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Biomedical Applications Team

PROJECT EXTENSION REPORT

January to December, 1978

Contract NAS5-23500

Innovations in health care using aerospace technologies

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UNIVERSITY OF WISCONSIN-MADISON

Advisory Center for Medical Technology and Systems

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January 15, 1979

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TABLE OF CONTENTS

DEFINITION OF PROBLEMS OF PERSONS IN SHELTERED CARE ENVIRONMENTS

I. INTRODUCTION

Over the past several years, the NASA technology utilization program has supported several projects related to rehabilitation engineering and problems in aging. In the fall of 1977, NASA co-sponsored with the Veterans Administration a conference on habitability in extended care environments which highlighted the importance of providing the opportunity for social interactions among residents in extended care facilities. Many of the problems of disabled persons result in decreased opportunities for independent action and impromptu social interactions. This is particularly true of elderly persons with general physical disabilities and also younger physically disabled persons who lack sufficient upper body control to be independently wheelchair mobile.

Section 504 of the Rehabilitation Act of 1973 prohibits discrimination on the basis of physical or mental handicap in any federally assisted program or activity. Barrier-free design requirements for all public buildings have been adopted in Wisconsin as well as many other states. Much of the implementation of this legislation has been targeted toward increasing the mobility of the disabled person who retains substantial upper torso strength. There are, however, substantial numbers of persons with various other disabilities whose requirements have been less adequately addressed. A preliminary look at this area indicates that techniques

which permit increased social interactions and self-reliance by bedridden persons in sheltered living facilities provide an excellent opportunity for application of NASA technology and expertise. Various telecommunications, display, input, control and information access techniques developed by NASA are potentially applicable.

In December of 1977, the Wisconsin BATeam proposed to extend the 1977 year contract to undertake a program to better define problems of elderly and disabled persons living in a sheltered care setting which may be appropriately solved by the application of NASA technology, particularly by means of telecommunications and accessible information systems. The program was intended to enhance the visibility of NASA capabilities in this arena, and provide functional definition and constraint descriptions. It also laid the groundwork for a reconfigurable system suitable for integration into a model sheltered living environment and increase the opportunities for Wisconsin BATeam involvement in rehabilitation and other interagency programs.

Around the turn of the year, NASA and the National Institute on Aging jointly sponsored two conferences to exchange information concerning respective programs and to develop areas of common interest. Many of the areas mentioned by the NIA representatives as being significant were related to specific medical or physical limitation problems for which NASA had previously completed projects or had current projects underway, such as the Meal System for the Elderly, the weight alleviation device to permit partial weight bearing after hip replacement, and the female urinary incontinence device. Meeting the psychologic and social needs of the elderly and the handicapped was felt to be important but somewhat difficult to approach in terms of technology application.

Specific communications aids have been conceived but an integrated, reconfigurable system capable of providing many of the information, communications, training, and entertainment functions required by persons with physical limitations has not been developed. The development of such a system utilizing NASA technology, appears, at least initially, to be a worthwhile goal.

II. STATEMENT OF WORK

The University of Wisconsin BATeam shall coordinate the operation of a project to define and characterize needs of the elderly living in sheltered care environments. A number of actions will be taken, based on this information, to explore, initiate, and support the transfer of NASA technologies to help meet some of these needs. The following tasks are to be performed under this contract extension:

Task 1: Gather information on the subject from medical doctors, nursing home administrators, researchers, government workers, special projects operated to meet needs of the elderly, industry sources, and published documents. Organize this information to define and characterize needs of the elderly, paying special attention to those needs that seem to offer opportunities for the new application of technologies. The contractor shall prepare a list of these needs, arranged in some useful order of importance in terms of the overall goals of the project.

Task 2: The contractor shall search for NASA technologies applicable to the needs of the elderly living in sheltered environments. These candidate technologies shall be identified in documented form. Matching of identified technologies with defined needs shall be attempted for those needs ranking highest in importance.

Task 3: An effort will be made to attack at least one matched need/ NASA solution in depth. A strategy for implementing the solution will be developed. This will be forwarded to the technical monitor for consideration, either as an RTOP draft or alternate plan of action.

Task 4: The contractor shall make other recommendations as appropriate in order to make best use of the information derived under this extension.

Task 5: A planning workshop shall be conducted. The subject of the workshop shall be to examine, in depth, the application of NASA technologies to one or more needs of the elderly living in sheltered environments. Results of this planning effort will serve as the basis for the involvement of field center staff in the application of NASA technology to these needs through an RTOP arrangement.

Task 6: A small-scale demonstration of an actual application of aerospace technology to one of the identified needs will be conducted. A report giving details of the application and results from the demonstration and potential for commercialization will be produced.

Task 7: A final report will be prepared summarizing the work done on each of the tasks, as well as directions established, activities completed, and RTOP's written as a consequence of this extension project.

III. PROGRAM ACTIVITY

Task 1

Problem Identification and Significance Evaluation

In order to gain an appreciation of types and significance of the various problems of the elderly and persons with physical limitations, during the first quarter of 1978, BATeam personnel visited several nursing homes and gerontology and rehabilitation centers. Numerous researchers in the field were contacted and asked to evaluate various problems. A presentation of the NASA Technology Utilization program was made to a regional meeting of the Wisconsin Association of Homes for the Aged and significant problem descriptions were solicited. Solicited problems were enumerated and categorized as shown in Table 1. Perceived significance of problems by providers tended to follow their personal interests. For example, one researcher felt the most significant impact of technology on the elderly would be an improvement in the maintenance of gerontological bibliographies. Nursing home administrators, on the other hand, were concerned with transferring patients, decubiti prevention, and special diets.

In order to develop, somewhat, a team consensus on the significance of particular problems and the relative appropriateness of the application of new technology, the problems were ranked by BATeam members, using the list shown in Table 2. Results shown are the mean of the ranking of the seven BATeam members. A summary of results is shown in Table 3.

Table 1

Problems in Aging

- Service Delivery

  - Medical
    Diagnosis of atherosclerosis and chronic brain syndrome.
    Provision of home care and self care

  - Nursing Home Care
    Skin care--decubiti prevention.
    Patient transfer.
    Special diet provision.

  - Dental
    Complicating medical conditions.
    Efficient fitting of dentures.
    Portable equipment for use in rural areas and nursing homes.

  - Information and Referral
    Maintenance of Gerontological bibliography.
    Maintaining and accessing data base.
    Providing ready access to I & R services.

  - Social
    Program accessibility.

  - Economic
    Ongoing funding beyond project demonstration.

- Psycho-social

  - Isolation
  - Lack of motivation and self-worth
  - Boredom
  - Severe monetary constraints
  - Vocational rehabilitation
  - Occupational opportunities

- Environmental Limitations

  - Barriers to access
  - Poor illumination
  - Confusing signs
  - Uncomfortable furniture
  - Dangerous furniture
  - Inconvenient appliances and fixtures
  - Institutional appearance

Table 1 (continued)

- Specific Sensory-Motor Limitations

  - Hearing
  - Vision
  - Ambulation
  - Range of motion
  - Physical strength
  - Memory
  - Concentration
  - Pain perception
  - Temperature perception

- Task Functional Performance Limitations

  - Getting up and down stairs
  - Getting around the house
  - Working around the house
  - Getting outside the house
  - Bathing and washing
  - Dressing and putting on shoes and socks
  - Cutting toenails
  - Preparing food
  - Eating without assistance
  - Hearing people talk
  - Hearing over telephone
  - Seeing to read paper or book
  - Seeing things on television
  - Discriminating temperatures
  - Taking care of hair--cutting, setting, combing
  - Seeing edges of stairs, etc.
  - Getting to and from work

Table 2

PROBLEMS IN AGING

2 = High
1 = Fair
0 = Low

	Signific. & Generality	Amenability to solution by technology	Amenability to solution by MSA technology	Suitability to MSA	Suitability to private sector	Lack of good commercially available solutions
Diagnosis of atherosclerosis and chronic brain syndrome	2.0	2.0	1.0	.67	.33	1.2
Provision of home care and self-care	1.7	1.3	.44	.89	1.0	.47
Skin care--decubiti prevention in nursing homes	1.3	1.1	.80	.41	.41	.83
Patient transfer in nursing homes	1.0	1.3	1.0	.71	.71	.53
Special diet provision in nursing homes	1.0	.71	.93	.93	.19	.93
Providing dental care in spite of complicating medical conditions	1.0	1.0	.40	.88	1.0	.93
Portable dental equipment for use in rural areas and nursing homes	1.5	1.9	1.1	1.6	1.4	1.3
Maintenance of gerontological bibliography	.73	1.3	.67	.93	.93	.73
Maintaining and accessing I&R data base by staff	.53	1.0	.50	.67	.58	1.5
Providing ready access to I&R services	.93	.88	1.0	.50	.58	1.5
Social program accessibility	1.7	.66	.50	.96	.96	.86
Ongoing funding beyond project demonstration	1.6	.96	0	0	0	1.5
Psycho-social isolation	1.7	.66	1.0	.91	.91	1.0
Lack of motivation and self-worth	1.7	.93	.50	.30	.30	.86
Severe personal monetary constraints	1.9	.59	0	0	0	1.3
Occupational opportunities	1.6	.91	.55	.74	.74	1.3
Vocational rehabilitation	1.4	.94	.55	.76	.79	1.1
Barriers to physical accessibility	1.6	1.6	1.0	.97	.93	1.0
Barriers to programmatic accessibility	1.7	1.9	1.4	1.7	1.7	1.4
Poor building illumination	.55	.12	.20	.21	.29	.52
Confusing building signs	.37	.89	.37	.36	.36	.55
Uncomfortable and dangerous furniture	.80	1.2	.57	.79	.79	.65
Inconvenient fixtures and appliances	.92	1.6	.71	.71	.64	.65
Institutional appearance of homes	1.0	.93	0	....	0	.53
Limitations in hearing	2.0	1.8	1.3	1.4	1.0	.87
Limitations in vision	2.0	1.7	1.1	1.1	1.1	1.0
Limitations in ambulation	1.8	1.7	.99	1.3	1.3	1.0
Limitations in range of motion	1.4	1.7	.80	1.1	1.1	1.2
Limitations in physical strength	1.2	1.2	.93	.86	.86	1.0
Limitations in memory	1.4	.67	.50	.93	.90	1.7
Limitations in concentration	1.1	.57	.40	.57	.71	1.2
Limitations in pain perception	1.1	.73	.33	.33	.33	1.4
Limitations in temperature perception	1.1	1.5	.93	1.0	1.0	.98
Limitations in taste	.46	.43	.46	.43	.46	1.7
Limitations in getting up and down stairs	1.4	1.7	.55	1.1	1.1	.73
Limitations in getting around the house	1.1	1.2	.58	1.1	.93	.75
Limitations in working around the house	1.3	1.5	.89	1.0	1.1	.93
Limitations in getting outside the house	1.4	1.0	.74	.73	.69	.95
Limitations in bathing and washing	1.4	1.5	1.2	.93	1.0	.79
Limitations in dressing and putting on shoes and socks	1.1	1.4	.96	.91	1.1	.78
Limitations in cutting toenails	.99	1.5	.58	1.1	.93	1.0
Limitations in preparing food	.96	1.5	.76	1.0	1.0	.63
Limitations in eating without assistance	.63	.91	.36	.95	.87	.90
Limitations in hearing people talk	1.5	1.8	1.5	1.4	1.4	1.0
Limitations in hearing over telephone	1.3	1.8	1.6	1.3	1.3	.67
Limitations in seeing things on television	.90	1.1	.33	.51	.33	1.5
Limitations in discriminating temperatures	.93	1.2	.95	1.0	1.0	1.4
Limitations in hair care	.24	.71	....	.24	.24	.53
Limitations in seeing edges of stairs, etc.	1.0	1.6	1.3	1.1	1.0	.11
Limitations in getting to and from work	.47	1.0	.57	.44	.44	.37

Table 3

SUMMARY OF PROBLEM RANKINGS

A partial listing of problem ranking from Appendix II by catagory follows. As can be seen, the class of problems relating to programmatic access was ranked high in all categories pointing to the desirability of developing a modular information access/communications system. Several problems relating to specific sensory-motor limitations were also identified as areas for specific projects. NASA appropriately already has programs underway in several of these areas.

Significance and Generality	(Mean Score)
Diagnosis of atherosclerosis and chronic brain syndrome	(2.0)
Limitations in hearing	(2.0)
Limitations in vision	(2.0)
Severe personal monetary constraints	(1.9)
Limitations in ambulation	(1.8)
Provision of home care and self-care	(1.7)
Social program accessibility	(1.7)
Psycho-social isolation	(1.7)
Lack of motivation and self-worth	(1.7)
Barriers to programmatic accessibility	(1.7)

Amenability to Solution by Technology	
Diagnosis of atherosclerosis and chronic brain syndrome	(2.0)
Portable dental equipment for use in rural areas and nursing homes	(1.9)
Barriers to programmatic accessibility	(1.9)
Limitations in hearing	(1.8)
Limitations in hearing people talk	(1.8)
Limitations in vision	(1.7)
Limitations in ambulation	(1.7)
Limitations in getting up and down stairs	(1.7)
Limitations in discriminating temperatures	(1.7)

Table 3 (continued)

Amenability to Solution by NASA Technology	(Mean Score)
Limitations in hearing over telephone	(1.6)
Limitations in hearing people talk	(1.5)
Barriers to programmatic accessibility	(1.4)
Limitations in hearing	(1.3)
Limitations in seeing edges of stairs, etc.	(1.3)
Limitations in bathing and washing	(1.2)
Portable dental equipment for use in rural areas and nursing homes	(1.1)
Limitations in vision	(1.1)
Diagnosis of atherosclerosis and chronic brain syndrome	(1.0)
Patient transfer in nursing homes	(1.0)
Providing ready access to information and referral services	(1.0)
Barriers to physical accessibility	(1.0)

Suitability to Pursuit by NASA	
Barriers to programmatic accessibility	(1.7)
Portable dental equipment for use in rural areas and nursing homes	(1.6)
Limitations in hearing	(1.6)
Limitations in hearing people talk	(1.4)
Limitations in ambulation	(1.3)
Limitations in hearing over telephone	(1.3)
Skin care--decubiti prevention	(1.1)
Limitations in vision	(1.1)
Limitations in range of motion	(1.1)
Limitations in getting up and down stairs	(1.1)
Limitations in getting around the house	(1.1)
Limitations in cutting toenails	(1.1)
Limitations in seeing edges of stairs, etc.	(1.1)

Suitability to Pursuit by UW-BATeam	
Barriers to programmatic accessibility	(1.7)
Limitations in hearing	(1.6)
Portable dental equipment for use in rural areas and nursing homes	(1.4)
Limitations in hearing people talk	(1.4)
Limitations in ambulation	(1.2)
Limitations in hearing over telephone	(1.2)
Skin care--decubiti prevention	(1.1)
Limitations in vision	(1.1)
Limitations in range of motion	(1.1)
Limitations in getting up and down stairs	(1.1)
Limitations in working around the house	(1.1)
Limitations in dressing and putting on shoes and socks	(1.1)

Table 3 (continued)

Lack of Good Commercially Available Solutions	(Mean Score)
Limitations in memory	(1.7)
Limitations in concentration	(1.7)
Limitations in taste	(1.7)
Maintaining and accessing information and referral data base by staff	(1.5)
Providing ready access to information and referral services	(1.5)
Ongoing funding beyond project demonstration	(1.5)
Limitations in seeing things on television	(1.5)
Barriers to programmatic accessibility	(1.4)
Limitations in pair perception	(1.4)
Limitations in discriminating temperatures	(1.4)

Cooperative relationships were established with the following:

- Martin B. Loeb, Ph.D., the Faye McBeath Institute on Aging and Adult Life, UW-Madison.
- Calvin M. Kunin, M.D., Geriatric Health Outreach Program, VA Hospital, Madison, WI.
- Gregg C. Vanderheiden, TRACE Research and Development Center for the Severely Communicatively Handicapped, Madison, WI.
- Stanley York, Wisconsin Association of Homes for the Aging, Inc., Madison, WI.
- Donald Warren, Ph.D., Wisconsin Foundation for Applied Technology, Madison, WI.

These relationships enabled the UW-BATeam to obtain further insight and perspective on numerous problems of the aged. In the course of these interactions, two new problem statements were prepared, UW-53, "Prepackaged Meal System with Special Dietary Considerations for the Elderly," and UW-54, "Unobtrusive Alerting System to Protect Confused Elderly Persons." These are reported in detail in the UW-BATeam quarterly report issued under Contract NAS5-24385, April-June, 1978.

Task 2

Attempts to solve several of these problems are currently underway by numerous groups including NASA. A number of the problems do appear to be amenable to solution by an integrated information-communications-display system. Accordingly, the BATeam is developing functional specifications for such a system.

The system envisioned would permit a person with limited mobility or sensory-motor function to readily gain access to a wide variety of information. Included would be self-care and self-triage medical

information, vocational and other educational material, recreational material, and the wide range of information currently supported by information and referral services. In addition, communications capabilities would be used to decrease psycho-social isolation and perform remote medical monitoring. Environmental control could also be provided. The system would be modular and reconfigurable to meet the input, output, and storage requirements of particular patients. The standard configuration would likely have voice input and voice and/or raster scan c.r.t. output.

Examples of existing NASA technology that may be integrated into this system have been identified and are incorporated into the system description under Task 3 below.

Task 3

DISCUSSION

Further investigation of the needs for assistive devices for independent living indicated a lack of compatibility among existing and developing devices. The efficient and optimal provision of assistive systems for the multiply disabled elderly will require a means of interfacing devices to work together for the individual.

Concurrent with increases in the duration of life is a requirement to maintain the quality of life. Dependency upon others for the conduct of daily life activities is not only expensive but also damaging to one's sense of self-worth. It has become generally recognized, both as a matter of public policy and from a humanitarian standpoint, that the opportunity for independent living of elderly and disabled persons should be increased to the greatest extent possible.

The UW-BATeam's investigation on problems of the elderly has indicated that there is a spectrum of difficulties which elderly persons experience and that there have been a large number of attempts to use technology to solve these problems individually. Sometimes this approach has resulted in a device which is capable of only assisting one individual, or more often is successful, to some degree, in assisting persons with the same category of diminished sensory/motor capacity. Additionally, there appears to be significant overlap in applicable technological approaches between rehabilitation methods and assist systems for the elderly. Moreover, elderly persons may, unlike the younger disabled, frequently have more than one area of diminished sensory/motor capacity. Thus, their ability to tolerate an independent living situation may be dependent upon compensating for two or more of these sensory/motor limitations.

An approach which will permit each individual elderly person requiring assistance and support systems only those functions which are required at a minimum cost would be facilitated by the development of a standardized interface system for control and communications among assistive devices for the elderly. The development of such a standardized system for interface would permit the efficient addition of functional modules (e.g., voice syntehsizer system, medical status evaluation module) as needed by the individual. Many hardware and software functions have already been developed by various groups but cannot easily be used together to assist the multiply disabled. The conceptual interface system would avoid the necessity of duplication by an individual manufacturer's previously developed systems for use with another manufacturer's device.

Design of assistive devices in a modular fashion permits efficient reconfiguration to meet the needs of individuals with particular sensory/

motor limitations. For example, a voice decoder module would permit vocal quadriplegics to control various functions such as automatic telephone dialing, information access, environmental control, etc. The tactile input-output module would similarly permit blind and deaf persons to control and access various support functions. In addition to being modular in terms of hardware, such a system would have modular software so that resource modules could be added independently of one another. Some function capabilities for compensation which are presently identified are:

- Patient education to improve self care and triage.
- Remote medical status monitoring.
- Automated communications to relieve psycho-social isolation.
- Sensory compensation.
- Motor compensation by means of environmental control.
- Memory support for those with failing recall.
- Vocational, educational, and occupation resources accessibility.
- Personal status monitor/alarm.
- Information and referral material
- Motivation and self-worth enhancement by interaction and positive reinforcement.
- Recreation by means of entertainment access and games playing.

In many cases, devices are available to perform one, or possibly more assistive functions for disabled persons. There is, however, no provision made to facilitate the efficient interconnection of two or more of these devices to provide an integrated system with all of the required functional assist capabilities for the multiple disabled person. This is in marked contrast to other scientific and technical areas where interfacing standards are widely used to enable interconnection and operation of different equipment types from differing manufacturers to form a complete system. Some examples of these standard compatibility protocols are RS-232, IEEE 488, and the S-100 standard.

SYSTEM DESCRIPTION (WITH TRANSFER POSSIBILITIES)

A. SYSTEM DESIGN

Requirement: System definition and development of module functional specifications. Design of system interconnection structure to insure bus compatibility of modules.

1. Function

   (a) Modularity--hardware and software.

   (b) Reconfigurability.

   (c) Distributed intelligence.

   (d) Communications protocol.

   (e) Bus definition.

2. Technology

   NASA expertise in system design and integration.

B. SYSTEM CONTROLLER

Requirement: Small, inexpensive enclosure capable of housing the necessary feature modules needed by the individual user. Overall system control, intercommunication coordination among modules, and self-test functions would ease operation.

1. Function

(a) Housing for feature modules.

(b) Power supply.

(c) Communication/data coordination and protocol.

(d) Personality definition--accommodation to feature modules in unit.

(e) Self test.

(f) Definition of soft fail system modes.

2. Technology

Extensive experience at Goddard in microprocessor-based control systems.

C. VISUAL INPUT/OUTPUT MODULES

Requirement: Convenient and legible display of information for normally sighted users, as well as the extra large or symbolic display for those with impaired sight. Presentation of input selections for disabled users coupled to specialized command sensor switch.

1. Function

(a) Presentation of pictoral, graphic, and alpha numeric information in variety of formats to user.

(b) Availability as part of an auxiliary input system with input selection by:

1. Scanning cursor.
2. Scrolling script.
3. Presentation of symbols, figures or other non-alpha designators, from specialized fonts in various formats.
4. Light pen.

2. Technology

(a) Computer Display System For Saturn Prelaunch Checkout. Developed for Marshall and Kennedy by Sanders Associates, Inc. (New Hampshire) . . . . embodied significant advances in digital television hardware and software for computer interface systems . . . . used by Sanders to design and install medical data management computer systems at the Mayo Clinic (Minnesota), Kaiser Memorial Hospital (California), and Walter Reed Hospital (District of Columbia) . . . . total value about $300,000 . . . . each system allows data input-output at several remote terminals in hospital . . . . enabled seven-year backlog of admissions and accounting data at Mayo to be brought up-to-date in 30 days . . . . improved capability for managing increasing amounts of medical

data from more admissions, shorter stay times per patient, more laboratory test results, and more data inputs to diagnoses. (Contractor, TEF 99, DRI Case No. 76502, 1/75)

(b) Digital TV-Display Device. The RTI Biomedical Applications Team initiated a special project to determine how the cathode ray tube oscilloscope could be replaced by a less expensive display device. The end purpose of the project was to demonstrate that new technology can be applied to the design of a new type of oscilloscope display device. What was envisioned was a device that could economically replace the oscilloscope in most medical research applications.

A prototype design was assembled and evaluated at Langley Research Center. It clearly demonstrated that the oscilloscope performance could be adequately matched by the new device at a much lower cost. The prototype was brought to Duke University for further evaluation. Also, the Team identified an electronics manufacturer who was enthusiastic about this project. He was especially interested in exploring the possibility of a joint development project. A proposal is being prepared by the company. The Team will work with this manufacturer to develop a clear commercialization strategy including the identification of the necessary funding.

(c) Visual Simulation Systems. Developed for Johnson by General Electric Co. (Florida) . . . . a computer-generated color TV display to simulate spacecraft docking, space shuttle landing and other space-related applications . . . . commercialized by G.E. in modular design for various applications . . . . currently

used in Navy's pilot training program and being installed for Boeing Co. to train pilots for aircraft such as the 727 and 747 . . . . other potential applications are: air traffic control training, highway and city planning, ship captain training, and animation for TV advertising . . . . unit's fast storage equipment can accommodate multiple users . . . . system cost is $250,000 to $1.5 million, depending on configuration. (Contractor, TEF 389, DRI Case No. 64101, 2/75)

(d) Active Filter Circuit Design Method. Developed for Marshall . . . . circuitry and design procedures utilized by Computer Image Corp. (Colorado) in development of its Scanimate computer . . . . contributed to unit cost reduction from $350,000 to $300,000 each . . . . annual sales about $900,000 . . . . 1973 service income $2 million . . . . product used to generate computer animation for television advertising for Pontiac, Wards, Amoco, Kellogg, Black Label, and Time magazine . . . . 15%-20% business in training, educational films . . . . customers include U.S. Navy, Signode Corp., Children's Television Workshop. (SBA/TSP, TEF 436, DRI Case No. 56028, 5/77)

D. TACTILE INPUT/OUTPUT MODULES

Requirement: For normal users, touch entry or selection of alternatives represents the means requiring least training and familiarization with the system. Tactile output may be the most practical method, particularly for deaf/blind users, or others with multiple impairments.

1. Function

(a) Input Modules:

(1) Provide the ability to the user of entering or selecting information for entry to the system. Options available would be:

(i) Keyboard device of reconfigurable format. Braile coding optional.

(ii) Transparent overlay sensor array to permit touch selection of input from visual display module.

(iii) Special control sensors.

(b) Output Modules:

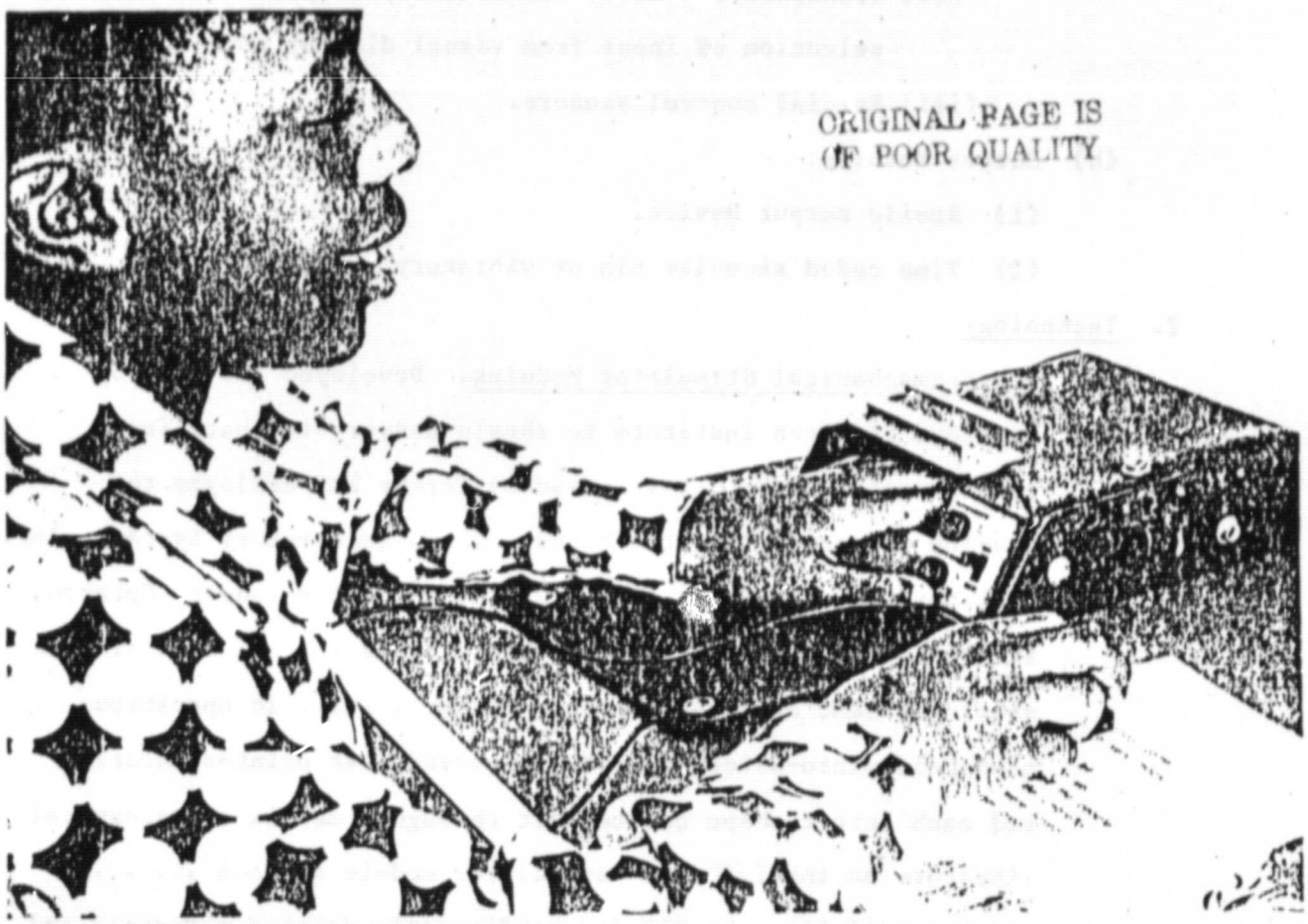
(1) Braile output device.

(2) Time coded singular pin or vibratory output device.

2. Technology

(a) Electromechanical Stimulator Modules. Developed for Ames by Stanford Research Institute to obtain sensory feedback from remote manipulators . . . . used by former SRI employee to develop new reader for the blind . . . . Telesensory Systems, Inc. (California), founded in 1970, marketed the new reader, Optacon, in 1971 . . . . company holds patent rights . . . . unit size is about the same as a small tape recorder . . . . in operation, hand-held photo-detector probe is passed over printed material and each letter shape can be felt through a matrix of mechanical vibrators on the 1/2" x 1" stimulator module surface . . . . 2 models available; the R1B for reading only printed materials and the R1C which can also be adapted to read printed information from video terminals and electronic displays . . . . R1B retail price

is $2,895, and the RIC price is $2,995 . . . . approximately 2,800 units sold to date, 25% to 33% outside U.S. . . . 1976 sales to date total approximately $2 million . . . . 100 units were tested by the National Center for the Deaf-Blind (New York) with favorable results . . . . 100 units are used in Pennsylvania schools . . . . 20 California school districts provide Optacon training . . . . user benefits include shorter learning time than Braille and ability to read most standard material . . . . reader is having a dramatic impact on the educational, vocational, and leisure activities of blind and deaf-blind persons. (Personnel/contractor, TEF 594, DRI Case No., 113671, 7/76)



This blind child is reading, thanks to a device called the Optacon. The boy is passing a mini-camera over a printed page with his right hand; with his left he is sensing a vibrating image of the letters the camera is viewing. The Optacon allows the blind to read almost anything in print, not just braille transcriptions. The system originated in research performed at Stanford Research Institute under NASA sponsorship.

E. VOICE SYNTHESIZER MODULE

Requirement: Blind persons would be unable to utilize the visual output module and would be able to receive information much faster than by tactile means, including braile.

1. Functions

(a) Provide an intelligible voice output to convey information available through the system.

(b) Provide an output available throughout the residence for alerting and informing the user of special conditions.

2. Technology

Voice synthesis systems have been developed by JSC for annunciator purposes. A project is presently underway at Ames on a portable speech prosthesis, which also employs voice synthesizer technology.

F. VOICE RECOGNITION MODULE

Requirement: Two basic categories of disability could significantly benefit from voice recognition technology.

(a) The quadraplegic user could readily and flexibly employ voice for input and control of the system. For this purpose, the module would only be required to identify and decode a limited vocabulary of control and input commands.

(b) The hearing impaired user could benefit from the availability of a more versatile voice recognition system capable of receiving voice information and providing visual display to the user.

1. Functions

(a) Voice Control Module. Recognize a limited vocabulary of words and numbers (less than 100) for input and control of the system.

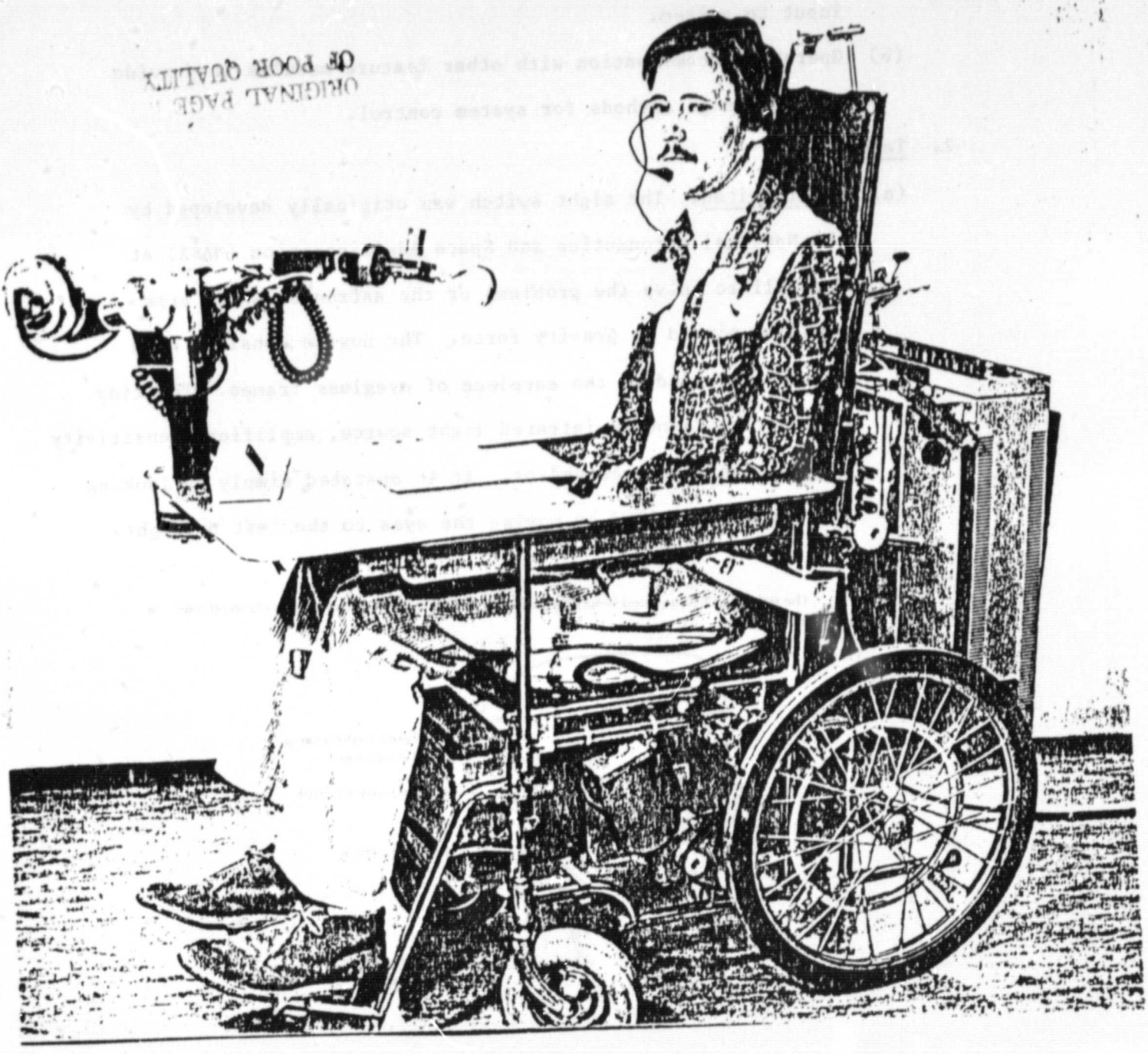
(b) Voice Recognition System. Recognize and provide input to the system verbal communication to allow the deaf user to receive information from a variety of sources. Display could be provided on the visual display module.

2. Technology

(a) Voice-Controlled Wheelchair. A quadraplegic from Pasadena, California, demonstrates the NASA-developed voice-controlled wheelchair and its manipulator, which can pick up packages, open doors, turn a TV knob, and perform a variety of other functions. A possible boon to paralyzed and other severely handicapped persons, the chair-manipulator system responds to 35 one-word voice commands, such as "go," "stop," "up," "down," "right," "left," "forward," "backward." Heart of the system is a voice-command analyzer which utilizes a minicomputer. Commands are taught to the computer by the patient's repeating them a number of times; thereafter the analyzer recognizes commands only in the patient's particular speech pattern. The computer translates commands into electrical signals which activate

appropriate motors and cause the desired motion of chair or manipulator. Based on teleoperator and robot technology for space-related programs, the voice-controlled system was developed by Jet Propulsion Laboratory under the joint sponsorship of NASA and the Veterans Administration. The wheelchair-manipulator has been tested at Ranchos Los Amigos Hospital, Downey, Calif., and is being evaluated at the VA Prosthetics Center in New York City.

(b) A voice recognition system is under development at Goddard by Lokerson at the present time.



G. SPECIAL SENSORS/CONTROL MODULES

Requirement: Users of the system with a variety of combined disabilities and sensory impairments would be unable to use effectively some of the visual, tactile, or audible input and output modules. For these individuals, special devices would provide alternate control and input mechanisms.

1. Function

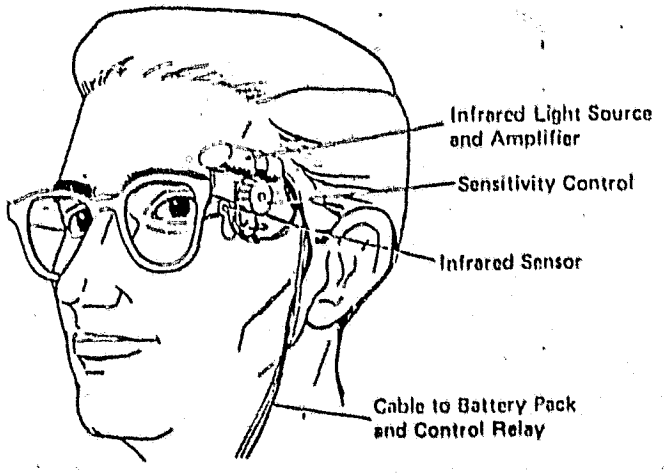
(a) Enable user with multiple disabilities to control and provide input to system.

(b) Operate in combination with other feature modules to provide custom design methods for system control.

2. Technology

(a) Sight Switch. The sight switch was originally developed by the National Aeronautics and Space Administration (NASA) at Marshall to solve the problems of the astronaut whose arms would be pinned by gravity force. The device consists of a cylinder mounted on the earpiece of eyeglass frames. The tiny cylinder contains an infrared light source, amplifier, sensitivity control, and infrared sensor. It is operated simply by looking at it and controlled by moving the eyes to the left or right.

The sight switch is operated simply by looking at it; it has been used experimentally to operate a wheelchair.



(b) Breath-Actuated Control. A prototype breath-actuated system was developed with TUO funding at Huntsville Hospital (Alabama) . . . . hospital project leader joined Scientific Systems International (Alabama) and developed new product based on prototype unit . . . . product, called Nu-Life is available on a custom-order basis . . . . price is $900 to $4,000 per unit, depending on accessories . . . . higher price includes a miniature computer with capacity for 99 control functions . . . . 17 sold since March 1974 . . . . potential market of 2 million severely disabled perople. (BATeam, Personnel, TUO-Applications Engineering, TEF 159, Case No. 108483, 11/76)

H. HEALTH ASSESSMENT MODULE

Requirement: Individuals who are elderly or have chronic diseases may have dietary or self-care programs which are often complex or easily forgotten. Patients may have procedures which are required to be performed periodically following discharge from the hospital. Additionally, elderly individuals may be uncertain about what types of symptoms should prompt a visit to the doctor, and those which do not.

1. Functions

   (a) Programmed Health Assessment. User operated interview to assist in determining probable desirability of visiting doctor in response to symptoms (linked to clinic via telephone).

   (b) Self Care Assistance. Tailored assistance instructions to aid in self care and post discharge conduct of recommended procedures.

   (c) Measurement of physiological parameters pertinent to assessing health status of patient for remote review by clinician via telephone line.

2. Technology

   (a) Skylab Medical Checklist. Developed by NASA for use by Skylab astronauts. Covers all body systems, diagnostic procedures, drugs on board and treatment to enable astronauts to provide themselves with routine and emergency medical care. The special nature of this document is highlighted by the following discussion taken from the manuscript:

> "The basic philosophy used in constructing this book is to present diagnosis and therapy sections which correspond to anatomical parts or functional sections of the body so that the user could enter the appropriate section corresponding to the location of his ailment. Confusion arises when the signs and symptoms do not point to a specific section. This can be as a result of signs

and symptoms which do not seem to relate or correlate to a single section (such as would result from referred pain--pain occurring in a different location from the causative disease or in the case where the symptoms are too vague or general (malaise, myalgia, headache).

This approach is justified by the fact that pain or discomfort is the most predominant complaint and local diseases usually cause localized pain; systemic diseases tend to produce a diffuse discomfort.

While no attempt is made here to make specific differential diagnostic judgments, the history and physical examination must be performed to collect the necessary information from which a diagnosis and course of treatment can be determined on the ground. In an attempt to accomplish this end with a minimum of communications with the ground, the systemic section is presented to address those sets of signs and symptoms which do not point to any other specific section and those which are too vague or generalized."

(b) JSC STARPAHC technology for remote physiological data acquisition.

(c) Automated Patient Monitoring System and NIMBUS Telemetry System. Developed for Marshall by Boeing Co. and for Goddard, respectively . . . . Marshall applications engineering project to demonstrate feasibility of using Saturn rocket telemetry system in medical context . . . . former NASA employee formed Care Electronics in 1969 to market new product--modified version of Marshall design . . . . NIMBUS telemetry estimated to have saved $500,000 in developing commercial system . . . . digital system collects several channels of data, such as blood pressure, EKG, and temperature, from 4 patients simultaneously and transmits to central control station . . . . includes automatic alarm feature . . . . total sales exceeded $4 million before the product line was terminated in 1974 . . . . approximately 200 systems still being used at medical facilities in Tennessee, Connecticut, Ohio and other states. (Personnel/Marshall, TEF 116, Case No. 62401, 8/76)

I. ALARM SENSOR MODULES

Requirement: Individuals with diminished sensory or motor capacity are likely to be less aware and able to respond to emergency situations including fire, tornado, intrusion. Additionally these persons are more apt to experience incidents (falls, heart attack, injury) which would require assistance.

1. Function

(a) Hazard condition sensors (e.g., fire, NOAA weather, intrusion) provide input to system; programming defines appropriate response alert mode (e.g., audible, wearable tactile device, automatic telephone dial response).

(b) Personal crisis alert device, wearable by user may be activated and cause system to execute programmed response to summon aid.

2. Technology

(a) Silent Communications Alarm Network (SCAN). Developed for Headquarters by Jet Propulsion Laboratory . . . . emergency communication system used by jail or prison guards or other staff . . . . consists of pen-sized transmitter containing no batteries or electronics, with receivers located to pinpoint person requiring assistance . . . . licensed by Sentry Products, Inc. (California) in 1974 . . . . company refined original system and now markets a broad product line to corrections, juvenile halls and court facilities . . . . other applications include schools, apartments for retirement, handicapped persons and industrial plants . . . . eventual use as part of home intrusion systems is planned . . . . total annual sales are $100,000 . . . . benefits expected to continue. (Purchased product line, TEF 586, DRI Case No. 112243, 8/75)

(b) A radio linked tactile stimulator system for the deaf-blind is presently under development at Ames.

J. TELEPHONE INTERFACE MODULE

Requirement: The effectiveness of the system in increasing the capability for interaction and communications with others would be enhanced by a versatile mechanism for connection and control of the telephone system. This represents the lowest cost and most flexible link from the user in his residence to others.

1. Function

   (a) Permit system control of all normally manual-activated modes of telephone operation.

   (b) Capability of automatic programmed telephone dialing for alerting outside individuals of conditions in the user's residence.

   (c) Capability of programmed response to interrogation over telephone system from outside residence to verify user health status, verification of scheduled activities, and self care.

2. Technology

   (a) In-House Telephone System. Developed by Johnson . . . . inexpensive, closed loop system accommodates 16 or more telephone or data units and 8 simultaneous 2-way conversations through 4 interconnecting wires; it uses fewer circuit components than existing systems and requires no central exchange control . . . . used by Cook Industries, Inc. (Tennessee), a major wholesale grain company, to design an in-house telephone system for its plants and facilities in the Memphis area . . . . company saved $8,000 by adopting NASA design . . . . use of the system is expected to continue. (TB/TSP, TEF 618, DRI Case No. 104504, 4/76)

K. ENVIRONMENTAL CONTROL MODULES

Requirement: Users with motor disabilities have often severely restricted capabilities for control of their residential environment (e.g., light, heating and cooling, entertainment such as radio and television).

1. Function

(a) Control linkages to appliances and devices in the residence to enable activation and regulation by the individual using the system.

(b) Status indication of environmental parameters to the user via the system.

2. Technology

(a) Apollo Guidance Computer Software and Data Communication Methods. Developed for Johnson by TRW Systems (Texas) . . . . used by TRW Controls (Texas) to develop software and interface equipment for computerized control systems for oil field production, oil and gas pipelines . . . . major intenational supplier of such systems, over 3 dozen major oil and gas company customers . . . . provides "real-time" monitoring and control from central station . . . . high-speed data transmission over voice grade circuits between central station and remote terminals is innovation in supervisory control systems . . . . computer systems replacing intermediate-level automation . . . . field production benefits through reduced operating cost and increased production . . . . Exxon Corp. (Texas) has computer production control (mostly TRW) in 20 major U.S. fields (200,000 barrels oil and 850 million cubic feet gas, daily) and estimates 1-2% production benefit . . . . other customers include Continental Oil Co. (Louisiana and California), Getty Oil Co. (Texas), Imperial

Oil, Ltd. (Canada), Mobil Oil Corp. (Oklahoma, California, Louisiana, Pennsylvania), National Iranian Oil Co. (Iran), Shell Oil Co. (Louisiana, Venezuela), and MAPCO, Inc. (Oklahoma). (Contractor, TEF 465, DRI Case No. 86005, 8/74)

(b) Multiplexer Circuit for Saturn Rocket Instrumentation. Developed for Marshall by SCI Systems, Inc. (Texas) . . . . used by SCI in remote data acquisition and control systems product line . . . . systems installed on oil and gas pipelines and oil field production equipment . . . . provides better centralized monitoring and control, with less manpower . . . . 50 installations worldwide, 30 in U.S. (Contractor, TEF 119, DRI Case No. 4793, 9/74)

L. INFORMATION STORAGE/RETRIEVAL MODULE

Requirement: Persons with diminished motor capability or physical disabilities experience difficulty in mobility. This tends to increase their dependence upon others for access to information and program materials of many types. This is most acute for those who live alone and do not have relatives or friends nearby. Educational and entertainment opportunities are most readily available in classrooms, libraries, theaters, and other places outside the home. Often the increased effort to gain programmatic access results in less contact and diminished feelings of self-sufficiency. Lack of outside stimulation tends to produce introversion and fewer topics of discussion to motivate communication with others.

1. Function

   (a) Capability of providing user access to educational, recreational, reference, and personal data in one or more of the following medias, for differing user needs:

      (1) Alphanumeric and text.

      (2) Video and graphic images.

      (3) Audible information.

      (4) Tactile information.

   (b) Memory loss compensation by programmable prompting/alerting function as required by user.

2. Technology

   (a) Medical Information Management System (MIMS) developed at Goddard Space Flight Center.

   (b) Videotape Storage and Retrieval System. Computerized system developed for Marshall by Ampex Corp. (California) . . . . NASA waived patent rights on key tape transport mechanism to Ampex in

1963 . . . . improved and commercialized by Ampex as Videofile system . . . . a single tape reel stores records from 10 four-drawer file cabinets . . . . total sales $23 million . . . . American Republic Insurance Co. (Iowa) installed Videofile in 1972 for all insurance records . . . . provides claims and rate analysts with immediate access to records . . . . system is faster and minimizes chance of error. (Contractor, TEF 226, Case No. 66201, 8/74)

(c) Apollo Guidance Computer Software and Data Communication Methods. Developed for Johnson by TRW Systems (California) . . . . used by TRW Data Systems (California) to develop computerized retail sales systems for department store chains . . . . largest supplier of such systems; has installed about 60 on-line computer systems (80% of total installations), with over 50,000 point of sale (POS) terminals connected to these systems . . . . typical system with 1,000 credit authorization terminals in 175 stores costs about $1.5 million; average improvements over nonautomated methods include 95% reduction in purchases on bad debt accounts, 75% reduction in fraud purchases, 20% cost savings in payroll for authorization employees, and 33% reduction in telephone calls . . . . systems with POS cash register terminals also provide improved inventory control, more accurate and faster sales transactions, more detailed merchandising information, and better sales data for management analysis . . . . TRW customers include Montgomery Wards, May Co., Neiman-Marcus, J.C. Penney, Rich's, Burdine's, Hudson's Bay Co., and many more. (Contractor, TEF 465, Case No. 104260, 10/74)

Task 4

DISCUSSION

Gerontologists and other experts in problems of the aged indicated that a valuable contribution might be made in developing a common interface concept for these devices. The considerable NASA expertise in systems management and technical interface development for subsystems could help to describe what an optimal interface concept might be. The following plan for possible RTOP investigation of this approach was prepared and submitted to TU Headquarters.

PROGRAM PLAN

A. INTRODUCTION

1. Objective

To implement and evaluate the effectiveness of a reconfigurable information-communications-display system intended to enhance the opportunities for independent living and social interaction of elderly and other persons with various degrees of sensory-motor limitations. Data will be collected to allow an evaluation of the costs of and the benefits resulting from various components of an integrated information-communications-display system including:

- Patient education and medical status monitoring component to increase the reliability of home care and/or self care.
- Multi-modal controlled communications component to increase socialization and motivation of persons with sensory-motor limitations.
- Information access and display component to increase educational, vocational and recreational opportunities of persons with limited mobility and/or sensory-motor limitations.
- Remote environmental control and monitoring component for use by persons with various sensory-motor limitations.

B. SPECIFIC AIMS

1. To implement a reconfigurable integrated information-communications-display system for efficient use by persons with various sensory-motor limitations.
2. To determine the value of such a system in increasing independent action and self-sufficiency during the conduct of daily life activities by persons with various disabilities.
3. To determine the effectiveness of user operated instruction, prompting, and memory support on improving compliance of persons dependent upon self care and health maintenance programs. Can these capabilities reduce frequency and duration of institutional visits or care?
4. To ascertain effectiveness of the system for increasing frequency and duration of social interaction by users.
5. To determine relative utility to user of sophisticated versus basic function modules for sensory-motor compensation (e.g., word recognition system with very limited control vocabulary versus comprehensive speech recognition capability).
6. To establish relative effectiveness and cost parameters, both capital and operating, of self-contained system in residences as opposed to lower cost, simpler home device with linkage to centralized support system.
7. To determine most appropriate configurations of system modules, both hardware and software, to allow effective general usage by target populations, only possible through commercialization.

C. METHODS OF PROCEDURE

1. Data Collection and Evaluation

The nature of the system intrinsically provides the ability to collect and process information regarding utilization by the user. Frequency and duration of use of each of the system functions could be easily internally recorded in a form directly usable for analysis.

Baseline data regarding each individual's living patterns would be collected prior to orientation and training in use of the system. Interview information and reassessment of the person's living patterns and activities, while having available use of the system, would be conducted. These data together with subjective information obtained from the user about its perceived value would be used with the other data for evaluation of the system.

2. Proposed Method of Operation

(a) Formation of an advisory panel composed of researchers in gerontology, social science, and rehabilitation medicine to establish system parameters and describe conceptual approach, desired functions and constraints.

(b) Preparation of detailed system description and functional specifications jointly by the advisory panel and systems/human factors engineering personnel.

(c) Identification of groups with required technical expertise to prepare proposals for development of system hardware and software modules.

(d) Review, revision, and validation of proposed system by advisory panel.

(e) Module design, development, and prototype fabrication.

(f) Assembly, installation, and testing of system at evaluation site.

(g) Development of specific evaluation protocol by advisory panel and selection criteria for individual users to begin evaluation.

(h) Solicitation of interest by capable appropriate agencies to determine potential sources of manufacture, distribution, sales, and operational support.

(i) Evaluation of system with selected individuals to establish suitability and effectiveness of system functions and module performance.

(j) Review of evaluation data by advisory panel, with indicated revision and modifications.

(k) Expanded evaluation and involvement of commercial concerns to develop design appropriate for manufacture and sale.

Task 5

Background: The UW-BATeam's investigation on problems of the elderly has indicated that there is a spectrum of difficulties which elderly persons experience and that there have been a large number of attempts to use technology to solve these problems individually. Sometimes this approach has resulted in a device which is capable of only assisting one individual, or more often is successful, to some degree, in assisting persons with the same category of diminished sensory/motor capacity. Additionally, there appears to be significant overlap in applicable technological approaches between rehabilitation methods and assist systems for the elderly. Moreover, elderly persons may, unlike the younger disabled, frequently have more than one area of diminished sensory/motor capacity. Thus, their ability to tolerate an independent living situation may be dependent upon compensating for two or more of these sensory/motor limitations.

Contacts with bioengineering and clinical personnel indicated interest in exploring possible solutions to this problem. To accomplish this, a planning workshop on interface concepts for electronic aids for the aged and disabled was organized. The objective of the workshop was to survey the application of NASA technologies to one or more needs of the elderly living in sheltered environments. Results of this planning effort are intended to serve as the basis for the involvement of field center staff in the application of NASA technology to these needs through an RTOP arrangement.

Following is the workshop agenda and a list of participants. Additionally, invitations were sent to all field center TUO's and BAT directors to encourage participation and contribution from technical staff at other TU units. Recommendations and a system concept design that resulted from workshop discussions are shown next.

AGENDA

A PLANNING WORKSHOP:
INTERFACE CONCEPTS FOR ELECTRONIC AIDS FOR THE AGED AND DISABLED

University of Wisconsin-Madison
November 14, 1978
Union South
227 N. Randall Avenue
Madison, Wisconsin

8:00 a.m.	Registration
8:30	Welcome and Introduction Melvin P. Siedband, Director, Advisory Center for Medical Technology and Systems, University of Wisconsin, Madison, Wisconsin.
8:45	The Spectrum of Existing Electronic Aids and Future Directions Maurice LaBlanc, Director of Rehabilitation Engineering, Children's Hospital, Palo Alto, California.
9:45	Coffee Break
10:00	Scope of Needs for Aids by the Handicapped Donald R. Warren, Director, Wisconsin Foundation for Applied Technology, Inc., Madison, Wisconsin.
11:30	Lunch - Communicative Aids and Current Standardization Efforts Gregg Vanderheiden, Director, TRACE R&D Center for Severely Communicatively Handicapped, University of Wisconsin, Madison, Wisconsin.
12:45	Working Session I - Scope of Interface Concepts
2:00 p.m.	Coffee Break
2:15	Working Session II - Technical Considerations of Interfacing
3:30	Presentation of Directions Developed in Working Sessions
4:00	Open Discussion and Establishment of Workshop Recommendations for Priorities in Development of Interface Standards

PARTICIPANTS

Luke Brenan, Stanford Biomedical Applications Team

Marshall Curtis, Wallops Flight Center

Douglas O'Handley, Jet Propulsion Laboratory

Donald R. Warren, Wisconsin Foundation for Applied Technology, Madison, WI

Gregg C. Vanderheiden, TRACE Center, University of Wisconsin

Betty Hasselkus, V.A. Geriatric Health Outreach Program, Madison, WI

Maurice LaBlanc, Children's Hospital, Stanford, California

Dr. Z. Khachaturian, National Institute on Aging, Washington, DC

Melvin P. Siedband, UW-BATeam

Bakki V. Kudva, UW-BATeam

William N. Fetzner, UW-BATeam

Jean C. Behrens-Tepper, UW-BATeam

James C. Houge, UW-BATeam

Recommendations for Coordination of Future Activities

1. Develop a forum to continue efforts in technology coordination to aid end users. Organization should be highly structured and oriented towards efficient operation.
2. Form a steering committee whose purpose would be to facilitate the founding of such an organization. Alternatively, this body would identify an existing organization which could be appropriate for these efforts.
3. Steering committee should prepare a directions paper to serve as a scope and starting basis for the organization.
4. Arrange for invited presentation to be made at a Rehabilitation Inter-agency Meeting to focus interest on this topic and make provision for discussion following these presentations.
5. Set specific objectives for coordination of interface convention development.
6. Define "interface" in terms of:
   a. Functions.
   b. Aspects (e.g., voltage signal level).
   c. Types (e.g., input versus output).
7. Establish international liaison with activities including Canada, United Kingdom and Sweden.
8. Develop a needs rationale for integrated scope of coordination of interface technology.

Recommendations for Technical Description for Interfaces

1. Function Definition
   a. To allow modularity.
   b. To permit expansion.
   c. To permit assembly of customized system.
   d. To allow common use of peripheral devices (e.g., switches, display devices).
   e. To allow exchange of data between parts of a system.
2. Aspects (i.e., parameters).
   a. Voltage level and polarity.
   b. Data format (e.g., serial, parallel rate).
   c. Coding (e.g., ASC II).
   d. Pinout location of interfaces.
   e. Connector compatibility.
3. Types of interfaces.
   a. Passive transducer to input processor.
      (1) Simple contact switch or emulation thereof.
      (2) Analog signals.
      (3) Pulse train signals.
   b. Active transducer to input processor.
      (1) Unprocessed signals.
      (2) Digital signals in coded formats.
   c. Processor to Processor
      (1) Intra package (digital signal within package).
      (2) Digital signal outside of package.
   d. Processor to output actuator.
      (1) High security public access.
      (2) ASC II compatible.
      (3) Bit line control.

CONCEPTUAL REPRESENTATION OF DEVICES AND INTERFACES

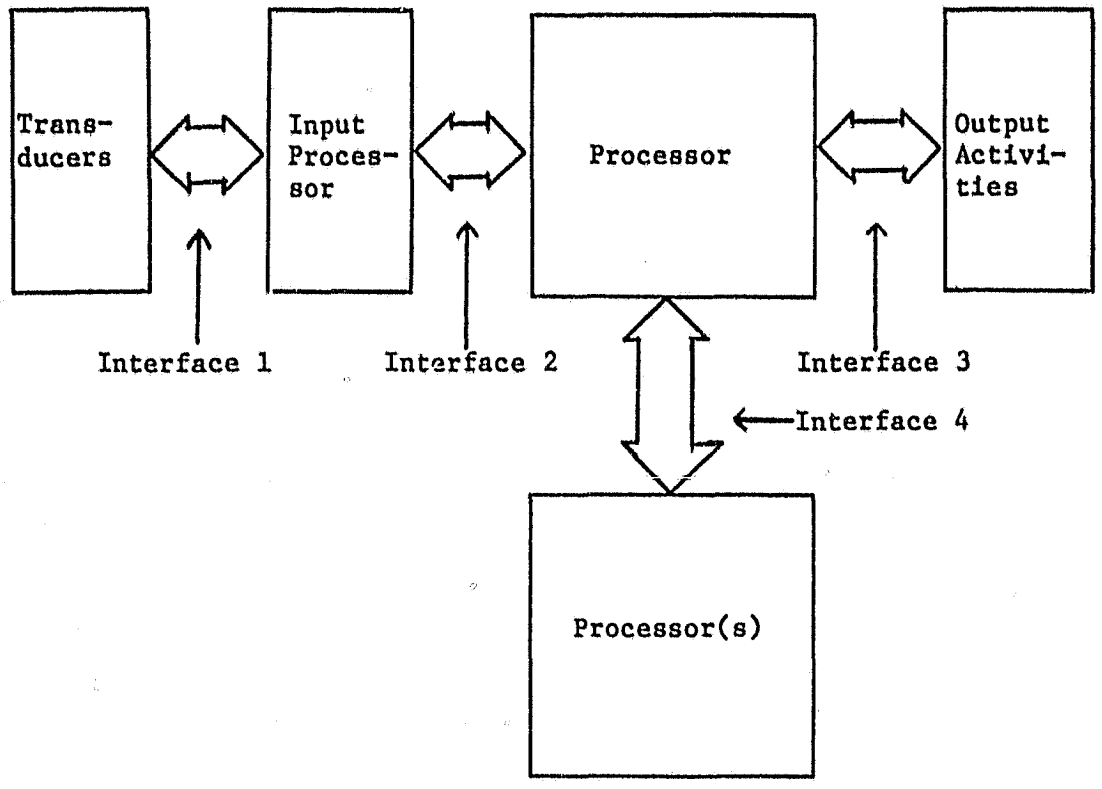


Figure 1

Task 6

Background: Continuing interaction with the geriatric health outreach program of the VA Hospital in Madison revealed that the elderly with severely diminished short-term memory need help to maintain dietary and medication regimens necessary to their continued health. An investigation was undertaken to examine the feasibility of an electronic memory compensation system for use by elderly persons having this difficulty.

Preliminary Functional Concept: An assistive electronic device could compensate for short-term memory loss by presenting on demand or at programmed times information necessary for the individual's independent functioning. Examples of this type of data are:

- Medication time, dosage, and special cautions.
- Dietary constraints.
- Self care methods (e.g., action recommended to stop acute heartburn).
- Appointments for doctor, dentist, and other necessary events.
- Shopping recommendations or restrictions.

The concept selected for investigation makes use of an electronic module connected to the users' television set. An internal clock would permit prompting at programmed times selected for the individual. A message containing the information (e.g., "9:00 AM - Take 2 aspirin tablets with water and record in log.") would appear on the television screen. The user would also have a small selector keypad to enable inspection of the stored information. During preparation for grocery shopping, he could press the "Shopping" button and see displayed recommendations and cautions about what should or should not be purchased according to his

dietary restrictions. Similarly, at the onset of an acute episode, he could press "Medication" and see displayed recommended steps and medications to terminate the condition. The device could be programmed in at least four ways:

1. Programmed by the user. This would require greater knowledge of the technology of the device and the use of a general purpose keyboard, both of which may be imposing to some elderly persons.
2. Programmed by plug-in modules or cassettes. These would be updated by the user's doctor or other care providers and replanned by the user.
3. Programmed by visiting nurse or other care providers. During visits to assess user's conditions and needs, revision as needed could be accomplished by a data entering device brought along at the visit.
4. The device could be both reviewed and updated via telephone modem. This raises the possibility of routine data retrieval regarding the user's activity so that visits could be optimally arranged.

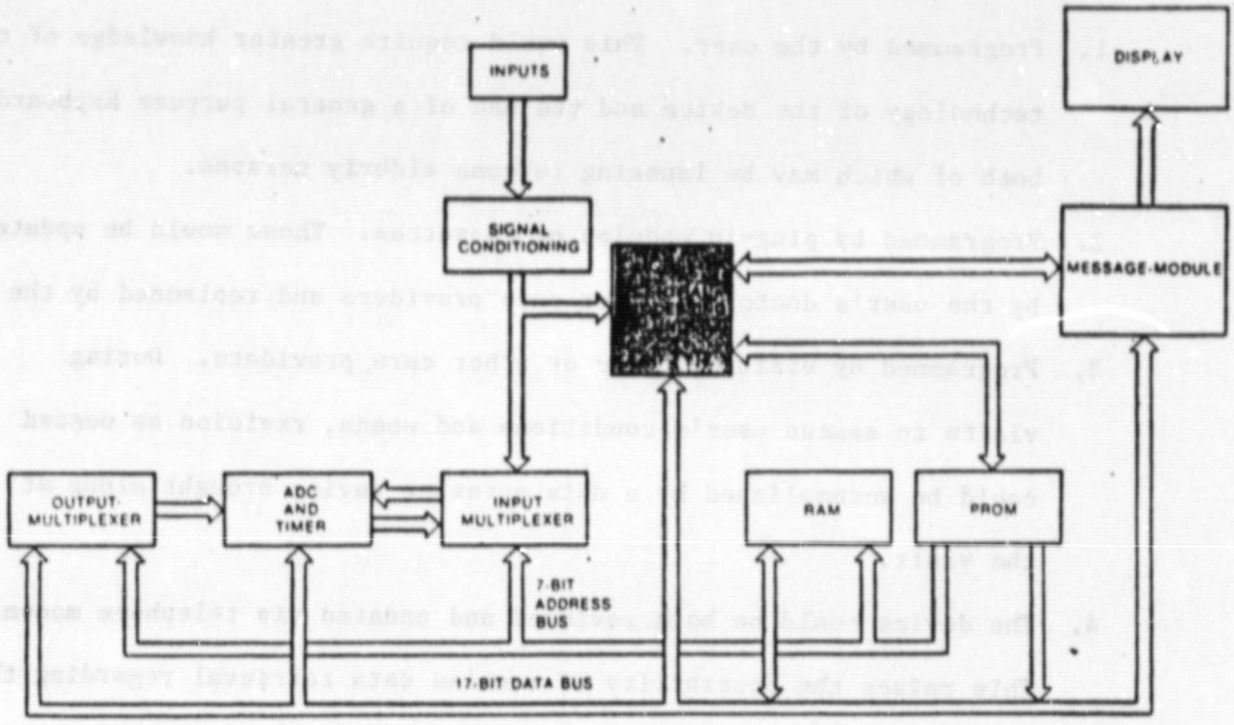
The third alternative was explored first due to the fact that regular home visits are already made by staff of the VA GHOP to their clients.

NASA Technology: A caution and warning system (CWS) was developed by JSC for biomedical monitoring and display of critical information (Figure 2). This concept was intended to be a 100% reprogrammable system to scan for prioritized parameter inputs and generate a wide spectrum of message, display, and alarm outputs. The generality and reconfigurability of this concept are directly applicable to the prompting and information display system for the elderly.

Caution and Warning System

A biomedical-monitoring and display system can be used for intensive-care and patient monitoring.

Lyndon B. Johnson Space Center, Houston, Texas



A Block Diagram of the Caution and Warning System: The CPU (central-processing unit) is the "brain" of the CWS. It selects the next functional-logic program step (i.e., programable read-only memory information address) based upon data given by sensor inputs, analog-to-digital conversions, time delays, and random-access memory (RAM) status data. The CPU is also constantly on the alert for an interrupt signal generated by one of the five critical-priority parameter inputs. Upon receipt of a priority interrupt, the CPU initiates a branch in the functional-logic software to a priority service subroutine. The RAM is a 64-bit memory that stores information concerning system status, and its contents are changed during the course of CWS operation. For example, if the CWS functional logic determines that a sensor has failed, this bit of information is written into the RAM so that the CWS will take into account the failed-sensor status every time the CWS interrogates that sensor. This memory gives the CWS the ability to "learn" about CWS status during system operation. The RAM can be reinitialized under operator control and will relearn the current CWS status at the time of the reinitialization.

A system consisting of several solid-state logic units linked to auditory and visual display devices and biomedical instruments is employed as a warning and diagnostic system for a life-support system.

The caution and warning system (CWS) represents a substantial improvement in sophistication over earlier systems. Life-support system parameters are continuously monitored. If a malfunction occurs in the life-support system, the CWS will detect and display the out-of-range condition. Proper corrective procedures and present status are automatically presented to an operator.

The system circuit design is based upon a digital, bus-oriented architecture, with its accompanying simplicity, flexibility, and noise immunity advantages. The CWS functional logic is completely contained within a solid-state, electronic PROM (programable read-only memory). This allows the CWS to be 100 percent reprogramable; that is, its operating functional logic can be completely changed by the substitution of the new PROM's for the existing PROM's.

All CWS functional logic is permanently stored on miniature solid-state electronic-memory integrated circuits, which relieves the operator of the responsibility of memorizing life-support system operational details and eliminates extensive checklists. Tests have demonstrated that specific malfunction procedures can be easily and accurately incorporated into a functioning caution

Figure 2

A model for a low-cost hardware implementation of the concept was suggested by work supported by ARC in development of a reliable scanning computer-controlled aircraft navigation receiver to seek VHF-omnirange (VOR) stations. This receiver automatically selects and displays selected beacon bearings, resulting in fewer manipulations required by the pilot for navigation. The initial design utilized an HP-9825 desktop calculator, but a lower cost system was subsequently developed using an MOS technology 6502 based microcomputer as the 8 bit computer control. Another valuable feature in this latest device is implementation of an IEE 488 standard interface to permit use in a wide variety of aircraft applications.

These three concepts--reprogrammability, the use of flexible existing microcomputer components, and a standard interface scheme--were basic to the design of the demonstration device.

A feasibility mockup was assembled. Co-funding was obtained from the Graduate School at the University of Wisconsin-Madison. A commitment has been obtained from staff of the GHOP to place the device in clients' homes and conduct a field trial of the concept. The mockup was demonstrated to members of a NASA site visit team in November and was completed in December 1978.

Present Status

Review meetings have been held with the staff of the GHOP who will be supervising the first on-site evaluation. The first clients will be an 80-year-old man and his wife who live in their own dwelling in a small, rural Wisconsin town. The man has diabetes, a heart condition, and severe loss of short-term memory. His wife's short-term memory is also significantly impaired. Due to his multiple medical problems and

associated dietary constraints, their ability to live independently is marginal because of poor compliance with necessary tasks. They are both willing to comply but are unable, due to memory lapses. The GHOP staff felt that this living situation would be an appropriate environment to initially assess the value and practicality of the prompting and information display system.

The home evaluation is scheduled to begin the third week of January 1979.

Future Directions

Discussions have been held with staff of both the TRACE Center for Severely Communicatively Handicapped and the Wisconsin Foundation for Applied Technology. Both groups have expressed interest in potential collaborative work to adapt the system to meet allied needs in the disabled client populations targeted by their efforts. The goal is to develop product concepts derived from the system developed for the elderly, and broaden the base of such a market to enhance likelihood of larger volume production of a "core" unit with the attendant cost advantages of large production quantities.

Additionally, the UW-BATeam has been asked by United Cerebral Palsy of New York City to make a presentation before their Bioengineering Committee and to assist in adaptation of this NASA-developed intelligent controller technology to the needs of their clients for increased influence over their environment and a greater degree of independence (see attached letter).

It is anticipated that this visit will result in a definition of functional needs and the exploration of a collaborative program to bring

about the use of this advanced technology for the benefit of UCP clients. The generalized system concept described under Task 3 will in all probability be expanded and focused as a result of this interaction. An early involvement of NASA field centers will also be sought. The first meeting with UCP is scheduled for January 16, 1979.

ucp

united cerebral palsy of new york city, inc.

122 east 23rd street/new york, n.y. 10010 / (212) 677-7400

November 28th, 1978

Mr. Melvin Siedband
Director, ACMTS
Biomedical Applications
Team
University of Wisconsin
1500 Johnson Drive
Madison, Wisconsin 53706

Dear Mr.Siedband:

We were very pleased to receive your letter of November 8th and to know that you share our concern for the handicapped.

We were particularly delighted to know that you plan to send one of your scientists to talk with us and to help us find some solutions to the problems of our severely handicapped clients.

We have organized a Bio-engineering Committee which meets regularly to discuss specific problems. I think it would be most helpful if your scientist could meet with this committee, together with our center directors and certain therapists who are directly involved with the clients' needs. There will also be an opportunity to observe our client population and gage the severity of their handicaps.

The next meeting of the Bio-engineering Committee is scheduled for Tuesday, January 16, 1979. We have set aside the entire day to meet with your representative. (Needless to say, if we may have more time, I assure you, it will be well used.)

Please advise as soon as possible whether January 16th is convenient. If not we shall be pleased to arrange a new date.

We look forward to a profitable cooperation.

Sincerely,

Sylvia M. Schmitz
Coordinator Research
and Grants Funding