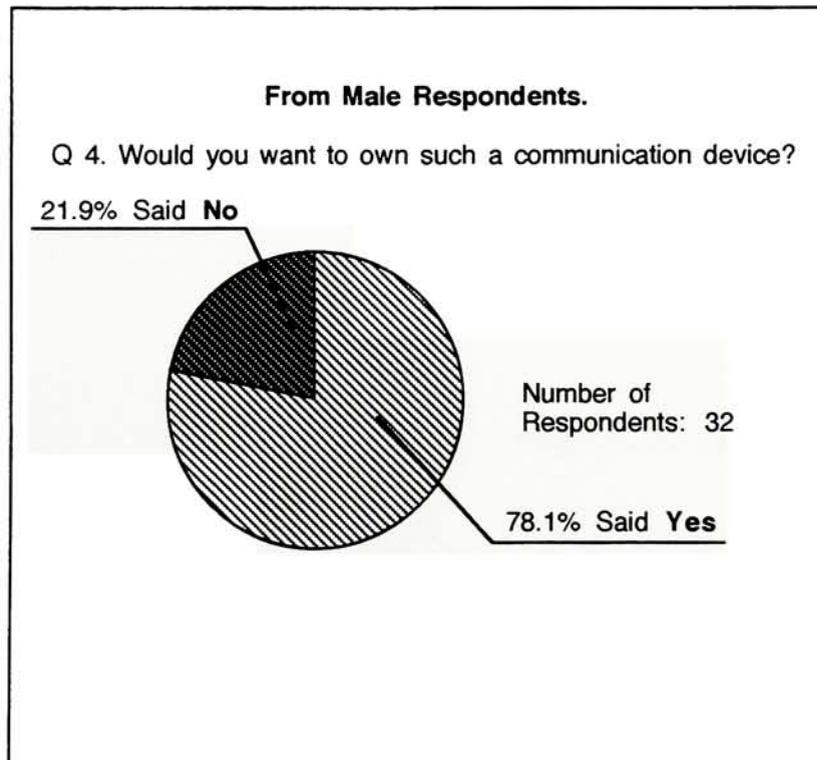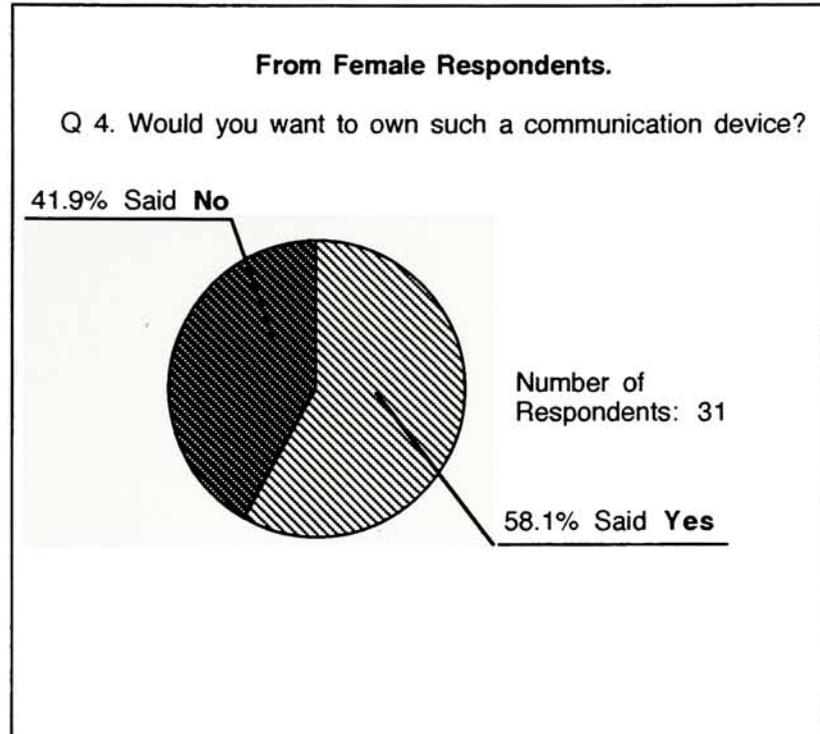
Fig. 6. Percentage of respondents by gender who use hearing aids

From Female Respondents.

Q 5. Do you use a hearing aid?

16.1% Said **No**

Number of
Respondents: 31

83.9% Said **Yes**

From Male Respondents.

Q 5. Do you use a hearing aid?

28.1% Said **No**

Number of
Respondents: 32

71.9% Said **Yes**

Fig. 7. Percentage of respondents by gender who use sign language

From Female Respondents.

Q 6. Do you use sign language?

3.2% Said **No**

Number of
Respondents: 31

96.8% Said **Yes**

From Male Respondents.

Q 6. Do you use sign language?

9.4% Said **No**

Number of
Respondents: 32

90.6% Said **Yes**
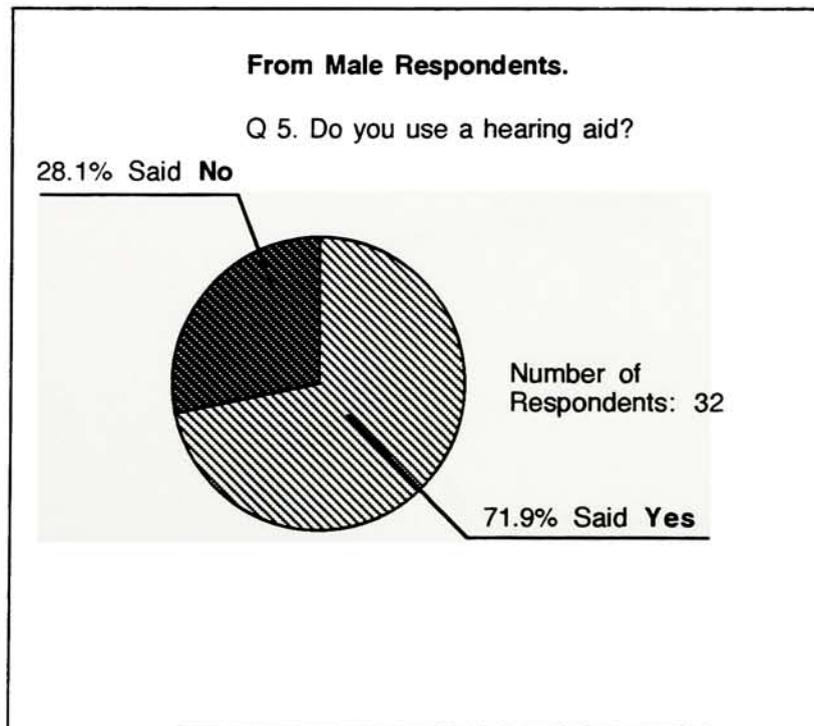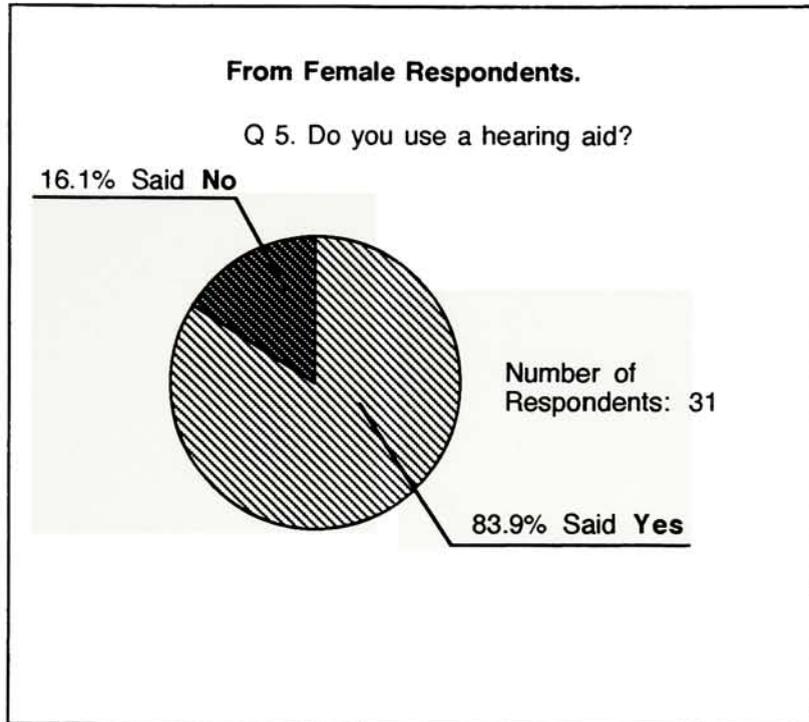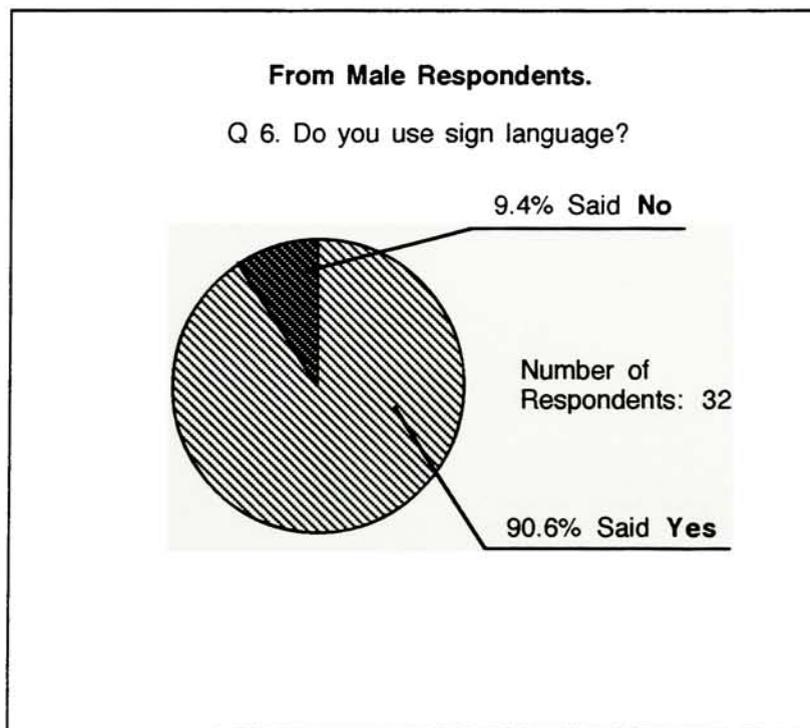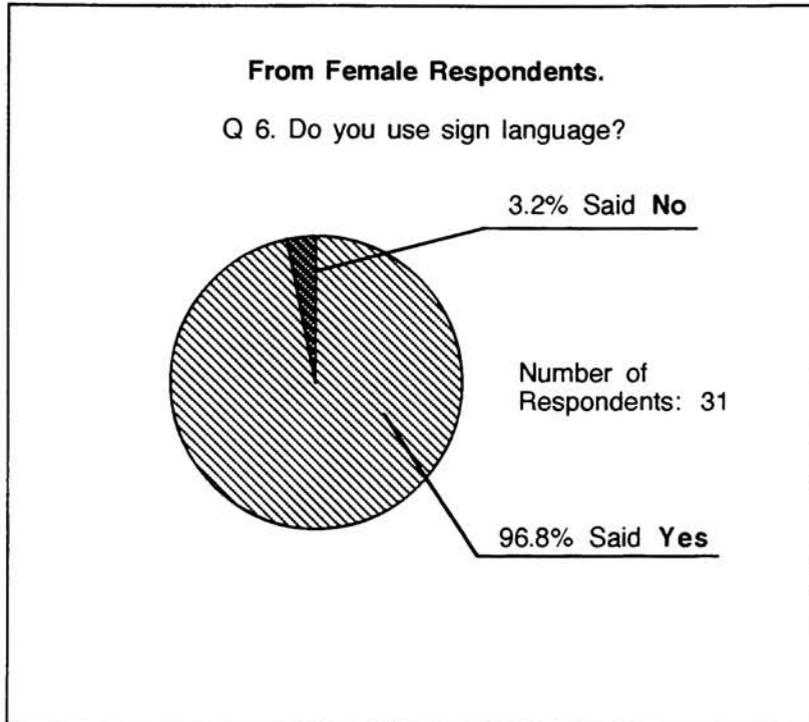
Fig. 8. Percentage of respondents by gender who lip-read

From Female Respondents.

Q 7. Do you use lip-reading?

9.7% Said **No**

Number of
Respondents: 31

90.3% Said **Yes**

From Male Respondents.

Q 7. Do you use lip-reading?

31.2% Said **No**

Number of
Respondents: 32

68.8% Said **Yes**

64
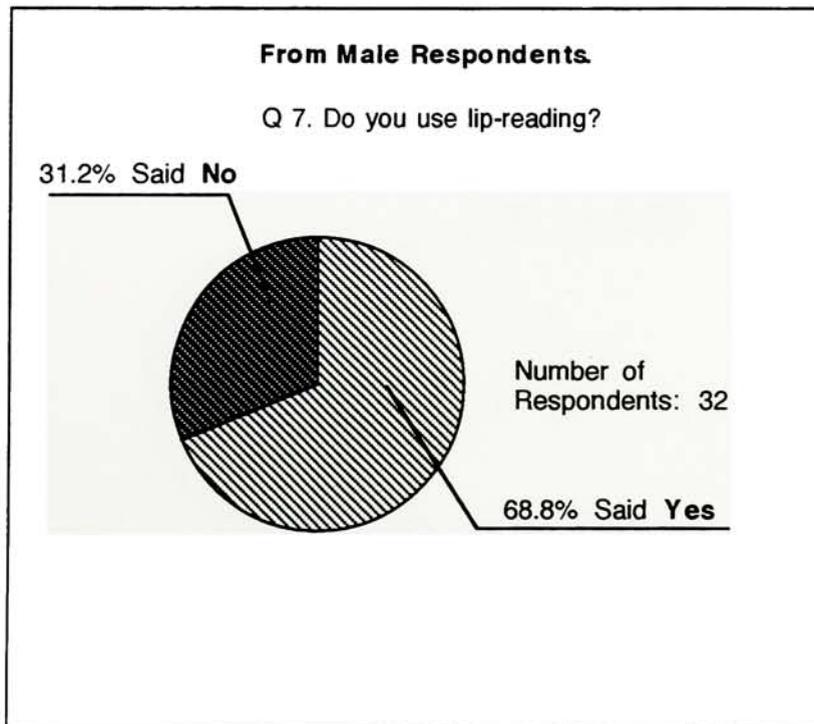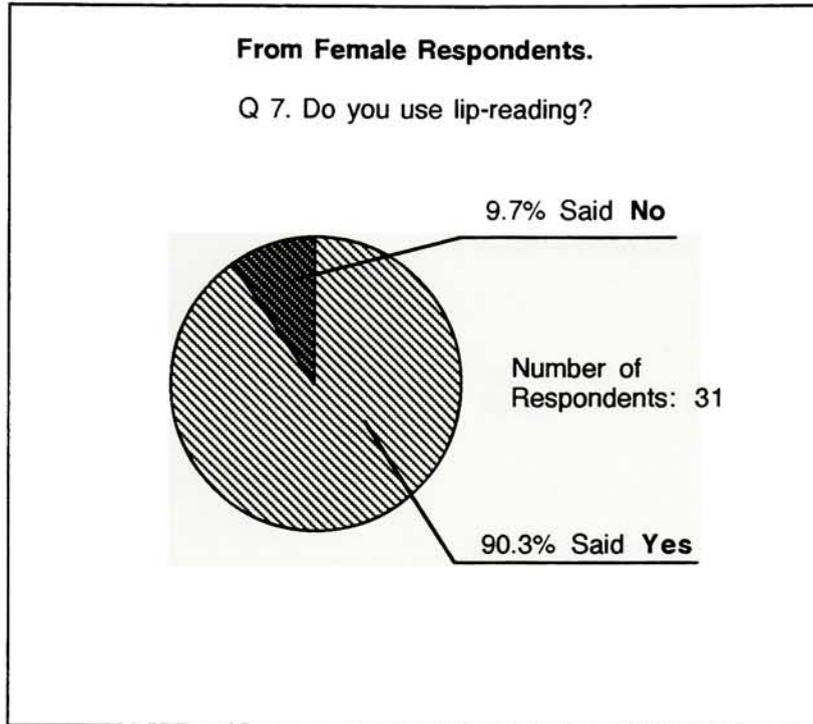
# Fig. 9. Percentage of respondents by gender who prefer interpreter or captioning

From Female Respondents.

Q 8. Which interpreter or captioning do you presently prefer?

16.1% **Interpreter**

Number of
Respondents: 31

83.9% **Captioning**

From Male Respondents.

Q 8. Which interpreter or captioning do you presently prefer?

12.5% **Interpreter**

Number of
Respondents: 32

87.5% **Captioning**
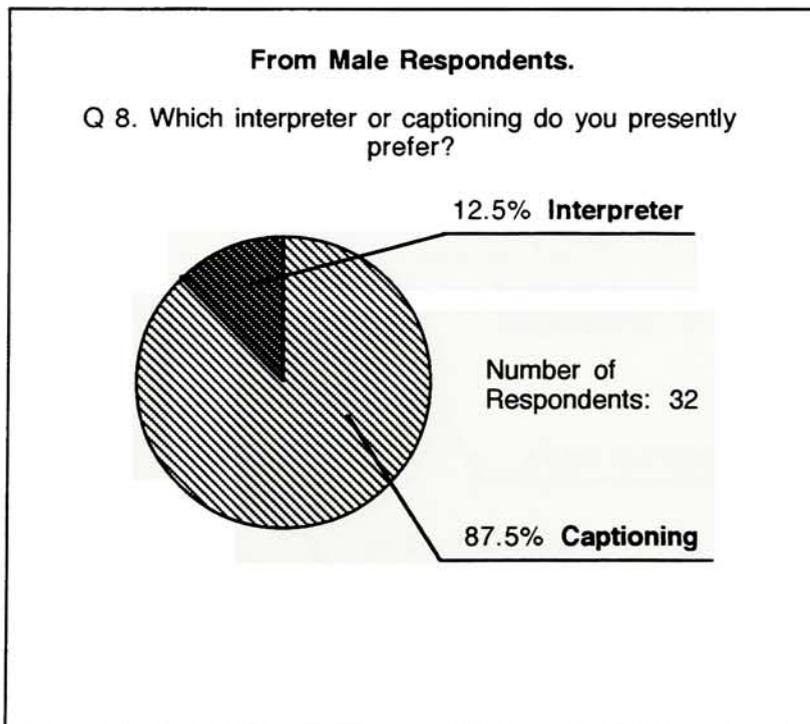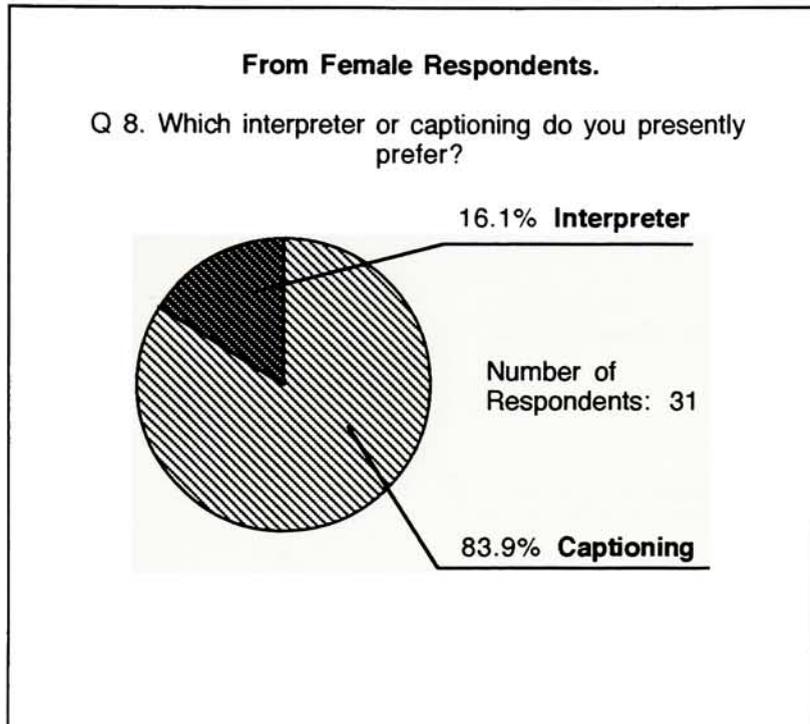
# Fig. 10. Percentage of respondents by gender preferences for carrying the device

From Female Respondents.

Q 9. How would you like to carry this electronic device?

22.6% **In Pocket**

Number of
Respondents: 31

48.4% **On Wrist**

29.0% **On Waist**

From Male Respondents.

Q 9. How would you like to carry this electronic device?

3.1% **In Hand**

9.4% **Around Neck**

Number of
Respondents: 32

43.8% **On Wrist**

18.8% **On Waist**

25.0% **In Pocket**
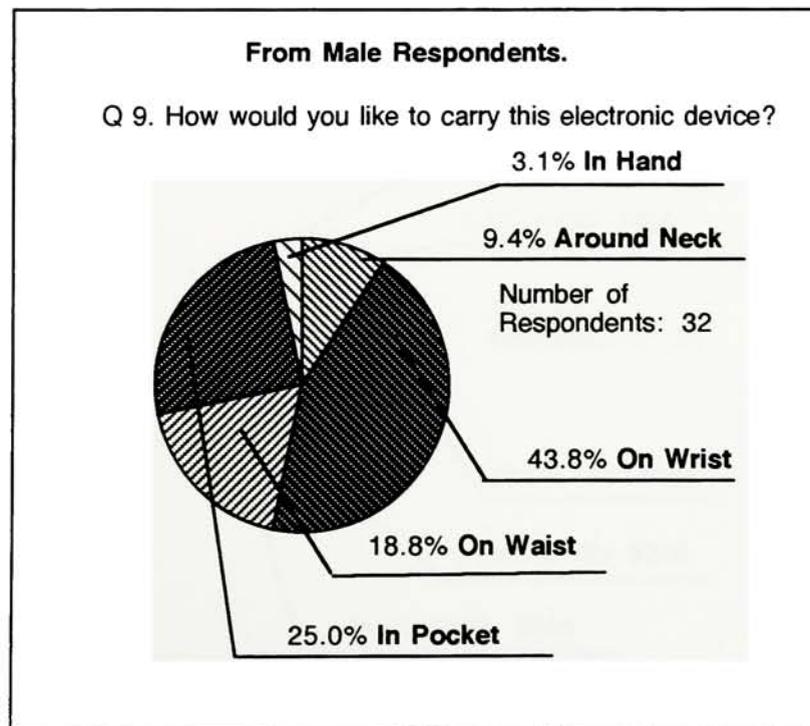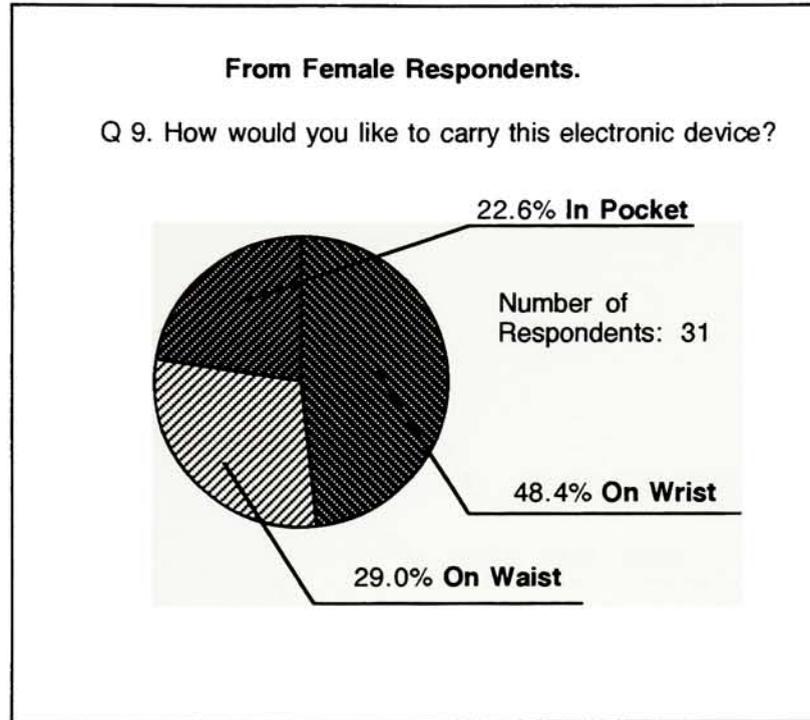
## Fig. 11. Percentage of respondents by gender would be willing to pay

From Female Respondents.

Q 10. How much would you be willing to pay ?

6.5% $300- $400

Number of
Respondents: 31

51.6% $ 5- $100

22.6% $100- $200

19.4% $200- $300

From Male Respondents.

Q 10. How much would you be willing to pay ?

9.4% $300- $400

3.1% $400- $500

Number of
Respondents: 32

37.5% $5- $100

31.2% $100- $200

18.8% $200- $300
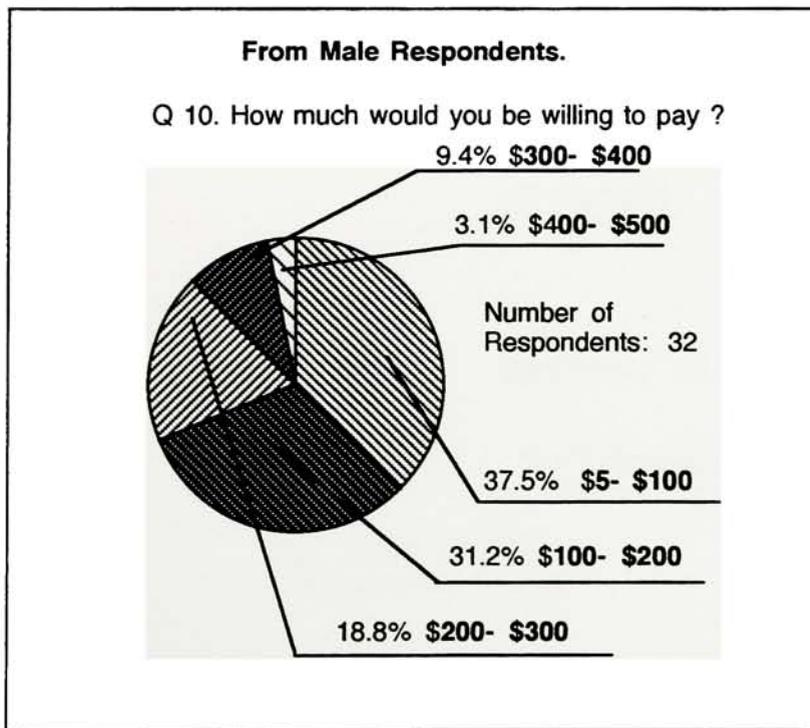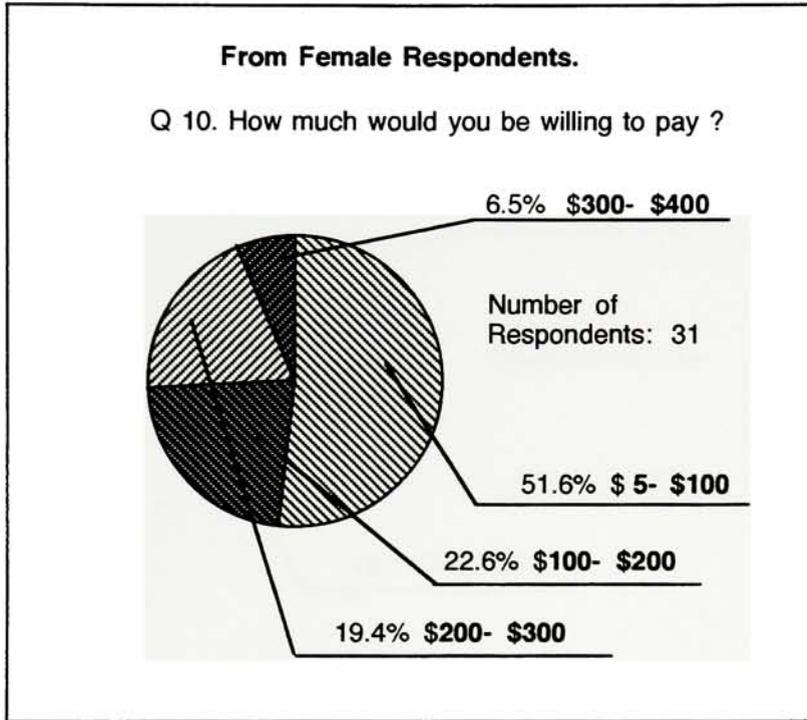
Fig. 12. Percentage of respondents by gender warning signal preference

**From Female Respondents.**

Q 11. What kind of warning signal would you prefer to receive?

25.8% **Both**

Number of Respondents: 31

58.1% **Vibration**

16.1% **Flashing**

From Male Respondents.

Q 11. What kind of warning signal would you prefer to receive?

31.2% **Both**

Number of Respondents: 32

50.0% **Vibration**

18.8% **Flashing**

From Female Respondents.

Q 12. What type of emergency situations should be included ?

9.7% **Ambulance**

Number of
Respondents: 31

41.9% **Telephone**

32.3% **Fire Alarm**

16.1% **Fire Engine**

From Male Respondents.

Q 12. What type of emergency situations should be included ?

15.6% **Ambulance**

Number of
Respondents: 32

34.4% **Telephone**

37.5% **Fire Alarm**

12.5% **Fire Engine**

# Fig. 14. Watch shape warning device

1. This style is a watch shape.
2. The red triangle on top and bottom are microphones. They can pick up emergency signals.
3. The yellow rectangle on top and bottom are flashing lights. When the microphone picks up an emergency signal, these lights will flash.

1. These two round black circles are vibration devices. When the microphone picks up an emergency signal. They will vibrate to warn the user.

Fig. 15. Pager shape warning device
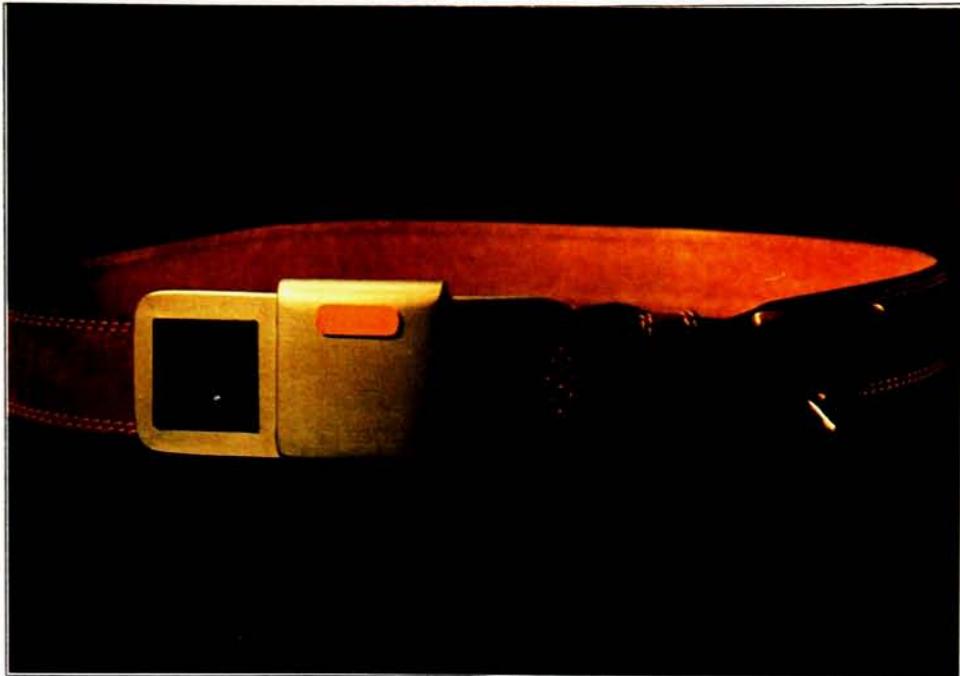
1. This style is a pager shape.
2. The red oval on the right is a microphone. It can picks up an emergency signal.
3. The yellow triangle is a flashing light. When the microphone picks up an emergency signal, this light will flash.
4. The brown square is a liquid crystal display. It can show you that someone is trying to contact to you by phone or TTY.

1. These two black circles are vibration devices. When the microphone picks up an emergency signal, they will warn the user by vibrating. The arc curve is a clip.

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Fig. 16. Key ring shape warning device

1. This style is a key ring shape.
2. The red oval is a microphone that can pick up an emergency signal.
3. The blue square is a car door remote control.
4. The yellow square is a warning flashing light when the microphone picks up an emergency signal.


1. This black square will vibrate when the microphone picks up an emergency signals.

Fig. 17. Pen shape warning device

1. This style is a pen shape.
2. The red button on top is a microphone. It can pick up the emergency signals.
3. The yellow triangle is a flashing light. When the microphone picks up the emergency signal, this light will flash.
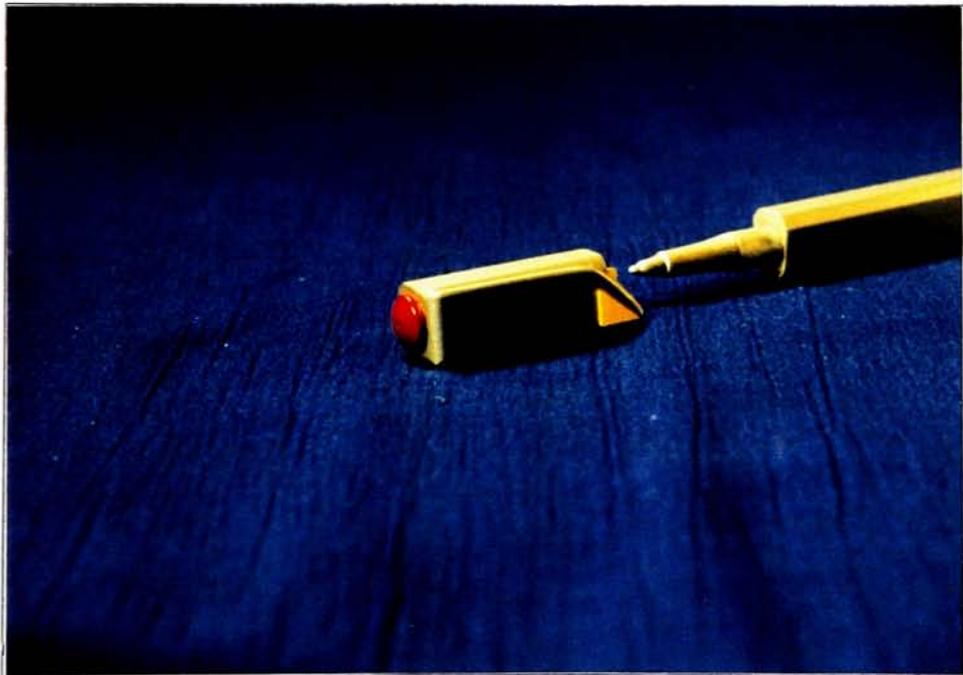
1. This is a regular pen for writing.

Fig. 18. Pen shape warning device (rear view)

1. This black circle is a vibration device. It will vibrate when the microphone receives an emergency signal.
2. When an emergency situation happens, this warning device will not only vibrate, but also flash.

Fig. 19. The notebook shape translator

1. This style is a note book shape.
2. The red button on both ends are microphones. They can pick up verbal speech and then translate it to captions, but they can't pick up emergency signals.
3. If you want to pick up warning signals, it should be combined with other warning devices such as Fig. 14 to Fig. 17
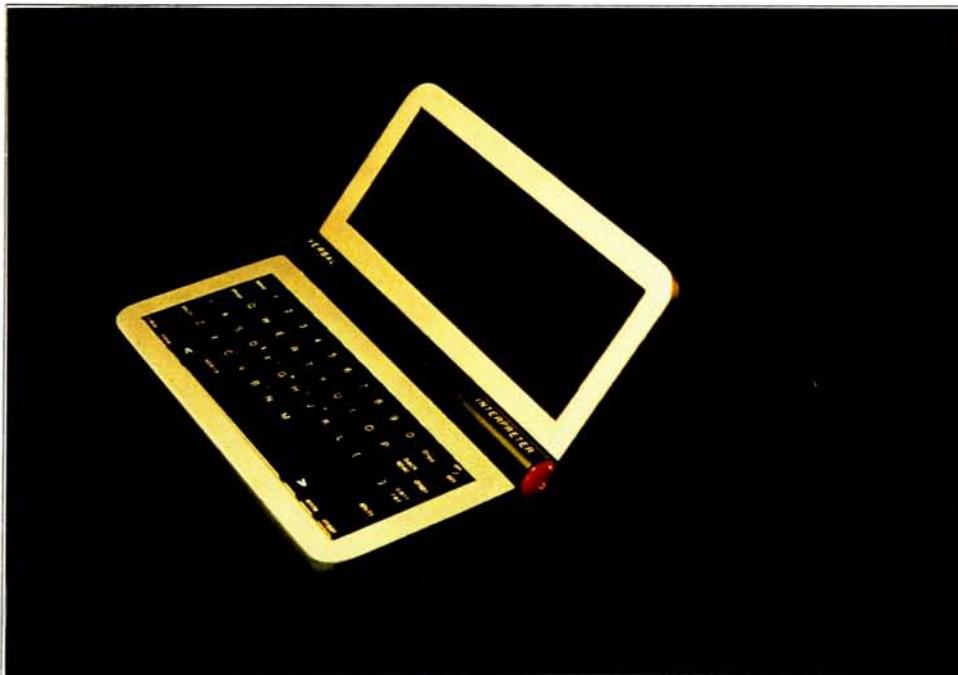

1. When this device open, you can very easy recognize the brown square is the liquid crystal display and the black square is a keyboard. This device can improve the communication between hearing impaired and hearing people.

75

Fig. 20. The vibrating translator device
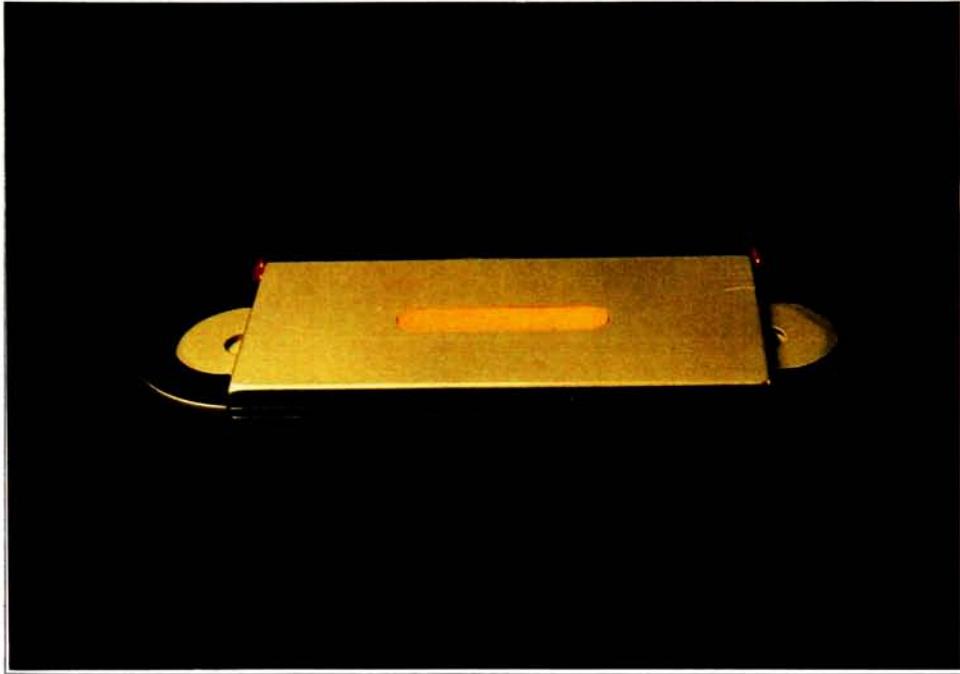
1. This style is a note book shape.
2. The red button on both ends are microphone. They can pick up verbal speech and emergency signals then translate it to captions.
3. The yellow triangle on top is a warning flashing light. When the microphone picks up an emergency signal, this light will flash and at the same time will vibrate.
4. The two half circles on both ends are the phone set. They can be adjusted to fit the different length of telephone.
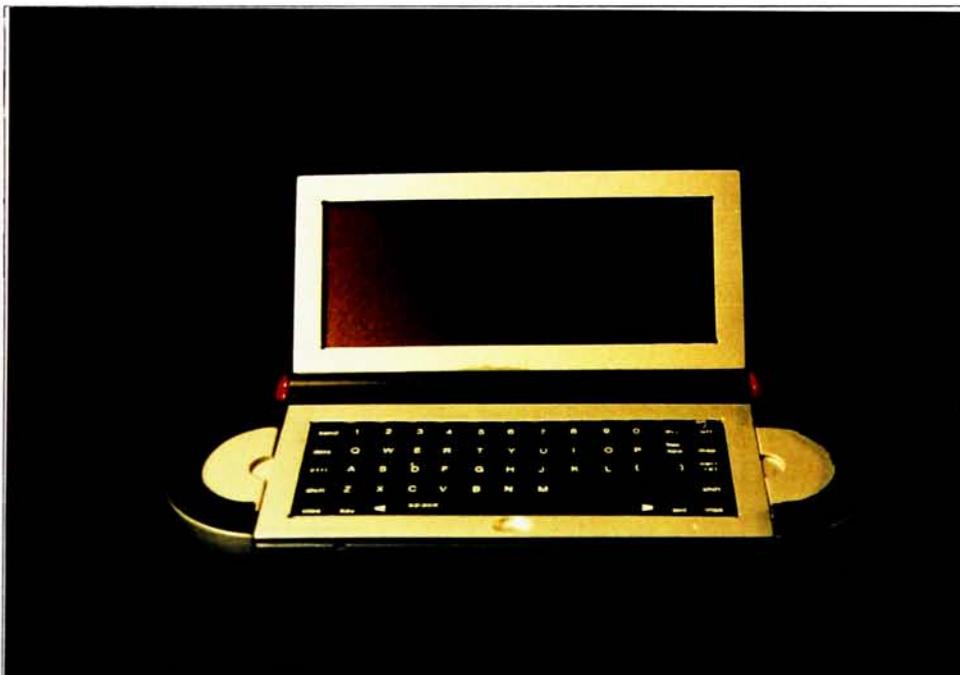
1. When it is open, you can very easily recognize there have the liquid crystal display and keyboard. The vibration device is installed inside the body on the bottom piece.

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Fig. 21. The vibrating translator device (open view)
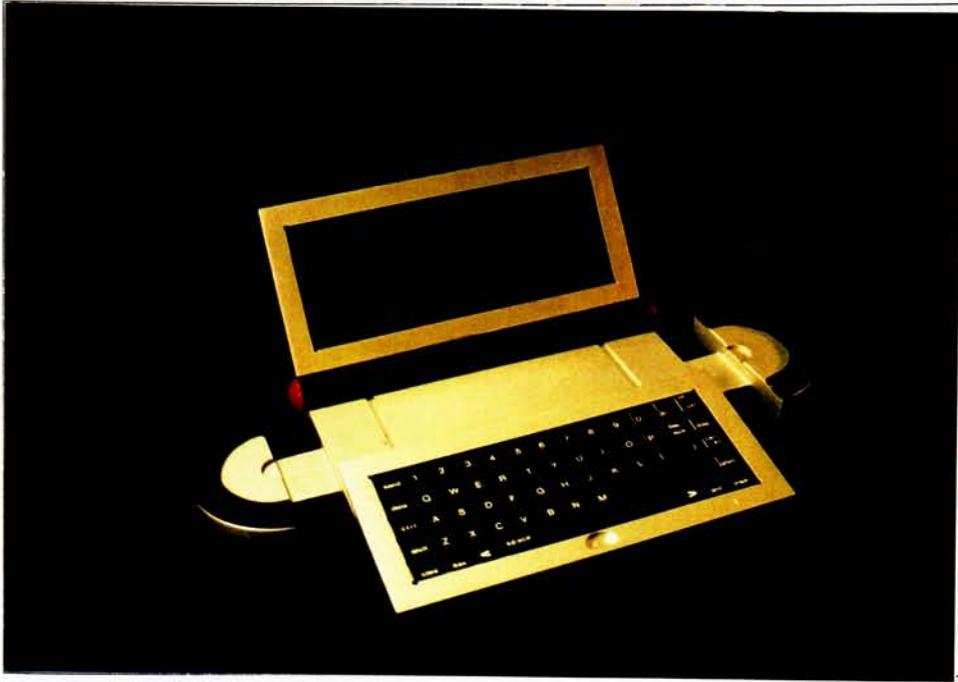
1. From this view, you can see that the keyboard can slide off and by using radio frequency, you can pick up this keyboard and type anywhere without using an electric cord. This idea is very similar to a TV remote control.

1. From this view, you can see how the telephone sets on this device. You can use this device with a cellular phone or with a public phone.

Fig. 22. Streamline Moderne warning device

Fig. 23 Streamline Moderne communication device
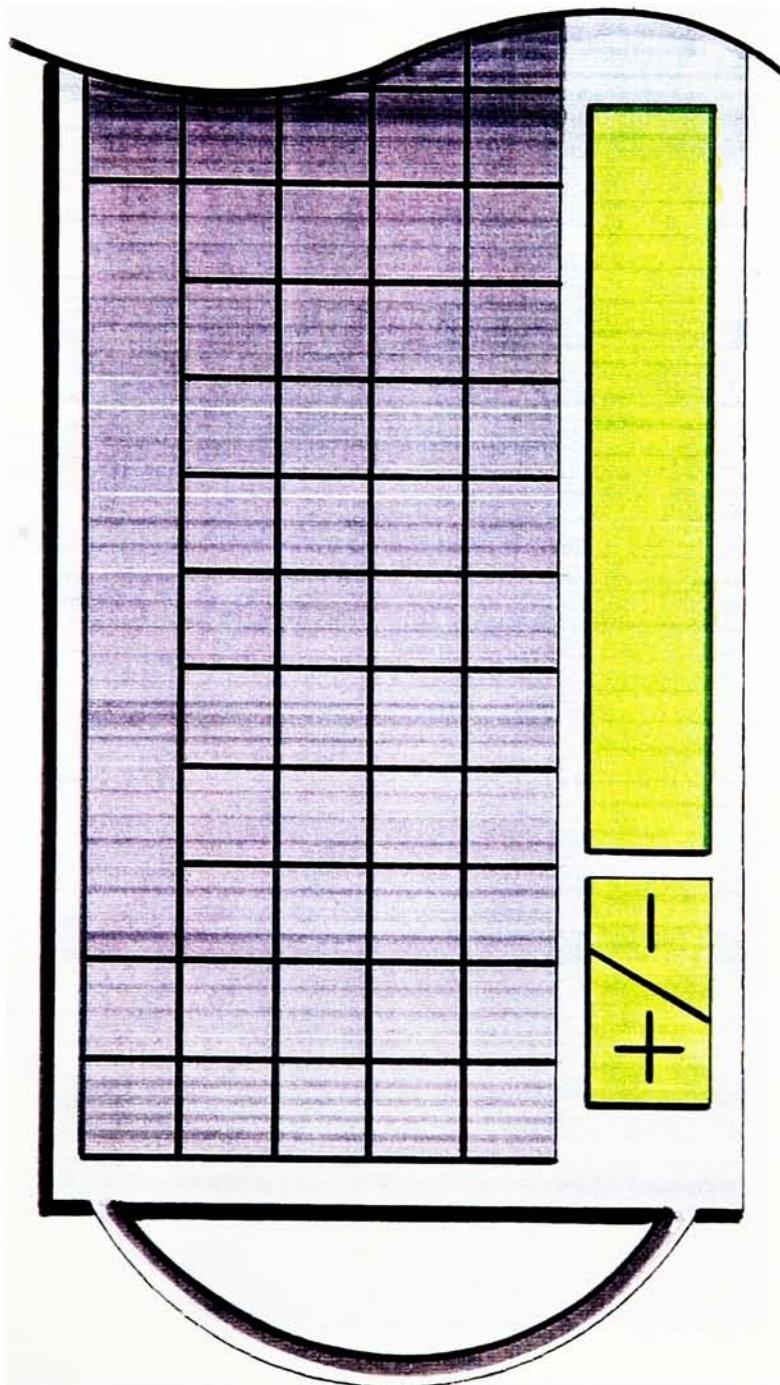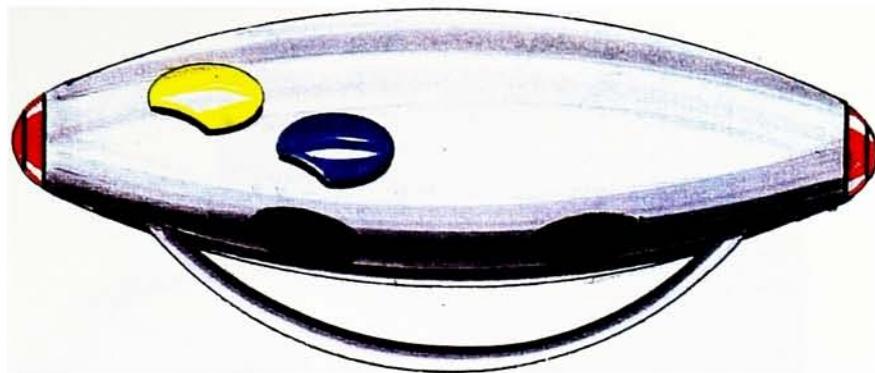
Fig. 24. Streamline Moderne translation device (top view)
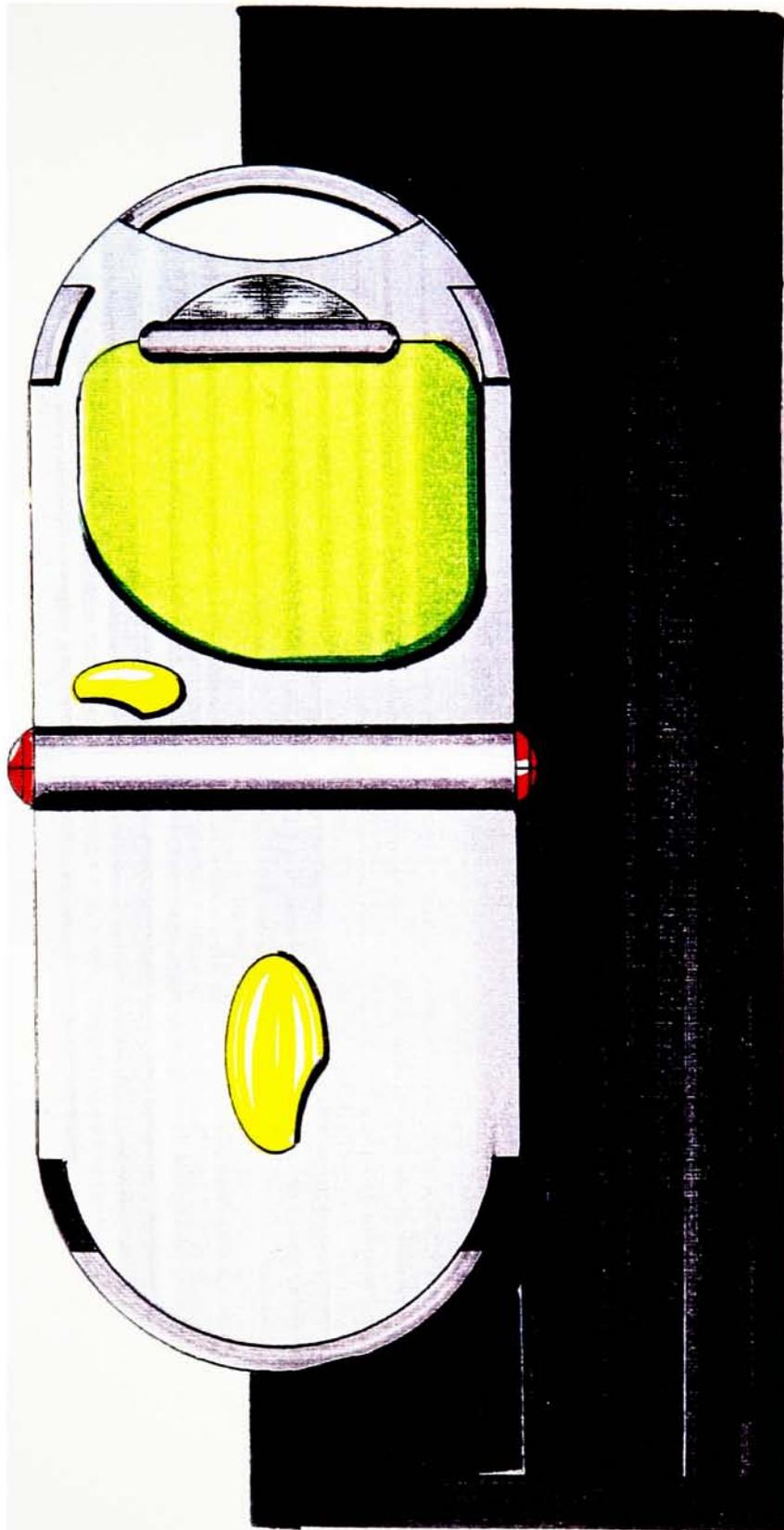
Fig. 25. Streamline Moderne translation device (perspective view)
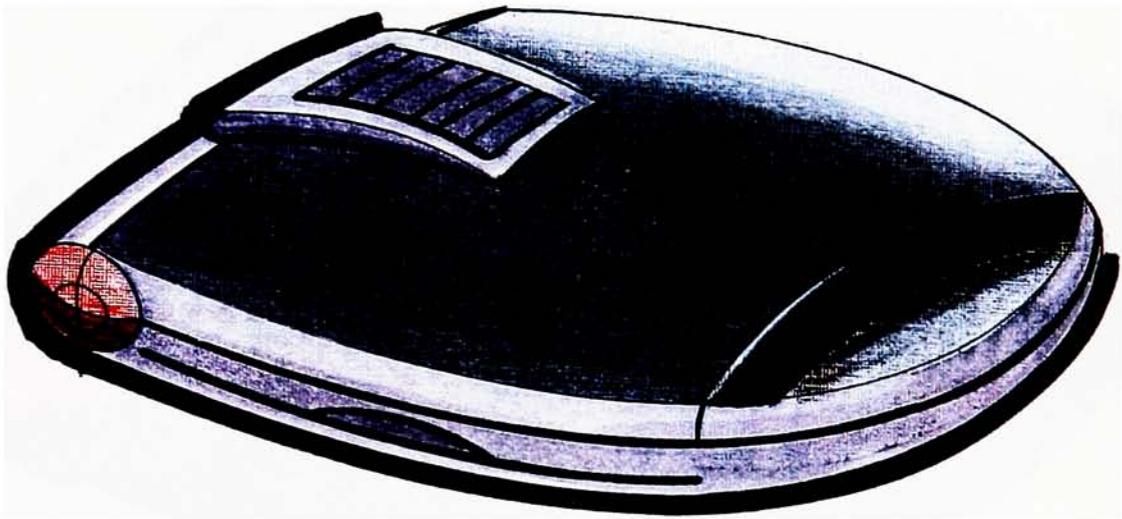
Fig. 26. Streamline Moderne case
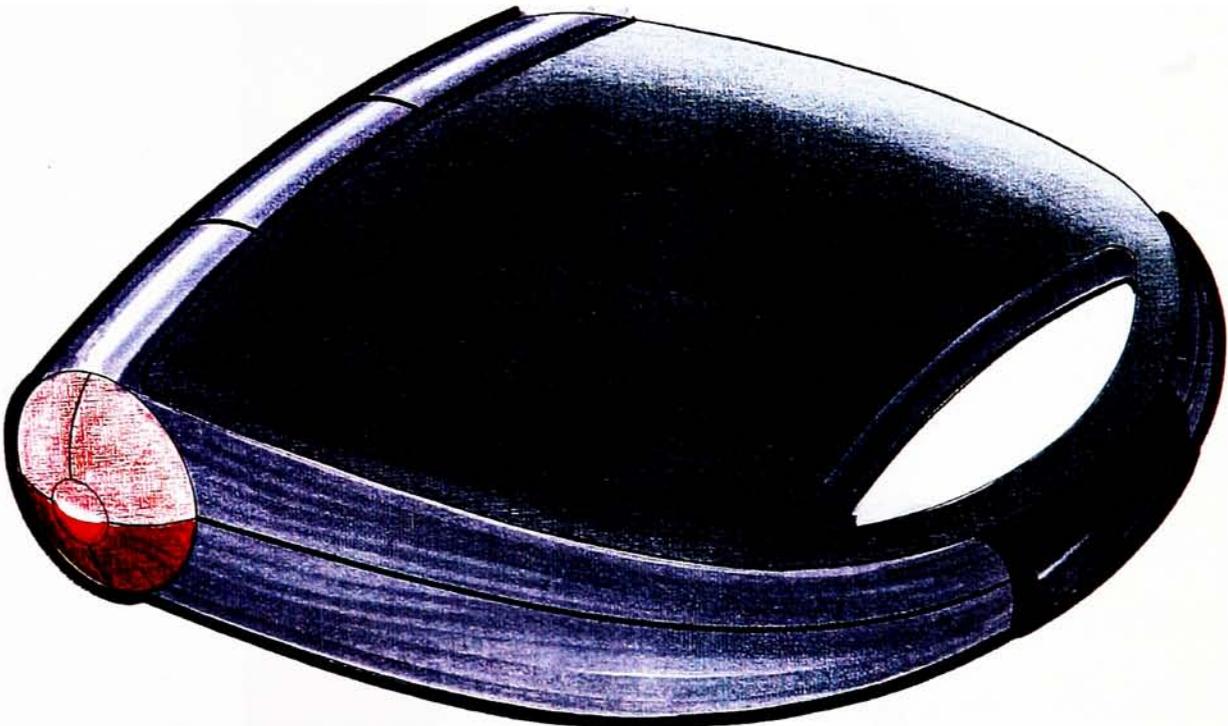
Fig. 27. Late Modern style warming device
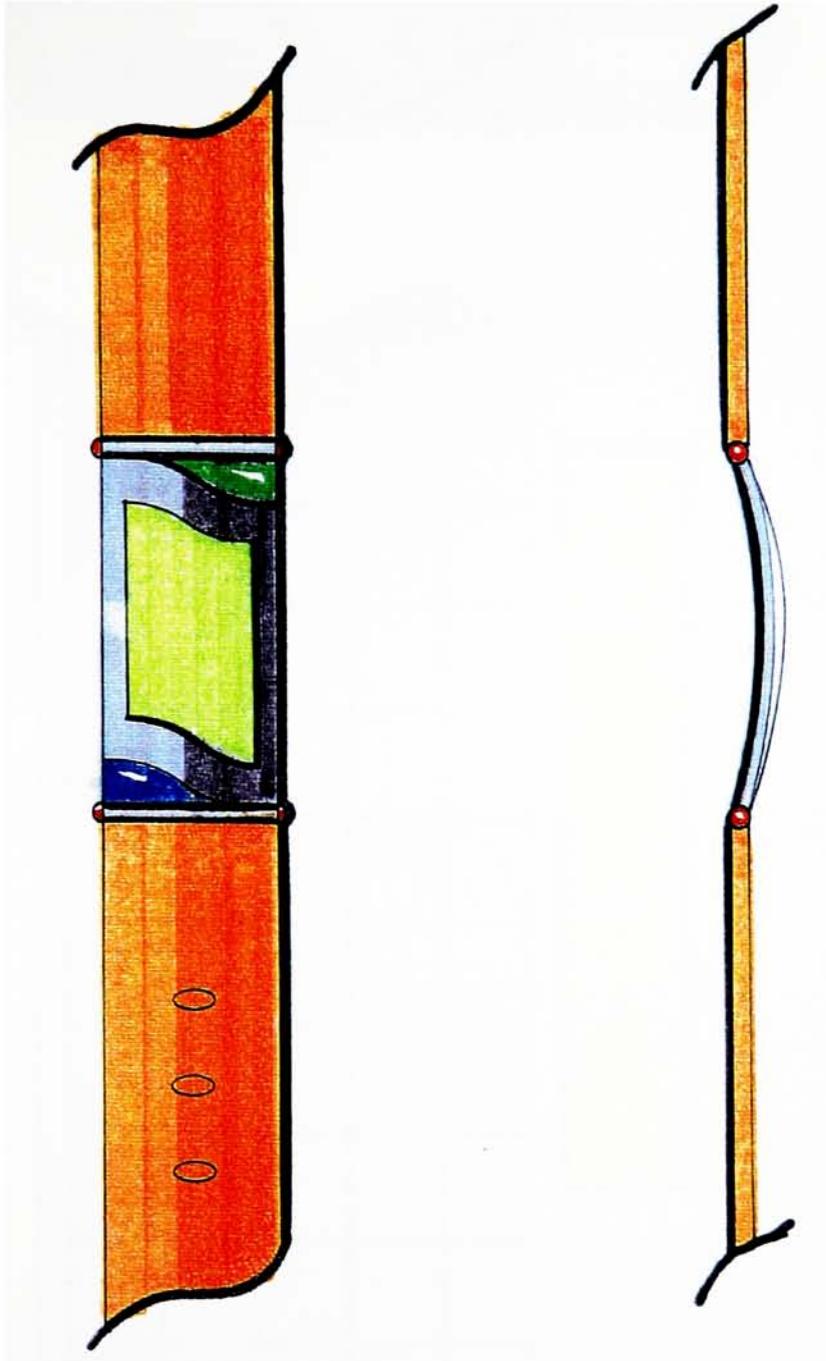
Fig. 28. Late Modern style communication device
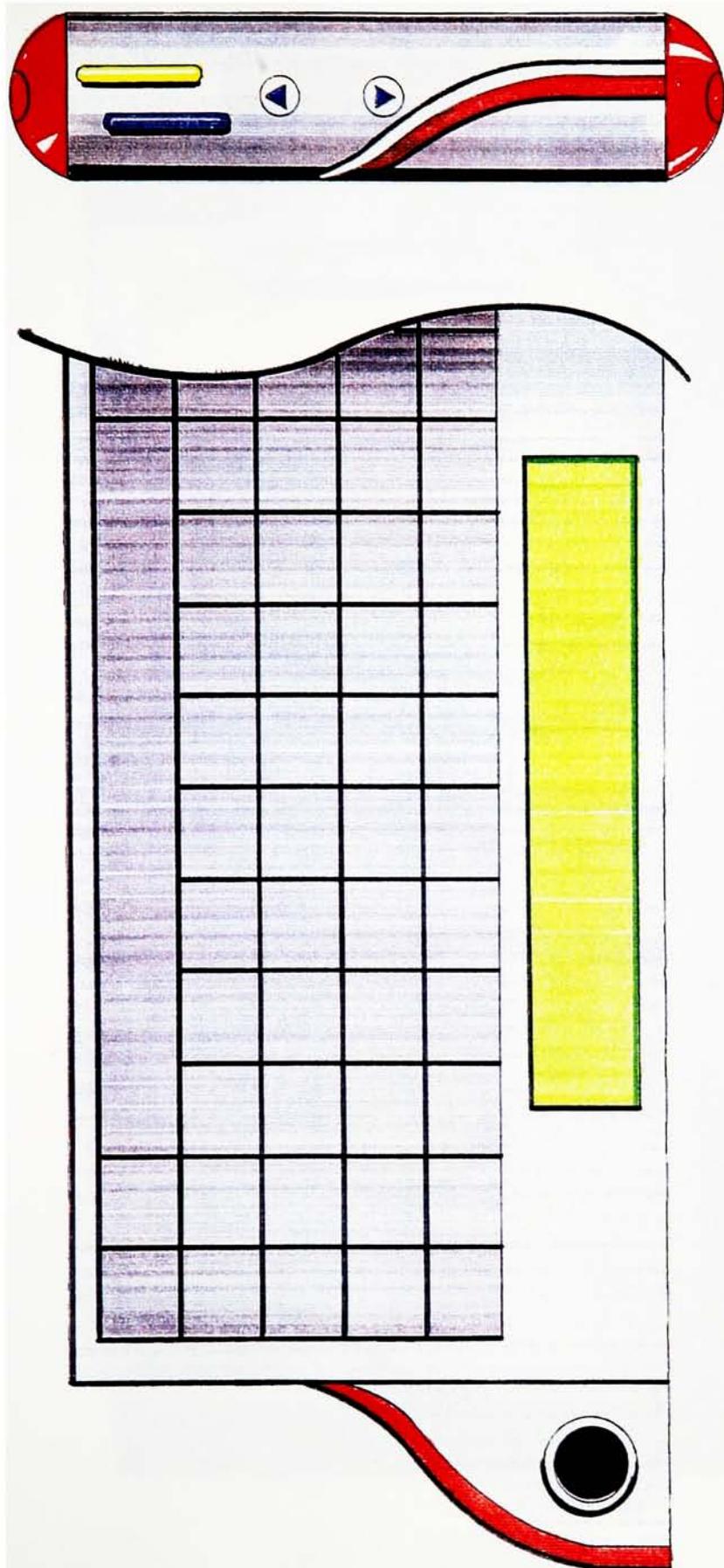
Fig. 29. Late Modern style translation device (top view)
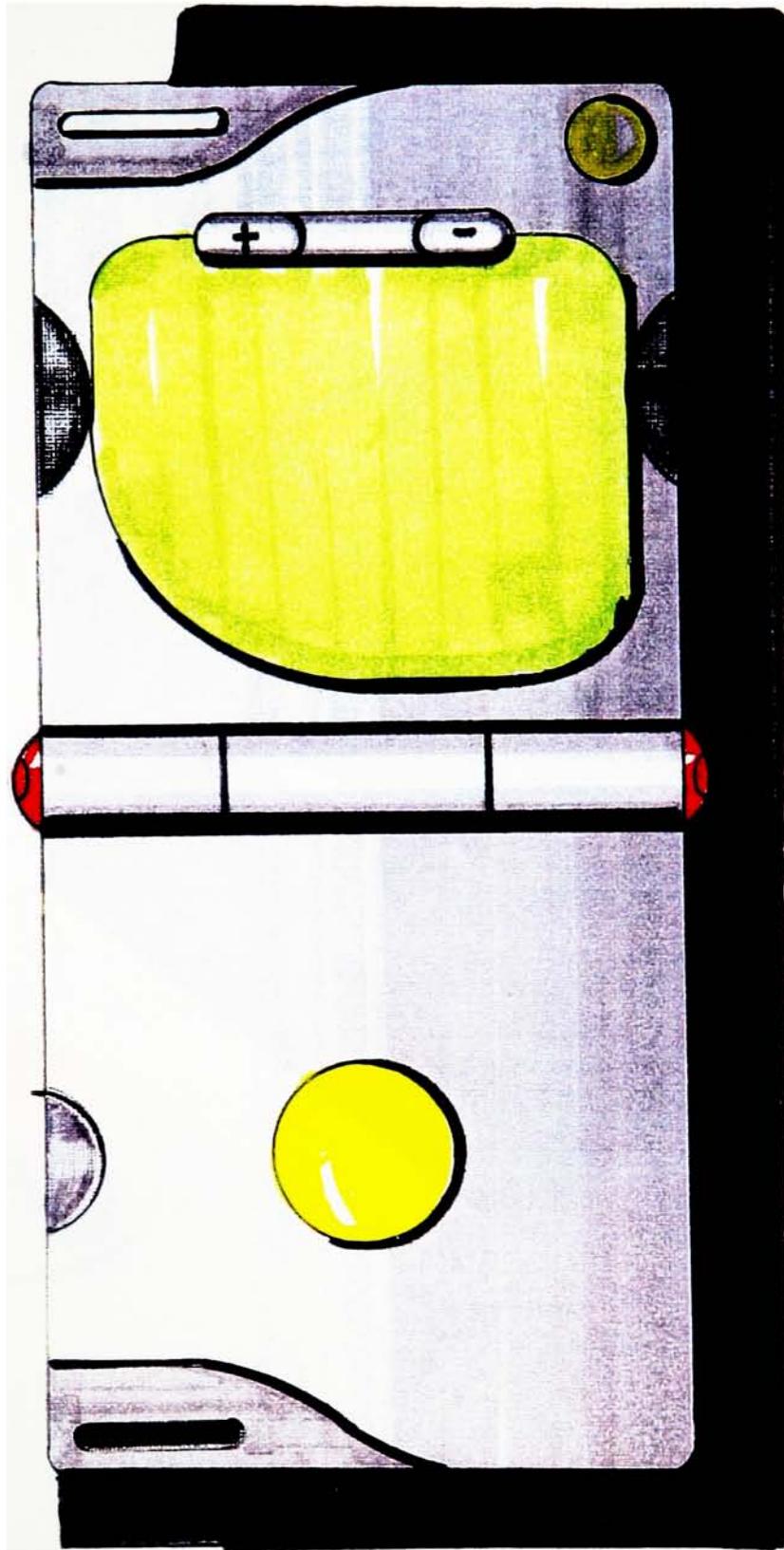
Fig. 30. Late Modern style translation device (perspective view)
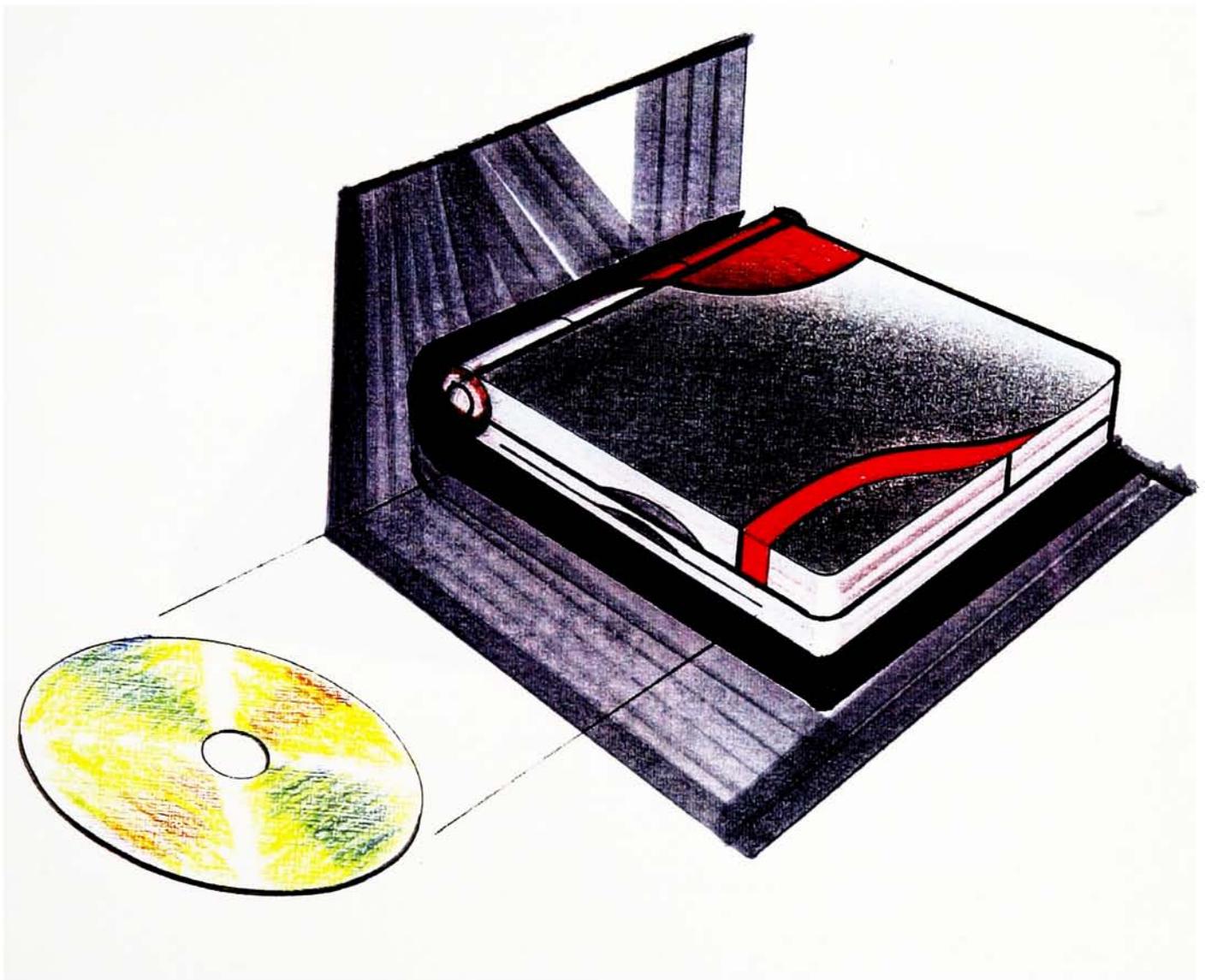
Fig. 31. Late Modern style case
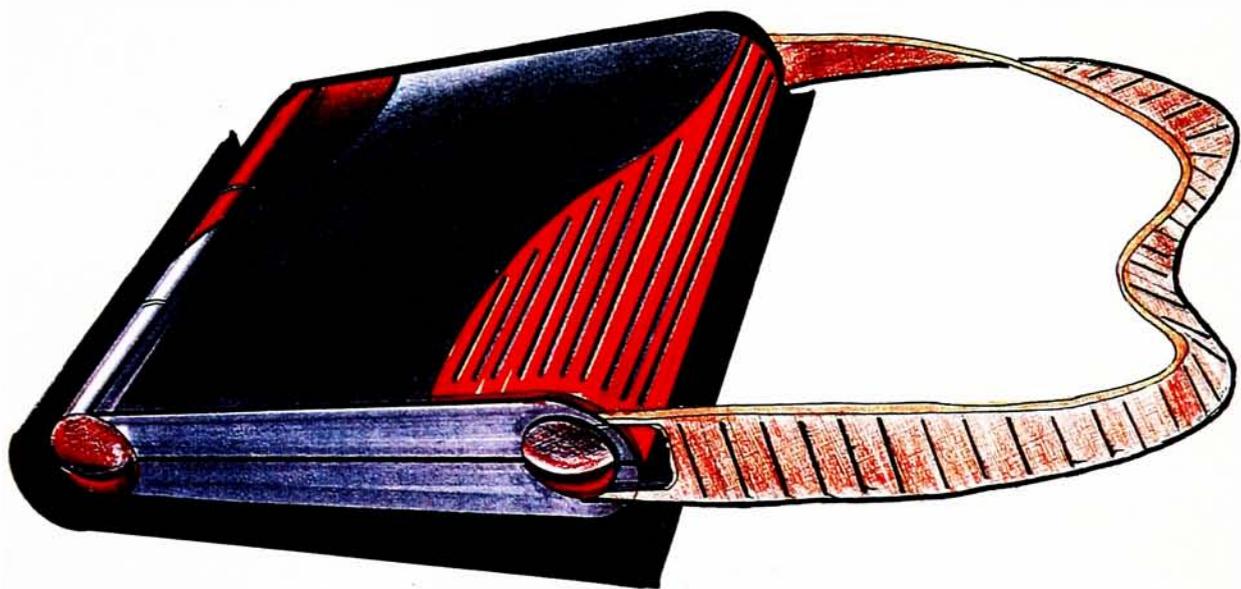
Fig. 32. Post-Modern style warning device
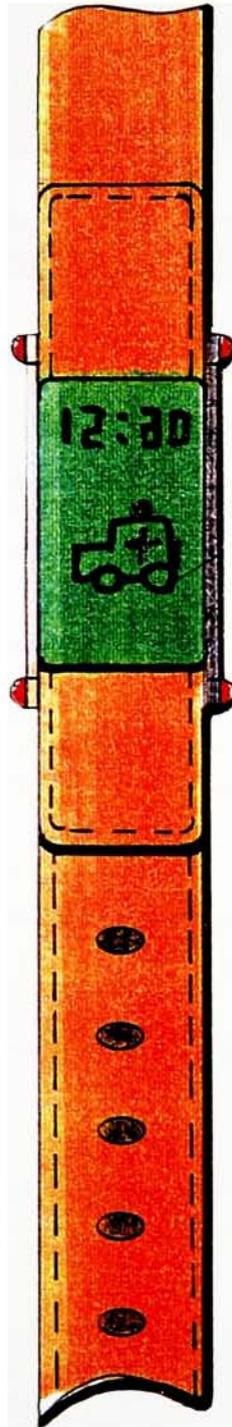
Fig. 33. Post-Modern style communication device

CALL

Microphone

Warning flashes

Button

Function Control Bar

LCD for info Status

keyboard
(Rolling)
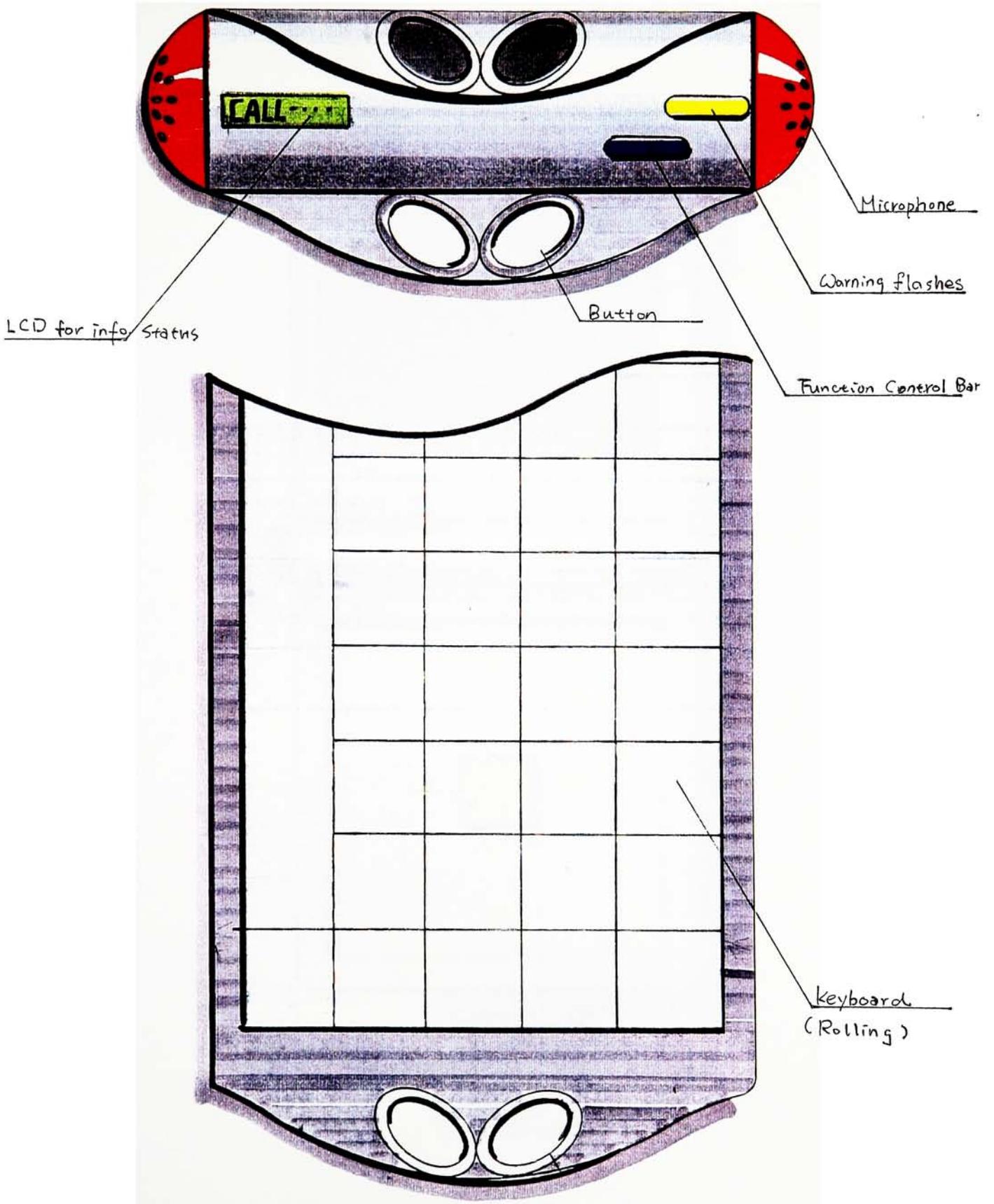
Fig. 34. Post-Modern style translation device (top view)
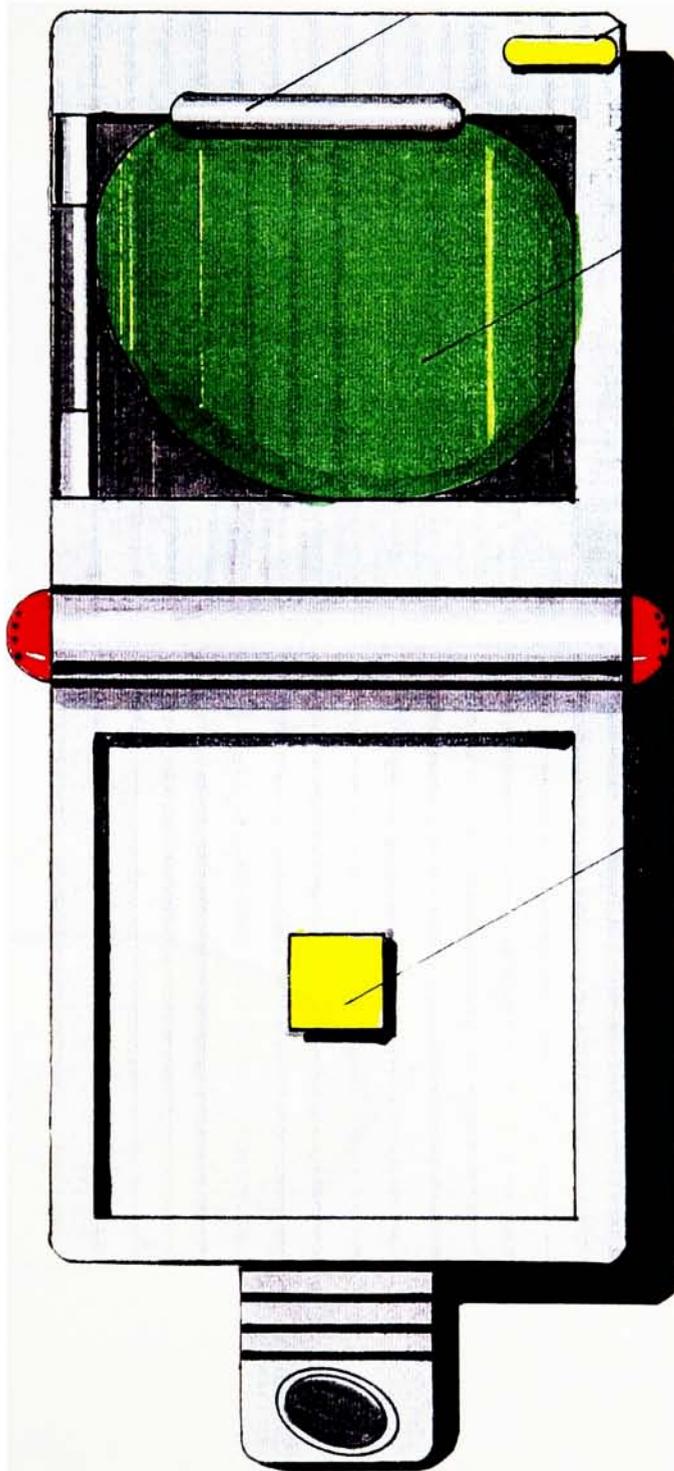
Fig. 35. Post-Modern style translation device (perspective view)
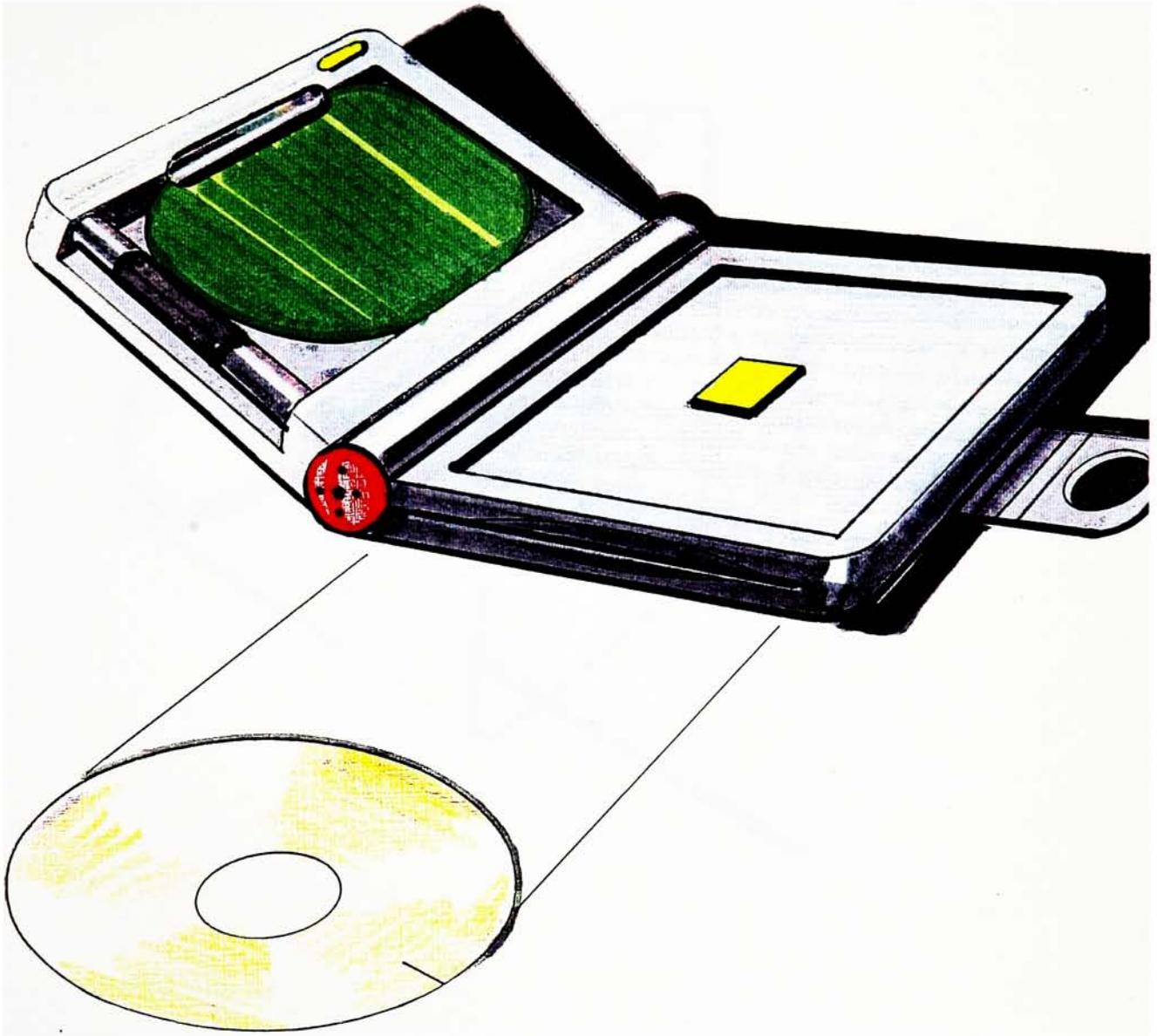
Fig. 36. Post-Modern style virtual vision glass and eyeglass frame
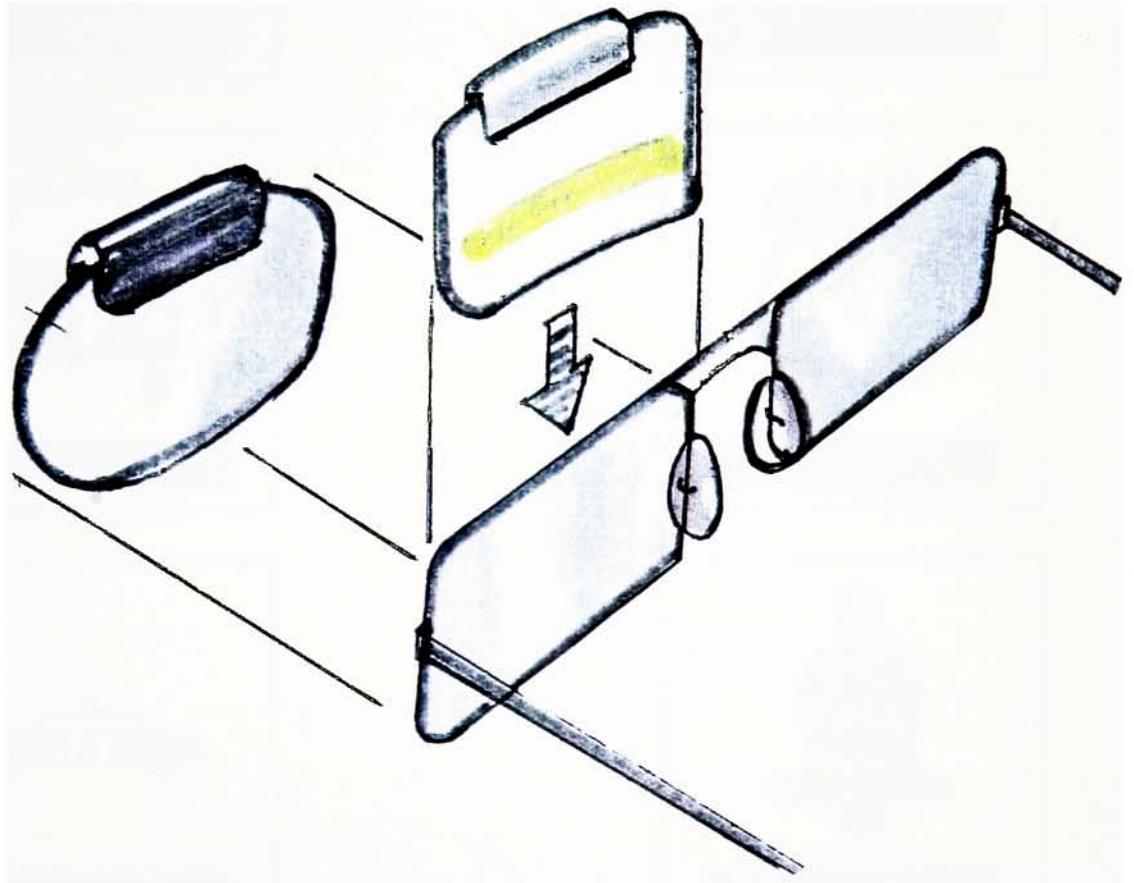
Fig. 37. Watch warning device icons

Fire Engine

Phone Ring

Ambulance

Alarm Clock

Police Vehicle

Door Bell

Fire Alarm
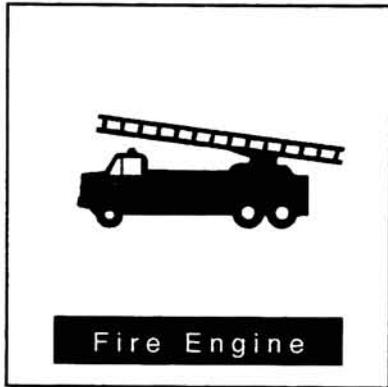
Fig. 38. Sequence of events for the Safety Guard
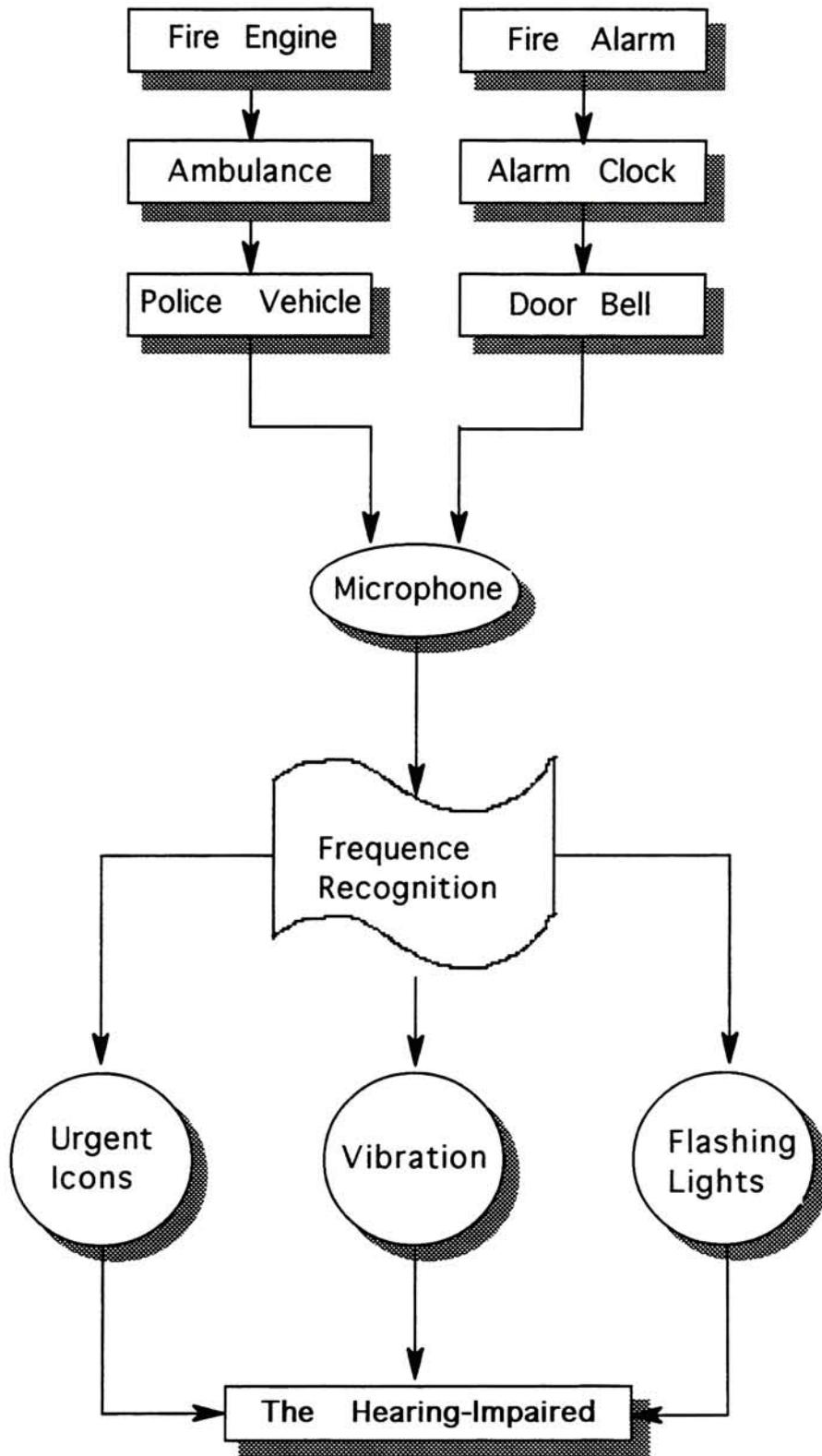
Fig. 39. Sequence by which the Safety Guard is used with the Communicator
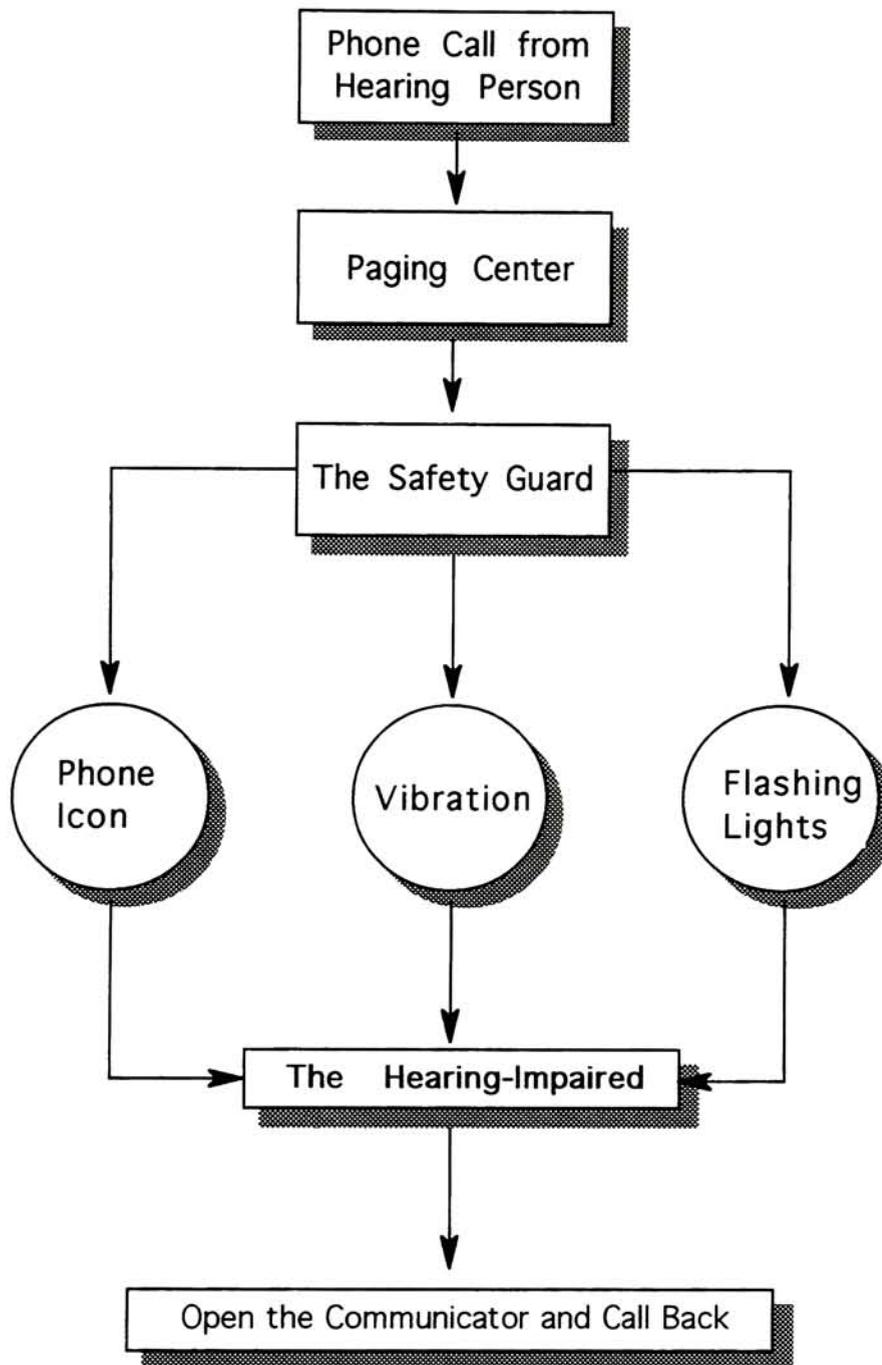
Fig. 40. Functions of the control bars
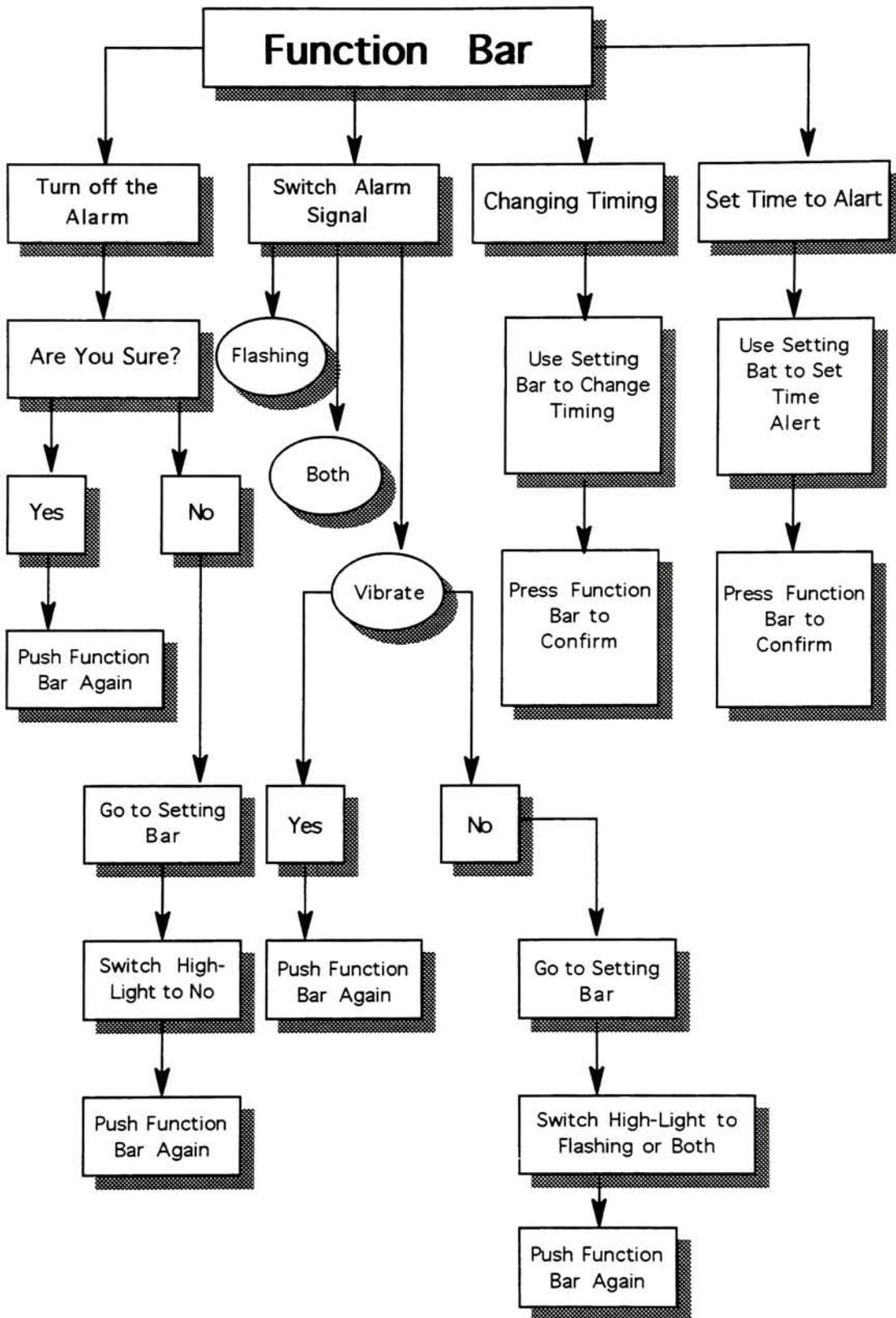
Fig. 41. Procedure by which a hearing person calls a
hearing-impaired by using the Communicator

Fig. 42. Function of the Safety Guard and Communicator
when used together
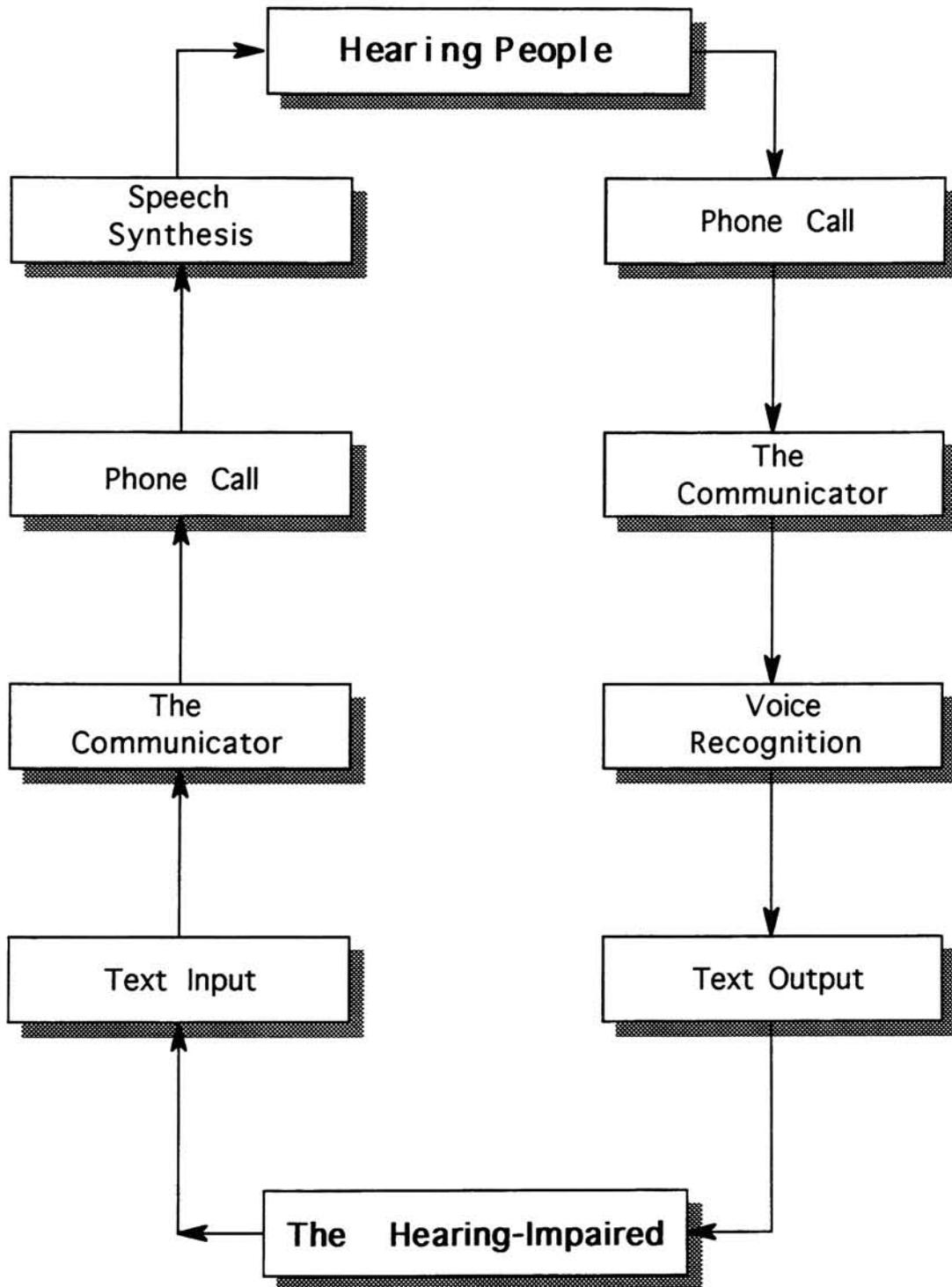
Fig. 43. Process by which a hearing-impaired person can speak directly with a hearing person without an interpreter
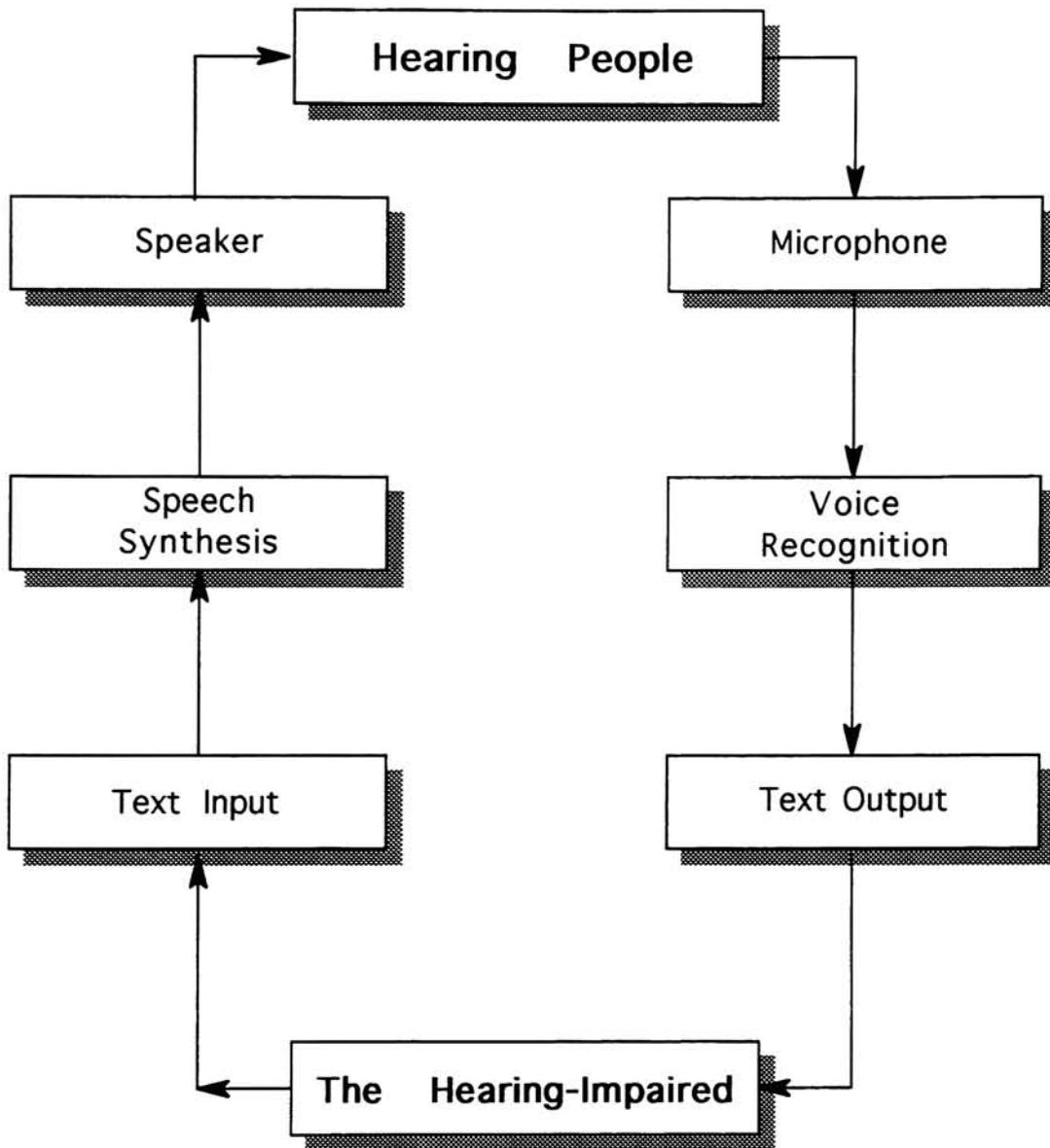
Fig. 44. The process by which a hearing-impaired student can attend a lecture with the Entertainer

```
                    ┌──────────────────────────┐
                    │   Lecture  or  Seminar    │
                    └──────────────────────────┘
              ┌──────────────┘          └──────────────┐
              ▼                                        ▼
    ┌──────────────────┐                    ┌──────────────────┐
    │    Microphone     │                    │    Microphone     │
    └──────────────────┘                    └──────────────────┘
              │                                        │
              ▼                                        ▼
    ┌──────────────────┐                    ┌──────────────────┐
    │      Voice        │                    │      Voice        │
    │   Recognition     │                    │   Recognition     │
    └──────────────────┘                    └──────────────────┘
              │                                        │
              ▼                                        ▼
    ┌──────────────────┐                    ┌──────────────────┐
    │  The  Entertainer │                    │  The  Entertainer │
    └──────────────────┘                    └──────────────────┘
              │                                        │
              ▼                                        ▼
    ┌──────────────────┐                    ┌──────────────────┐
    │  Recorded   all   │                    │ Projected  words on│
    │  information into  │                    │        the         │
    │ the Compact Disk  │                    │ Virtual  Vision Glass│
    └──────────────────┘                    └──────────────────┘
        │         │                                    │
        ▼         ▼                                    │
  ┌────────┐ ┌────────┐                                │
  │Put the │ │Projected│                               │
  │CD into │ │words on │                               │
  │the CD  │ │  the    │                               │
  │drive of│ │Virtual  │                               │
  │the     │ │Vision   │                               │
  │Computer│ │Glass    │                               │
  └────────┘ └────────┘                                │
        │         │                                    │
        │         ▼                                    │
        │   ┌──────────────────────────────┐           │
        └──▶│   The   Hearing-Impaired      │◀──────────┘
            └──────────────────────────────┘
```

100
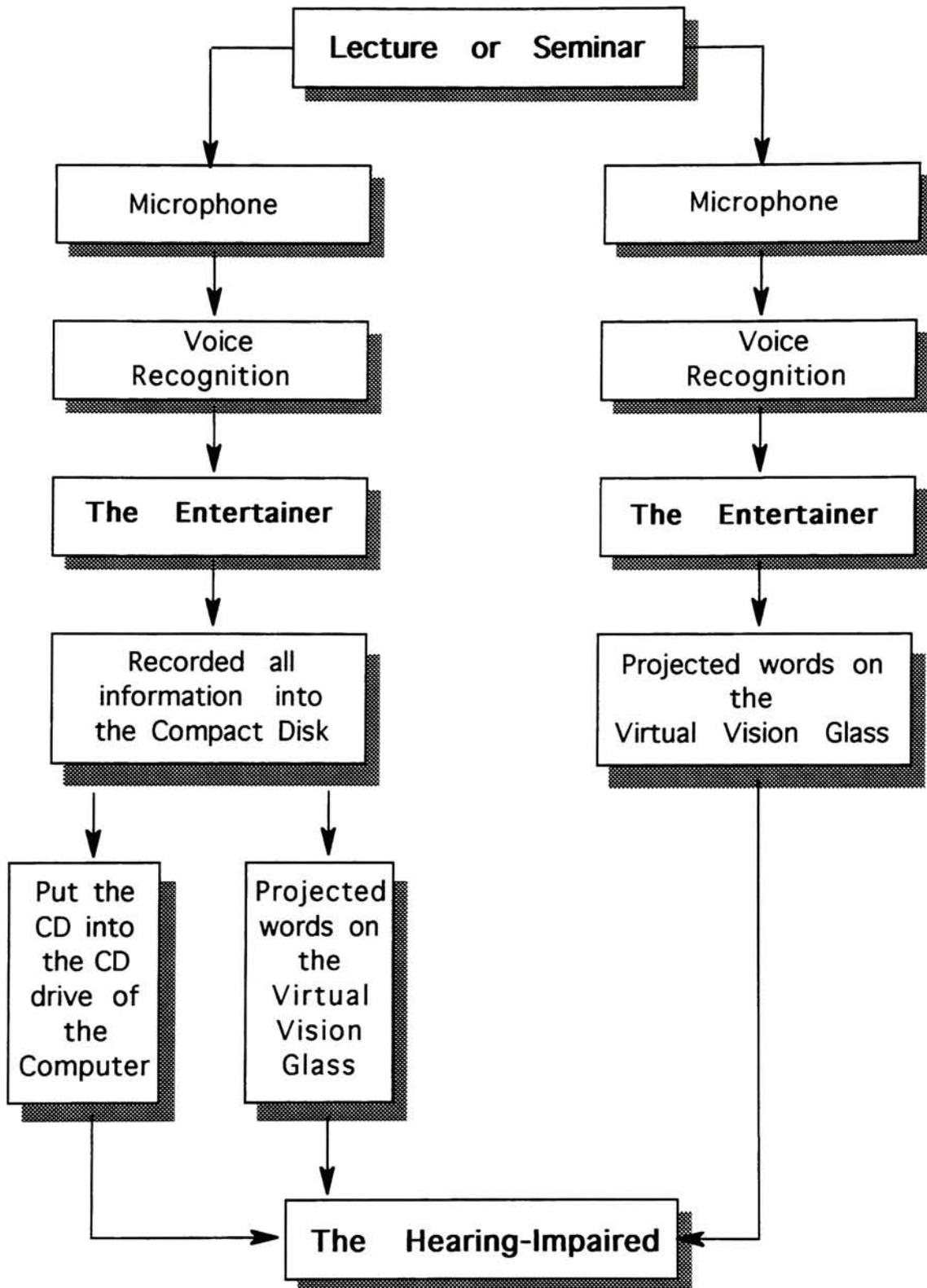
Fig. 45. The Entertainer as traveling guide for the
hearing users

Drive into a unfamiliar area

Open the Entertainer and turn on the power

Put the Virtual Vision Glass on the eyeglass frame or attach to the frame for non-eyeglass user.

Insert a CD map into the Entertainer

The map would be projected on the Virtual Vision Glass
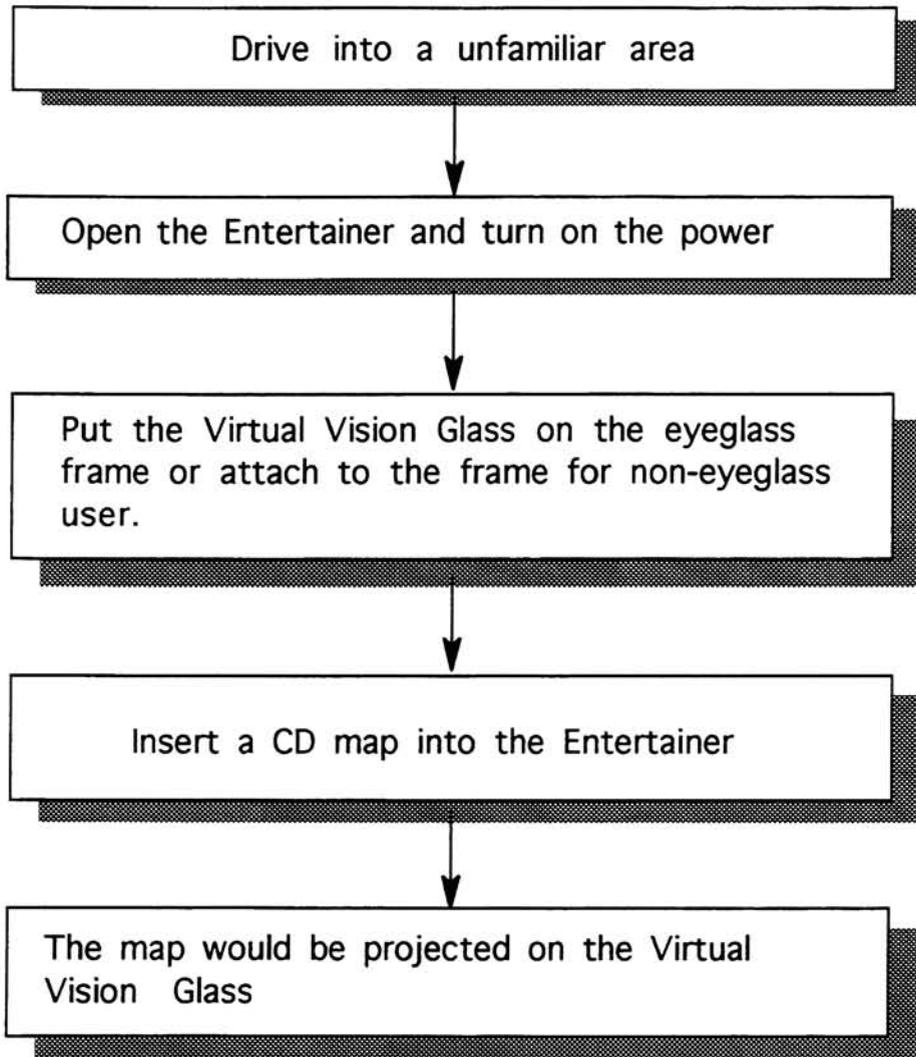
Fig. 46. Process to translate voice from movies, TV, or radio for hearing-impaired

Movie

Televsion

Radio

Microphone

Voice Recognition

The Entertainer

Caption projected on Virtual Vision Glass

Fig. 47. Safety Guard technical drawing (Dimension)

1.375
.876
.250
.250
.320
.239
.597
Ø .375
Ø .063
R .094
R .125
.103
R .125 1.125
.125
.125
R .125
R .125
R .125
R .125
R .063
R .063
.867
.876
.250
R .350
R .688

.250
.125
.876
.875
.500
1.019 .249
.375
10.188
.250
.500
.250
.250
.250
.250
.250
3.043
.125
.125
.250
.876
.125
.125
.375

Safety Guard		
A 1:2	Yu-Chun Hsu	
Unit: Inch	Date: April 22, 96	

Fig. 48. Safety Guard technical drawing
(Material and Color)

Velcro
| // | NYLON | BLACK |

Velcro
| // | NYLON | BLACK |

Microphone
| // | ACETAL | RED |

Warning Flash Bar
| // | ACRYLIC | YELLOW |

Time Display
| // | LCD | GREEN |

Warning Display
| // | LCD | GREEN |

Alarm Control Bar
| // | ABS | SILVER |

Time/Mode Control Bar
| // | ABS | SILVER |

Velcro
| // | NYLON | BLACK |

Open Tab Indicator
| // | ABS | YELLOW |

Safety Guard		
A 1:2	Yu-Chun Hsu	
Unit: Inch	Date: April 22, 96	

Fig. 49. Communicator technical drawing (Dimension)
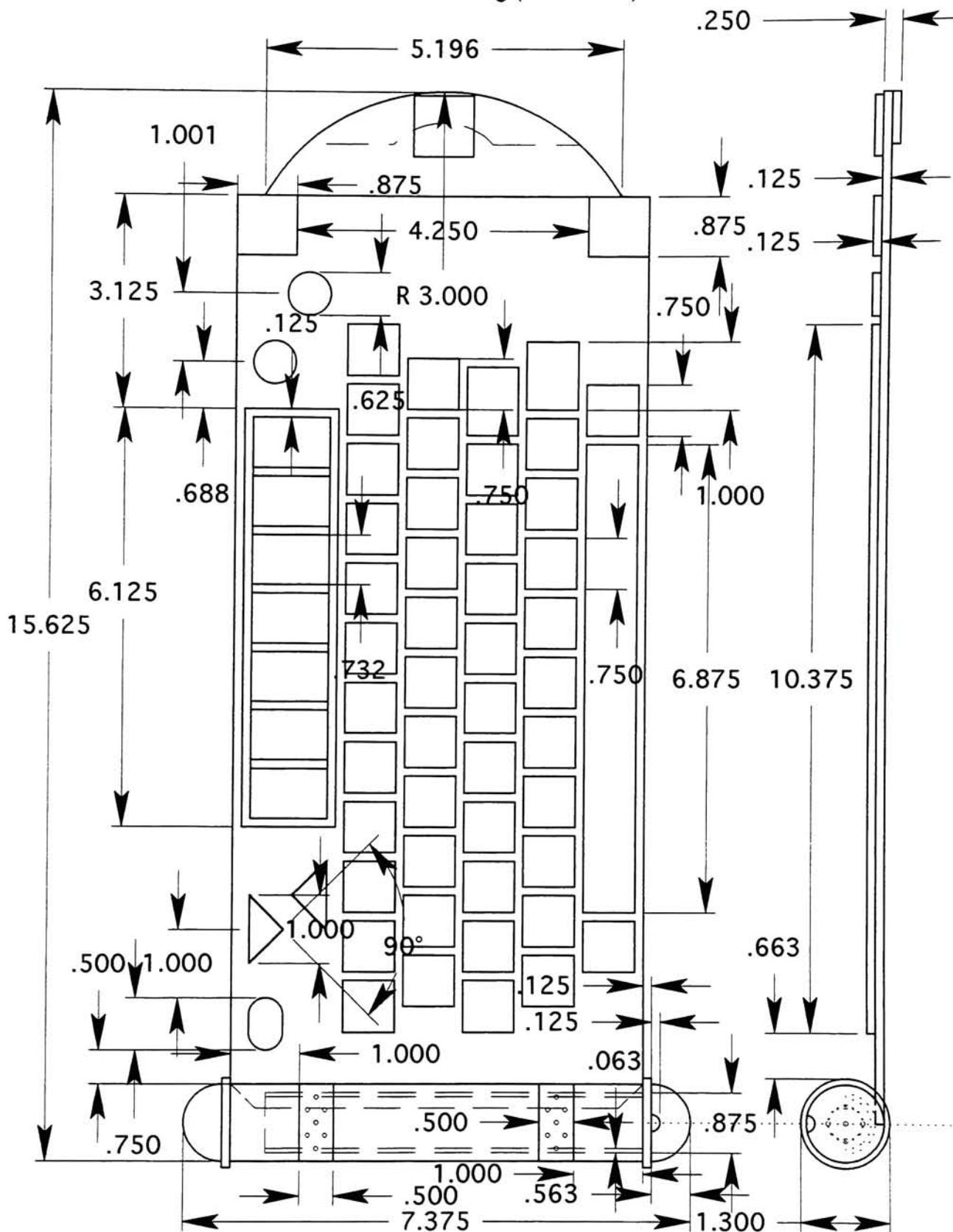
Communicator

A	1:2	Yu-Chun Hsu
Unit: Inch	Date: April 22, 96	

Fig. 50. Communicator technical drawing
(Material and Color)

Opening Tab Indicator
// ABS YELLOW

Velcro
// NYLON BLACK

Velcro
// NYLON BLACK

Rolling Keyboard
// EVA BLACK

Volume Button
// EVA BLACK

Display
// LCD GREEN

Key Pads
// EVA BLACK

Display Adjustment
// EVA BLACK

Power Button
// EVA BLACK

Microphone
// ACETAL RED

Microphone
// ACETAL RED

Speaker
// ABS SILVER

Communicator

A | 1:2 | Yu-Chun Hsu

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Unit: Inch | Date: April 22, 96

Fig. 51. Entertainer technical drawing (Dimension)

Fig. 51. Entertainer technical drawing (Dimension)

Entertainer		
A **1:2**		**Yu-Chun Hsu**
Unit: Inch	Date: April 22, 96	

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Fig. 52. Entertainer technical drawing
(Material and Color)

Opening Tab Indicator
| // | ABS | YELLOW |

Velcro
| // | NYLON | BLACK |

Rollable Cover
| // | EVA | BLACK |

Recording Buttons
| // | ABS | BLACK |

Power Button
| // | ABS | BLACK |

CD Holder
| // | ABS | SILVER |

Power Button
| // | ABS | BLACK |

Virtual Vision Glass Holder
| // | ABS | SILVER |

Microphone
| // | ACETAL | RED |

Velcro
| // | NYLON | BLACK |

Adjust Focus Buttons
| // | ABS | BLACK |

| **Entertainer**		
A 1:2	**Yu-Chun Hsu**	
Unit: Inch	Date: April 22, 96	

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Fig. 53: Models Composite

1. This picture contain all design products. From top to bottom, there are the Communicator, the Entertainer, the Safety Guard, and the bag. This bag was designed to pack the Communicator and Entertainer together that allowed for comfortable carrying and storage.

Fig. 54: The Safety Guard Model

1. The Velcro closure and flexible material allow for comfort and adjustability.

Fig. 55. The Communicator Model (Open)
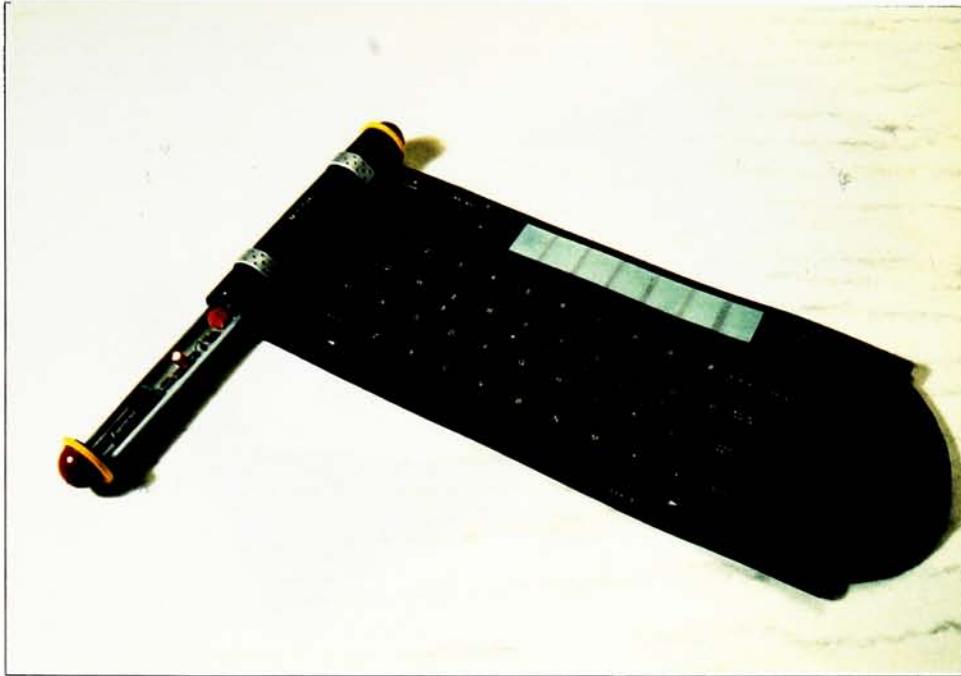
1. The Communicator's main function is a combination of a cellular phone and portable TTY.

2. The battery is located in the shaft of the communicator and is easily accessed by a twist-and-pull motion on the lower yellow ring. The electronics are also located here for easy maintenance.

Fig. 56. The Communicator Model (Closed)

1. The full-size keyboard allows for comfortable usage, and can be rolled up for easy portability and storage.

Fig. 57. The Entertainer Model
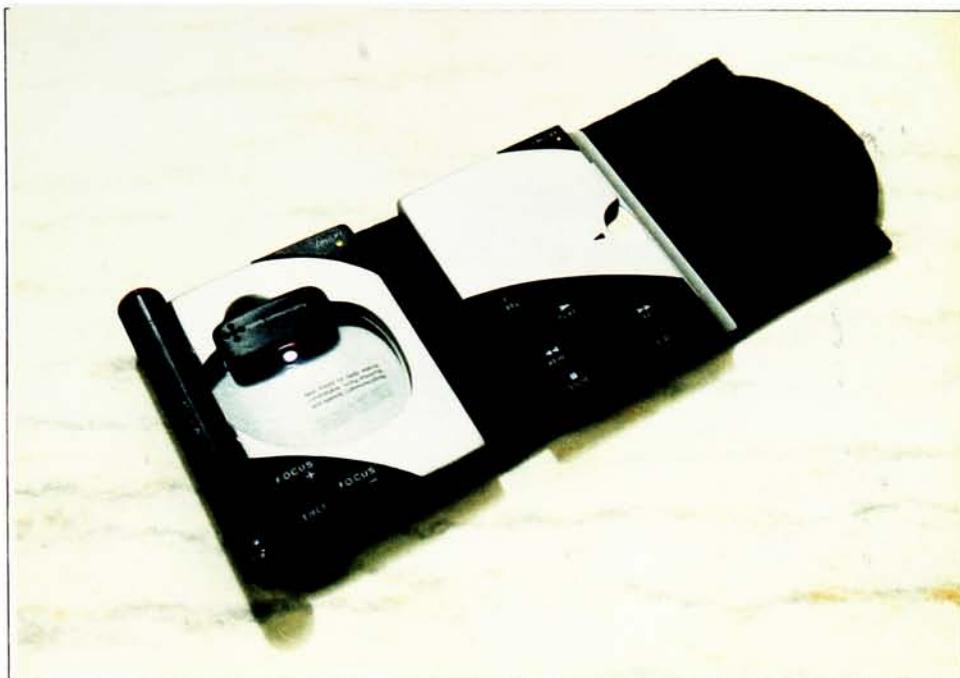
1. The Entertainer provides translation of spoken words, such as from radio, TV, and movies or another person, by projecting these words on Virtual Vision Glass. It acts as a personal interpreter and note taker by recording and playing back words.

1. The read and write compact disk can record and play back words, like a tape recorder would for a lecture in a classroom or seminar.

2. The user can also call up maps from a disk and display location detail on Virtual Vision Glass while traveling

Fig. 58. The Entertainer Virtual Vision Glass Model

1. The Virtual Vision Glass can simply clip on a regular eye glass frame.

2. If users do not have glasses, they can use the Virtual Glass in its own frame.

1. The Entertainer can fold to pocket size for easy portability.