FINAL REPORT

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Research and Development of a Versatile Portable Speech Prosthesis

MEMBER OF REHABILITATION ENGINEERING SOCIETY OF NORTH AMERICA

Research and Development of a
Versatile Portable Speech Prosthesis

FINAL REPORT

May 1978 - November 1981

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Summary

The Versatile Portable Speech Prosthesis (VPSP) is a
synthetic speech output communication aid for non-speaking
people (see Figures 1-2). It was intended initially for
severely physically limited people with cerebral palsy who
are in electric wheelchairs. Hence, it was designed to be
placed on a wheelchair and powered from a wheelchair battery.
The VPSP has been dubbed the "Talking Wheelchair," though the
name is misleading because it can easily be separated from
the wheelchair.

The VPSP is "versatile" because it is designed to accept any
means of single switch, multiple switch, or keyboard control
which physically limited people have the ability to use. It
is "portable" because it is mounted on and can go with the
electric wheelchair. It is a "speech prosthesis",
obviously, because it speaks with a synthetic voice for
people unable to speak with their own voices.

The advantages of speech have been eloquently expressed by
Michael B. Williams, a writer with cerebral palsy and a
disabled people's rights activist:

> Advantages of Speech Output Devices Over
> Communication Boards
>
>
> * The "speaker" need not be physically close
>   to the "listener" to transmit a message.
>
> * The "speaker" can communicate:
>   **when the"listener's" back is turned.
>   **when the "listener" is in another room.
>   **with a group of people.
>   **with people who have vision problems.
>   **with people who have difficulty reading.
>   **with small children.
>   **in the dark.
>   **words he/she can't spell.
>
> * The "speaker" can make up his own "fun" or
>   "crazy" words.
>
> * The "speaker" can create "throw-away" lines for
>   future use quickly in conversation.

SUMMARY

The project was initiated in May 1978 and completed in November 1981. One prototype unit was built and tested with users and avenues were pursued by which to make the results of this research available to the user population.

This report will explain how the project developed, how it was conducted, the results of testing with users, and future plans.

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Figure 1.
VPSP showing CRT in front and CPU, speech
synthesizer, and wheelchair battery in
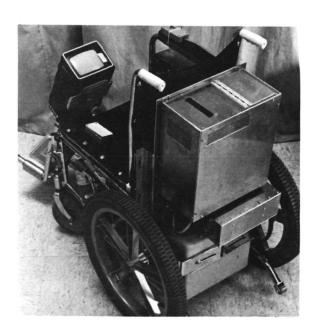rear. Typical single control switch is
on seat of wheelchair.

Figure 2.
VPSP showing Everest and Jennings Model 3P
Electric Wheelchair on which components
have been placed.

Background

Various estimates (Bureau of Education for the Handicapped, 1976; Firing, 1978; National Academy of Sciences, 1971; National Center for Health Statistics, 1971; National Institute of Neurological and Communicative Disorders and Stroke 1976; Rehabilitation Engineering Center U. of Va., 1978; Shanks, 1980) suggest that there are about two million people in the U.S. with speech impairment, or about 1% of the total population. The number of people requiring communication aids or speech prostheses is difficult to assess from the available information. Estimates of the number of those with a serious or disabling speech impairment range from roughly 200,000 to 1 million, or .01 to .05% of the total population. While there are a number of communication aids with visual and printed outputs, speech can provide faster and more efficient communication, easier group or classroom participation, telephone conversation, the ability to communicate with children who cannot read, a way to interrupt or initiate communication and the psychological benefit of being able to speak.

Some commercially available devices offer speech capability, but they all have major failings:

* The vocabulary is limited to pre-stored
  words or phrases, which limits a user's
  conversation.
* User-created vocabulary items cannot be
  stored when the aid is turned off.
* Phoneme-programmable speech synthesis
  requires extensive user training in
  order to achieve intelligible speech.
* Message construction for those individ-
  uals that cannot use keyboards is painfully
  slow and frustrating.

Beginning in 1974 the Man-Machine Integration Branch (now the Man-Vehicle Systems Integration Division) of the Ames Research Center, National Aeronautics and Space Administration conducted extensive psycholinguistic human factors research on applications for synthesized speech in airline cockpits. Transfer of this technology to solve the communication problems of the non-vocal appeared promising. Research and patient services at the Rehabilitation Engineering Center, Children's Hospital at Stanford, are aimed at providing technology to augment the capabilities of multiply involved, severely physically disabled persons.

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Accordingly, Children's Hospital at Stanford submitted a proposal to NASA-Ames and received a grant in April, 1978 to research and develop a prototype device that would meet the objectives desired.

A team was assembled, consisting of Maurice LeBlanc of the Rehabilitation Engineering Center of Children's Hospital at Stanford; Charles Lingel, Consultant Engineer; Dr's Carol Simpson and Douglas Williams, of Psycho-Linguistic Research Associates (PLRA); and Dr. Gene Schmidt (later replaced by Mr. Gary Steinman) and Luke Brennan of the Stanford Biomedical Applications Team.

Objectives

The goal of this project was to develop and test a VPSP for use by severely motor-impaired, non-vocal people. The original proposal (Children's Hospital at Stanford, 1977) listed the project objectives as:

* The vocabulary will be easily programmable by the naive user.
* The user will be able to store, retrieve, and edit his/her own vocabulary.
* The intelligibility of the speech will be improved.
* There will be a user control interface to allow operation by severely physically involved people.
* It will offer advancement toward:
    # Providing the voice prosthesis with some "linguistic competence" so it can anticipate message phonology and syntax.
    # Making the voice prosthesis more interactive with the user.
    # Making the prosthesis tolerant of user errors, so as not to waste the user's time.

Design of the original version of the VPSP was completed in May 1979. Additional user controls were added by November 1979. The final VPSP features which are significant advances are:

* Speech output from normally-spelled English text.
* Enabling the user to create, store, retrieve, and edit his own vocabulary.
* Improvement in the intelligibility of the speech over any synthesized speech communication aid commercially available.
* Choice of user controls, and standard plugs and software interface to make changing controls a plug-and-go operation.
* Providing the voice prosthesis with some "linguistic competence" so it can anticipate message phonology and syntax, thereby increasing communication speed.
* Making the voice prosthesis tolerant of user errors. It is highly interactive, allowing optional automatic verification, and several choices of error removal.

Approach

The task of designing the software for the VPSP was intimately entwined with the user's capabilities. The interface between the VPSP and the user had to be designed in a way that would make it easy for the user to learn to operate the device and that would maximize speed of communication. The speed problem was especially important for the 1-switch users that the VPSP project initially addressed. The task was made more difficult by the fact that the very people who could best tell us how they wanted the device designed could not do so because of their inability to speak. The solution to this problem lay in assuming that there would be great similarity in the perceptual and cognitive functioning of the 1-switch, non-vocal population and the able-bodied population. Basic principles of good human factors design, taken from the literature, were simply applied to the VPSP design. Examples of these principles are:

* Immediate, unambiguous feedback by system to user's input.
* Consistent ordering of command sequences, of elements in visual displays, and of system behavior to user inputs.
* Consistent, unambiguous meaning for special symbols.
* Elimination of computer jargon--operations are named in familiar terms.
* Elimination of linguistics jargon--language elements are named in familiar terms.

It was decided to use a cathode ray tube (CRT) display as the means for the VPSP to "communicate" with the user. The CRT was chosen for its flexibility in display layout and alteration, despite the disadvantages of large size, power consumption, and fragility.

A search of the literature revealed a dearth of experimental data on user performance pertaining to the design of visual displays of any sort for use in x-y scanning display and control systems. Some considerations are obvious from the mathematics of the x-y scan operation. However, questions regarding the arrangement of letters and words within the matrix could not be answered from available literature. Thus, it was decided to perform some short experiments to resolve these questions.

Page Layout Research and Design: Able-bodied individuals served as subjects in a set of psycho-linguistic experiments that compared different formats for the display of visual information to the user, with the displays being simulated with printed sheets of paper. Certain principles

of psycholinguistic design, derived from this research (see Simpson, et. al.,1979 and Simpson, 1980) were then used to guide the VPSP design for the 1-switch and joystick versions. Visual search time for words in a row/column layout was found to be faster with a syntactic layout than with layouts arranged alphabetically, by word frequency of usage, or randomly. As used here, syntactic layout has the words arranged in columns by syntactic category and these columns ordered according to syntactic surface structure order. The experiment on visual search times for layouts of letters for spelling new words compared alphabetical to grapho-phonotactic layouts. Grapho-phonotactic layouts are analogous to syntactic layouts in that letters are arranged in columns according to their position category in the spelling of English syllables with the columns ordered from left to right according to orthographic (spelling) surface structure order. The position categories and rules for orthographic surface structure order were derived from the work of Benjamin Whorf (1940) and translated from Whorf's phonemic analysis into a corresponding orthographic analysis.

Secondary variables studied in the second experiment were letter clusters, affixes, and boxes around categories. (See Simpson, 1980 for details) Results of the experiment showed alphabetical layout to be faster than the syntactic analog of letter layout, which we are calling grapho-phonotactic layout. Also, displays with letter clusters resulted in longer search times than those with single letters. However, actual users of the 1-switch VPSP greatly preferred the grapho-phonotactic layout, and also found it slightly faster than the alphabetical layout. It should be noted that visual search time for a desired item is only part of the time required to retrieve that item when one is using an x-y scanning system. The number of scanning moves of the cursor for spelling words is smaller for the grapho-phonotactic layout than for the alphabetical layout. This feature probably explains the user's preference for the grapho-phontactic layout.

Page Hierarchy Research and Design: As with page layout, there were many questions regarding the best hierarchy for the display pages in terms of the paths the user could take to get from one page to another. Accordingly the software was designed to be extremely flexible so as to permit easy restructuring of page hierarchy during the course of tests with actual users.

For the initial design, the page hierarchy was organized according to a simple syntactic surface structure similar to the early, phrase structure (pre-transformational) grammar proposals of Chomsky (1969). Separate pages dealt with declarative sentence structure,

and interrogative sentence structure, noun phrases, verb
phrases and various semantic categories of words. In
accordance with human factors principles above, the pages
were given familiar terms as names -- "words that name
things," "action words," "make a new phrase," "ask a
question." From the "make a new phrase" page the user could
go directly to the "words that name things" page without
going back to a main menu page - the "table of contents"
page. From the "words that name things" page, the user
could go directly to a page with a particular semantic
category of nouns or adjectives, say "places" or "food" or
"names of people", or "kind-of words". The VPSP kept track
of the user's path through the pages, remembering up to 10
previous pages, in order. When the user had finished with a
special purpose page, e.g. "words that name things", he or
she had only to use a VPSP command called "return to
previous page" in order to be returned to the page that held
the words needed to continue with the general sentence type
(declarative or interrogative) that was under construction.
The diagram in Figure 3 illustrates this phrase structure
style of page hierarchy. An arrow from one page to
another indicates that one can go directly from one to the
other in the direction of the arrow and be automatically
returned to the first using the "return to previous page"
command.

Observations of frequency of "page" usage by users showed
that very few of the special purpose semantically
organized "pages" provided were used often enough to warrant
their inclusion in a production VPSP. Overlapping semantic
categories for many frequently used words required
duplication of a given word on several pages in order to
make it easy to find. As a result of this observation, most
content words - nouns, adjectives, adverbs, and verbs - were
placed in a large, alphabetically ordered "dictionary"
comprising 25 "pages" with a total of 925 words. The
dictionary was developed by analyzing several lists of
frequently used words taken from written, conversational,
and basic daily living vocabularies (Kucera and Francis,
1967; French, Carter, and Koenig, 1930; and Bliss, 1975).
The only semantically-based "pages" that were retained in
the final VPSP were calendar words (days of the week,
months), numbers, time words (before, after, until ...), and
places (closet, living room, kitchen, museum, hospital ...).
In contrast to the semantically based pages, users made
extensive use of the syntactically based pages for making
declarative statements, asking questions, possessives,
connector words (of, and, but, or, perhaps, maybe, in, the,
a, this ...). Also frequently used were the morphologically
based pages for suffixes - one for prefixes and one for
endings. The dictionary and the grapho-phonotactic spelling
pages were also used extensively.

APPROACH

The observations of experimental results, then, determined
the following VPSP software design features:

* For those versions that use indirect selection
  via a single switch or a joystick, letters on
  the spelling page are arranged grapho-phono-
  tacktically.
* Layouts of words on sentence construction pages
  and the links among pages are syntactic rather
  than alphabetical or semantic.
* The dictionary is alphabetical.

Except for the dictionary pages, words and phrases on most
pages are grouped by syntactic category. But the
syntactic structure of the page hierarchy is far simpler
than even the simplistic phrase structure proposed by
Chomsky. (Figure 4 illustrates this). The early hierarchal
structure was compared to the final one in terms of
longest switch closure distance between any two pages.
Since 1-switch users get from one page to another by closing
a switch when the cursor gets to the page they want (see
section on VPSP Software below), the number of switch
closures to get to a page, i.e. the switch closure distance
to the page, is an indicator of time and difficulty to get
to that page. It was found that the early structure had
several pages that were as many as eight switch closures
away from some of the other pages; in contrast, the maximum
number of switch closures between any two pages in the new
layout is four with the exception of the user's own text
pages. The text pages can be from 2 to 6 switch closures
away, depending on the user's position in the structure. In
addition to the shorter switch closure distance between
pages, the final version has more pages and more pre-spelled
words than the original version of the VPSP. Thus there
were multiple benefits of simpler hierarchical structure. A
list of the final pages is shown on page 13.

PARTIAL DIAGRAM OF ORGINAL
1-SWITCH VPSP PAGE HIERARCHY

*☐ TOC

☐ ASK   ☐ WORD ☐ PLAC   ☐ NAME   ☐ MAKE ☐ ACTS   *☐ SPEL   ☐ HELP   ☐ CONN   ☐ARE   ☐ USE 1
                                                                                    ☐ USE 2
                                                                                    ☐ USE 3

☐ SOUND ☐ ALPH ☐ END.

☐ HELP   ☐ NAME ☐ WORD ☐ CONN ☐ ACTS

☐ NUMB ☐ KIND ☐ PERS ☐ PLAC ☐ POSS ☐ FOOD ☐ CLOTH
                                                ☐ DRINK

☐ Pg.2
☐ Pg.3
☐ Pg.4

* A * in front of a page
  name means that you can
  go directly to that
  page from any other
  VPSP page.

→ User can go from one
  page to the other in
  direction of the arrow
  and can return to the
  orginal page using the
  *return command.

Figure 3.

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Figure 4.

REVISED VPSP PAGE HIERARCHY

*□TOC

□ USE F □ ASK
□ USE 2
□ USE 3

□ PG.2

□CONN □DCT □ACTS

□ MAKE □ PLAC □TIME

*□SPEL □CALEND * UC

□POSS □ACTS □DICT

□ABYD = □ANSW = □ BASIC = ... = □WARM □CONN □PREF □END

(25 DICTIONARY PAGE)

□ SOUN □ NUMB

→ User can go from one page to the
   other in direction of the arrow
   and can return to the orginal
   page using the * return command.

* A * in front of a page name means
   that you can go directly to that
   page from any other VPSP page.

APPROACH

List of Pages for 1-Switch and Joystick VPSP

Startup

Table of Contents #1

Table of Contents #2

Ask a question

Useful phrases

Make a new phrase

Spell new words

Connectors (this, and, but, of, some...)

Places

Acts (get, go, make, give, want...)

Time words (then, later, since...)

Calendar

Sound spelling

Prefixes for words

Endings for words

Possessives (my, his, our, your...)

Numbers

Dictionary

Directions to use talking wheelchair

20 blank user pages, each renameable by the
user (each can hold 14 lines)

25 dictionary pages, each with 37 words

9 text pages, user programmable up to
512 characters

APPROACH

Research and Development for Keyboard System: It was
assumed that keyboard users should have available the same
sorts of functions provided by word processing software –
insert and delete characters anywhere within the text,
cursor movement in four directions, text displayed in
multiple lines rather than just one line at a time.
These functions were provided. An initial command syntax
using labeled function keys for going to pages by name
and clearing parts or all of a page was developed. This
keyboard version was used in the evaluation with users
described later. During that evaluation, all keyboard users
and most of the experimenters, including the authors, were
observed to repeatedly make the same mistakes in the order
in which they used the function keys to go to new pages.
So, after the evaluation, the command syntax was changed to
make the "mistaken" order be the correct order for using the
function keys. A pilot study with one keyboard user who had
not been in the original evaluation and who, therefore, had
equal exposure to each version of the keyboard system, showed
a 22% to 58% reduction in time required to perform the
various functions with the new version. He also expressed
preference for the new version over the old version for all
the functions tested – going to a new page, finding an
existing page, and clearing a page. Although further
testing of the keyboard system would have been desirable,
time and project funds did not permit this.

Hardware

The VPSP is a prototype device constructed mainly from off-the-shelf components. Its major technological contributions are in the area of human factors design. For research and development purposes it was designed to be portable on a standard electric wheelchair, and to be powered for several hours operation by the wheelchair batteries. Wheelchair mounting was chosen as a design factor because the majority of the target user population were so severely disabled that they would be confined to a wheelchair in any case. The device proved to be so useful that ambulatory patients often used it, and the wheelchair was a hinderance. The actual prosthesis has no requirement for wheelchair mounting if it were redesigned to optimize it for hand-portable use. A commercial version would be expected to be independent of a wheelchair. It was designed so that any of the user controls could be changed in seconds. Currently available controls include several varieties of single-switch, a joystick, a five-switch slot control, and a keyboard.

The hardware consists of a standard S-100 cardcage, a Cromemco Z-80 CPU, 16K of RAM, a 12cm (5 1/4") floppy disk drive and controller, and a custom video and memory-mapped synthesizer interface. This is all enclosed in an aluminum box and fits on the standard mounting brackets on the back of an Everest and Jennings wheelchair. The speech synthesizer is a Votrax ML-1, repackaged to reduce its size and to provide for battery power. The video display is a standard Hitachi 12cm (5") TV, modified for direct video input and located in any of several mounting spots, depending on user preference. The speaker is Radio Shack 12cm (5") unit in an 18mm (3/4") plywood box mounted on the side of the wheelchair. (See Figure 5-6).

The single switch and the joystick inputs are memory-mapped, and the keyboard is interfaced via a standard TTL parallel port. The hardware was distributed around the wheelchair so as to maintain the balance and function of the wheelchair as much as possible. This objective seems to have been accomplished, for in the user evaluation trials, the VPSP was used at schools, at parties, in user's homes, and transported in buses, vans, and pick-up trucks without damage or problems. Further hardware details and photographs are included in LeBlanc, et. al. 1980, and Simpson, 1979. An operation manual for the system is included as Appendix V of this report.
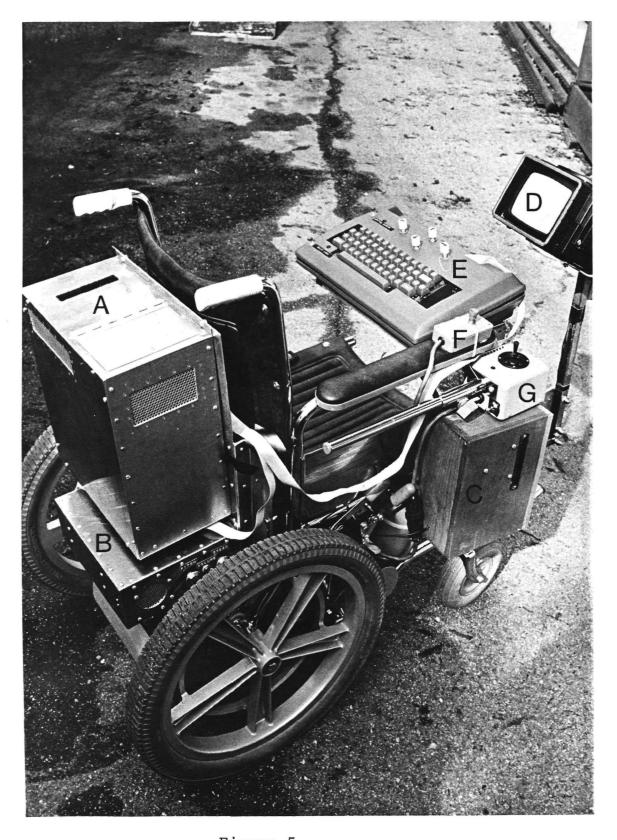
Figure 5.
VPSP Components: (A) computer, (B) speech synthesizer,
(C) speaker, (D) CRT (standard Hitachi TV), (E) keyboard,
(F) on-off switch, (G) wheelchair joystick control.
Single switch and joystick controls for VPSP not shown.

User Controls:

```
┌─────────────┐              ┌─────────────────────┐        ┌──────────────────┐
│  Single     │─────────────▶│                     │◀──────▶│  5" Disc         │
│  Switch     │              │                     │        │  (Long-Term      │
└─────────────┘              │                     │        │  Storage)        │
                             │                     │        └──────────────────┘
┌─────────────┐              │  Z - 80 Computer    │
│  Joystick   │─────────────▶│  16 K Memory        │        ┌──────────────────┐
└─────────────┘              │  Disc and Video     │        │  CRT             │
                             │  Interface          │───────▶│  (Modified 5"    │
┌─────────────┐              │                     │        │  TV set)         │
│  5 - slot   │─────────────▶│                     │        └──────────────────┘
└─────────────┘              │                     │
                             │                     │
┌─────────────┐              │                     │
│  Keyboard   │─────────────▶│                     │
└─────────────┘              └─────────────────────┘
                                        │
                                        ▼
                             ┌─────────────────────┐
                             │     Votrax          │◁  Speaker
                             │     Synthesizer     │
                             └─────────────────────┘
```
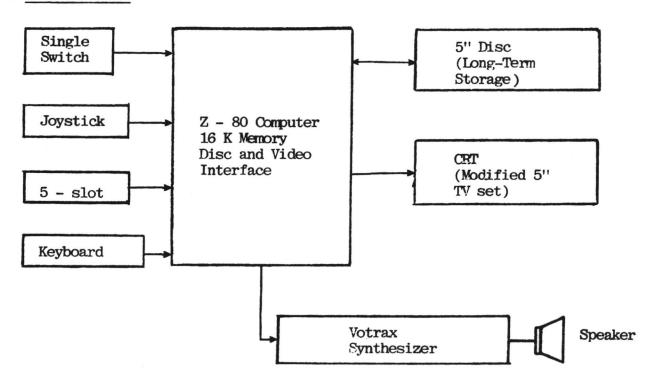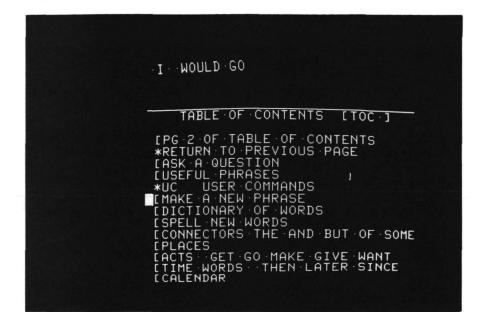
Figure 6.
VPSP System Block Diagram

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Software

The VPSP software is modular. The various modules are combined into three different versions of the VPSP for varying degrees of user physical ability. These are 1) single switch, 2) joystick, and 3) keyboard. All three versions have in common the system boot, disk I/O, video I/O, and text-to-speech routines. Each version has its own user interface control driver. The single switch and the joystick versions have a common set of display "pages" (files) with user commands, pre-spelled words, and phrases to save time during text creation. A spelling page with individual letters and punctuation marks provides for unlimited message creation. In the keyboard version, the display pages are blank until written upon by the user via the keyboard. All three versions have some pages reserved for operating instructions, and all three versions provide message editing and storage commands along with the "talk" command. Each of the three versions is linked from appropriate modules and loaded onto one side of a floppy diskette, along with the "pages" (files) appropriate for that version. Each version, including the text-to-speech routines, occupies less than 16K of RAM. 60K of the available storage on the diskette is used for "page" (file) storage, less than 16K for program, and less than 1K for the system boot routine.
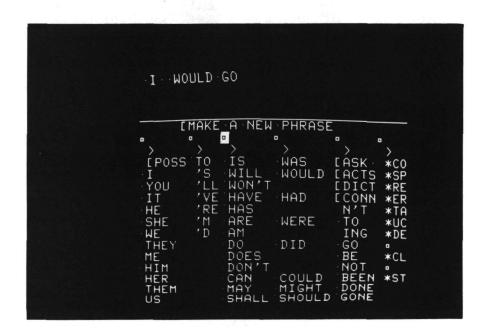
Single-switch system operation: A single button turns on the system, and a "startup" page is presented which gives the user a choice of eight cursor speeds, and a choice of verify "on" or "off", an option which is useful to those with poor controllable movements. When both choices have been made, the "Contents" page is displayed. This gives the user single-switch-closure access to a 925-word dictionary, a spelling page so he can make new words, a "numbers" page, a "calendar" page, pages of prefixes, endings, connectors, possessives, actions, times, places, and user-definable blank pages. If he wants to speak a pre-stored phrase, he merely selects the appropriate page, the line he wants to speak, and the "talk" command; the phrase will be spoken immediately. If he wishes to add to a stored phrase, or concatenate stored phrases, that is easy also. Any words or phrases he constructs may be stored on diskette by simple commands.

Joystick system operation: To switch to the joystick system, one changes the diskette and plugs a joystick, essentially four directional control switches and one selection switch, into the port previously occupied by the single switch. The joystick version is much the same as the single switch, except the "startup" page only presents the "speed" choice, which selects how fast the cursor moves when the joystick is held in one direction. The joystick can also be stepped from one item to the next. The pages are all the same as the single-switch version, but of course the cursor

moves only under user control via the joystick. It can be operated much faster than the single-switch version, if a user has the ability to control a joystick. (See Figures 7-9).
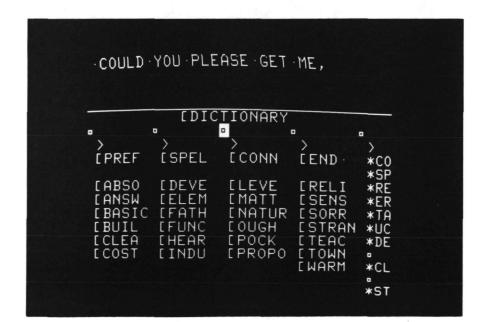
·I··WOULD·GO

TABLE·OF·CONTENTS   [TOC·]

[PG·2·OF·TABLE·OF·CONTENTS
*RETURN·TO·PREVIOUS·PAGE
[ASK·A·QUESTION
[USEFUL·PHRASES   ]
*UC   USER·COMMANDS
[MAKE·A·NEW·PHRASE
[DICTIONARY·OF·WORDS
[SPELL·NEW·WORDS
[CONNECTORS·THE·AND·BUT·OF·SOME
[PLACES
[ACTS··GET·GO·MAKE·GIVE·WANT
[TIME·WORDS··THEN·LATER·SINCE
[CALENDAR

Figure 7.

Table of Contents page for single-switch and joystick versions of VPSP.

·I··WOULD·GO

[MAKE·A·NEW·PHRASE

[POSS TO   IS   WAS   [ASK *CO
·I   'S   WILL WOULD [ACTS *SP
·YOU   'LL WON'T   [DICT *RE
·IT   'VE HAVE HAD   [CONN *ER
·HE   'RE HAS   N'T   *TA
·SHE   'M   ARE   WERE   ·TO   *UC
·WE   'D   AM   ING   *DE
·THEY   DO   DID   ·GO
·ME   DOES   ·BE   *CL
·HIM   DON'T   ·NOT
·HER   CAN   COULD ·BEEN *ST
·THEM   MAY   MIGHT DONE
·US   SHALL SHOULD GONE

Figure 8

Make-a-new-phrase page for single-switch and joystick versions of VPSP.

·COULD·YOU·PLEASE·GET·ME,

[DICTIONARY

[PREF [SPEL [CONN [END· *CO
                            *SP
[ABSO [DEVE [LEVE [RELI *RE
[ANSW [ELEM [MATT [SENS *ER
[BASIC [FATH [NATUR [SORR *TA
[BUIL [FUNC [OUGH [STRAN *UC
[CLEA [HEAR [POCK [TEAC *DE
[COST [INDU [PROPO [TOWN
                     [WARM *CL

                            *ST

Figure 9.

Main dictionary page for single-switch and joystick versions of VPSP.

SOFTWARE

Keyboard system operation: The keyboard system is enabled
by plugging in the keyboard and replacing the floppy disk.
On system startup, it shows an alphabetized list of all
existing pages. A page may be selected by typing its
name and hitting the "GO" key. Any page may be spoken by
hitting a "talk" key.   The usual wordprocessing
features (insert, delete, cursor move) are available for
changing text on the screen.   All commands are usable
one-handed, or with a headstick. (See Figures 10-12).

All three versions adhere to some basic principles of human
factors for software design. The user is always given
feedback regarding system status. Error messages are
explanatory, helpful, and friendly.   Command syntax is
designed according to the way users think it should be, not
the way the designers (the authors) originally thought it
should be. Nothing the user can do using the controls can
hurt the system.

```
1.5M    KATH    PG·P
6USR    KEY2    PG·R
AGRE    KEYS    PG·S
CONT    LAFF    PG·T
DEAR    LIS/    VPSP
DIR1    MACH    VSTA
DIR2    MSSA    WEST
E.··    MSSG
EASY    NASA
EXCU    NEWP
FREE    NO··
GREG    NOTE
HARD    PG·I
HELO    PG·K
JOHN    PG·N
JUNK    PG·O              LAFF▮
```

Figure 10.

A typical Table of Contents page for keyboard version of VPSP.


```
PG·I                              PG·1


ALTHOUGH·MY·EXTERNAL·BODY·HAS·CH
ANGED,·BECAUSE·OF·THE··ILLNESS,·
MY·SPIRIT·AND·PERSONALITY·HAS·RE
MAINED·INTTACT.▮
```

Figure 11.

A short message page from a user of keyboard version of VPSP.


```
PG·N                              PG·N


WHEN·SALLY·FIRST·FOUND·OUT·FROM·
THE·DOCTOR,·THAT·A·BABY·WAS·GROW
ING,·IN·HER·TUMMY,,·SHE·WAS·VERY
·HAPPY·AND·EXCITED...AS·A·SURPRI
SE·TO·DAN,·SALLY·PUT·UP·BRIGHT·P
OSTERS,·WHICH·TOLD·HIM·THE·GOOD·
NEWS,·ABOUT·THE·BABY...THE·POSTE
RS·WERE·RED,·ORANGE,·AND·YELLOW,
,AND·THEY·WERE·THE·FIRST·THINGS·
THAT·DAN·SAW,·WHEN·HE·CAME·HOME·
FROM·WORK...DAN·WAS·HAPPY·AND·EX
CITED,·THAT·HE·WAS·GOING·TO·BE·A
·DADDY,·SOON.▮
```

Figure 12.

A larger message page from a user of keyboard version of VPSP.

An essential part of the approach to the project was an objective evaluation of VPSP with several users, to insure that it was easy to use and effective. Funding was obtained from National Institute for Handicapped Research NIHR Grant G008005817 to Children's Hospital at Stanford, Rehabilitation Engineering Center to perform a clinical evaluation of the VPSP. Handicapped persons, ranging from institutionalized severely impaired cerebral palsy patients to ambulatory stroke victims were asked to help and were paid a small honorarium. They each were given a maximum of two hours training, and sent home with the device for a week. Measurements of communication speed were taken, and all users answered questionnaires about the device. The results from five subjects were reported in the progress report, (LeBlanc, et. al, 1980) and are summarized in Figure 13. A sixth used the VPSP extensively after that report, and her results are reported in Appendix I. All users felt that the VPSP was a great help to them.

The communication speeds are given in words per minute to facilitate comparison with other data in the literature. It is important to note that the speed to construct test messages on demand measures only a part of the entire process which we shall call "communication of intentions". It starts by giving the user a simulated intention (or thought) to communicate, namely the test message. The listener (experimenter) is already present and attending to what the user is about to communicate. The message is constructed in any of several possible ways, all of which affect the message construction time. Slowest will be messages which must be spelled out letter by letter. Fastest will be messages which the user happens to have previously composed and stored in the system (if the system permits this). The test messages used for comparison of VPSP to "own system" were partly of the first type. Others made use of some of the pre-spelled words on the VPSP pages. In one case, the entire message was present on a page of "useful phrases". For any subject, the range of words per minute varied by at least a factor of four for short sentences depending on how much of the message could be composed from words that were already on the pages. This effect was also present for systems such as word boards that contained words as well as letters although word boards cannot hold anything close to the more than 1000 pre-spelled words in the VPSP. The words per minute data given here can be used to determine how fast the particular VPSP users in this study could compose new messages, after using the VPSP for a week. They have no bearing on the words per minute rate for messages the user has composed at leisure and then stored for later retrieval and talking. For the 1-switch version, a speech of 500 words length retrieved in 27 seconds at VPSP speed 5 (one cursor move per 0.85 sec) and then spoken in real

time at a speech rate of 125 words per minute results in an actual communication speed of 112 words per minute.

Nor can the comparative words per minute data allow us to compare the times it would take a VPSP user to communicate an intention using his or her "own system" versus the VPSP. Consider the individual who wants to ask to have a friend over for dinner and has to do this with a wordboard. How long does it take from the time this wordboard user thinks about wanting to make this request to the time that another individual realizes there is something the wordboard user wants to say? This time must be added to the total time for communication of intention. With the VPSP the individual can compose or retrieve a message without assistance and can make him or herself heard when he or she is ready to speak. Two of the VPSP features that all users found highly desirable were the ability to interrupt and speak when they wanted to and the ability to store messages that had taken considerable time to compose.

One of the secondary, but important, findings of the VPSP evaluation has an impact on all scanning control and display systems. It was observed that those single-switch system users with a lot of uncontrollable movement had a very difficult time making any voluntary action within a uniformly paced time frame such as that produced by an automatically moving cursor. The x-y scanning control and display system for the VPSP had been chosen because this is something of an industry standard for a wide range of aids for the disabled. A comparison of the words per minute rates on the 1-switch VPSP for subjects LL and DA, who had this problem, to those for subject SS, who did not, shows the magnitude of the problem. See Figure 13. The 1 to 4 words per minute rate of SS is probably more representative of the rate that is to be expected of a 1-switch VPSP user than are the rates of LL and DA.

Our findings indicate that there is a group of individuals who cannot operate any of the scanning aids that have been designed for them simply because of this problem while making voluntary actions on demand in time. Research is proceeding on this problem, as described in the "Benefits of VPSP Project" section.

The clinical testing results can be summarized as follows:

* Users had no conceptual problems using any version of the VPSP.
* Except for users who had difficulty making voluntary movements on demand in time, users had no problems physically controlling the VPSP.

* Message construction time varied from 1 to 3 words per minute (wpm), with the one-switch version to 10 wpm with the keyboard. (Note: the 10 wpm rate was achieved with single finger typing. Obviously, someone able to use more fingers would have a higher rate).
* Retrieved user-stored message for any of the versions were spoken at 100 wpm or better, including access time.
* Rates for users own system--which included wordboard, pencil and paper, and a Handivoice 120--ranged from 0.3 wpm with a word board to 12.8 wpm with pencil and paper.
* Except for the pencil and paper system, these systems had no capability for retrieval of user-stored messages.
* All VPSP users wanted to keep the VPSP.

In addition to the formal clinical evaluation, professional opinions were solicited from two individuals who are experts in the field of assistive communication devices: Dr. John B. Eulenberg, Director of the Artificial Language Laboratory, Michigan State University, and Judy Montgomery, Director of the Non-Oral Communication Center, Fountain Valley, California. Their letters are included in Appendix III. Also in Appendix III is a letter from Michael B. Williams, a non-oral person who used the keyboard VPSP at the 5th West Coast Computer Faire. Several of his suggestions were implemented in the second generation keyboard version.

Another goal of the VPSP project was to improve synthesized speech intelligibility over that available with commercial devices. A controlled, comparative intelligibility study of VPSP and the Handivoice was performed. Mean VPSP intelligibility scores were more than twice those of the Handivoice. (See Appendix II for the complete study report).

	WORDS			SENTENCES		
Subject/System	Mean	*(WPM)*	Range	Mean	*(WPM)*	Range
Single-Switch Users:						
DA VPSP	1284	*(.04)*	904–1664	Not done due to S fatigue		
OWN Wordboard	146	*(.32)*	104–188			
LL VPSP	577	*(.14)*	382–772	893	*(.22)*	n/a
OWN Letterboard	72	*(.99)*	47–98	144	*(1.42)*	n/a
SS VPSP	58	*(1.1)*	36–87	149	*(1.8)*	53–251
OWN (none tested)						
KEYBOARD USERS:						
IS VPSP	12.6	*(5.4)*	6–28	35.4	*(6.2)*	29–57
OWN Pencil/ Paper	14.8	*(4.6)*	10–24	39.2	*(5.6)*	37–43
BW VPSP	8.5	*(8.0)*	4–17	20.8	*(10.6)*	12–26
OWN Pencil/ Paper	5.8	*(11.6)*	4–8	17.2	*(12.8)*	13–26
PA VPSP	8.1	*(8.3)*	6–11	21.0	*(10.5)*	18–24
OWN Handivoice	22.1	*(3.1)*	6–30	21.4	*(10.3)*	18–31

Figure 13.
Means and ranges of times, in seconds, for subjects to compose test words and sentences. Average words per minute are shown in parentheses (WPM).

Negotiations with Manufacturers

Part of the purpose of the VPSP project was to get the device manufactured if testing showed it would be a useful product. The reception by the handicapped community - users, therapists, and users' relatives - was encouraging as evidenced by the large volume of inquiries received. Over 2000 fliers were distributed and more than 200 inquiries from individuals and institutions representing ten different nations plus the media coverage listed in Appendix IIII testify to the public interest in the VPSP. This, together with the evaluation results was encouraging enough so that invitations were sent to all manufacturers of aids for the handicapped who had shown interest during the project, and others who might be interested in manufacturing such a product.

In May 1980, a manufacturers' conference was held at Fairchild Auditorium on the Stanford Campus (see Figures 14-16) to show prospective manufacturers the the VPSP and solicit their proposals for manufacturing it in quantity. Four manufacturers responded with proposals, and in August clarification of their responses was asked for since the original proposals had been insufficiently detailed to allow one to be chosen. All revised proposals were requested by October 1, 1980. On the basis of the responses submitted by that time, a decision was made on October 20, 1980 to offer the VPSP manufacturing rights to Computers for the Physically Handicapped, Inc. In January, members of the VPSP team visited CPH and held technical discussions regarding the transfer of the relevant information, licensing agreements, and the use of consultant's time by CPH. In March, a copy of the VPSP team's proposed legal agreement was sent to CPH for signature or revision, Unfortunately, changes in the national economic climate coupled with the press of other business caused CPH to be unable to handle the VPSP project in the manner originally envisioned. Thus, while the VPSP is still needed by a large population and no device is on the market which fulfills the need, no manufacturer is currently developing it. Because of national and even international interest in the VPSP, Children's Hospital at Stanford and the VPSP Team are continuing the effort to provide for manufacture of the VPSP. The best result of this continuing effort would, of course, be finding a manufacturer for VPSP. However, even if that does not come about, the Rehabilitation Engineering Center is willing to provide the VPSP on a case-by-case basis, an alternative which is more expensive for the patient but, in some cases, well worth it.
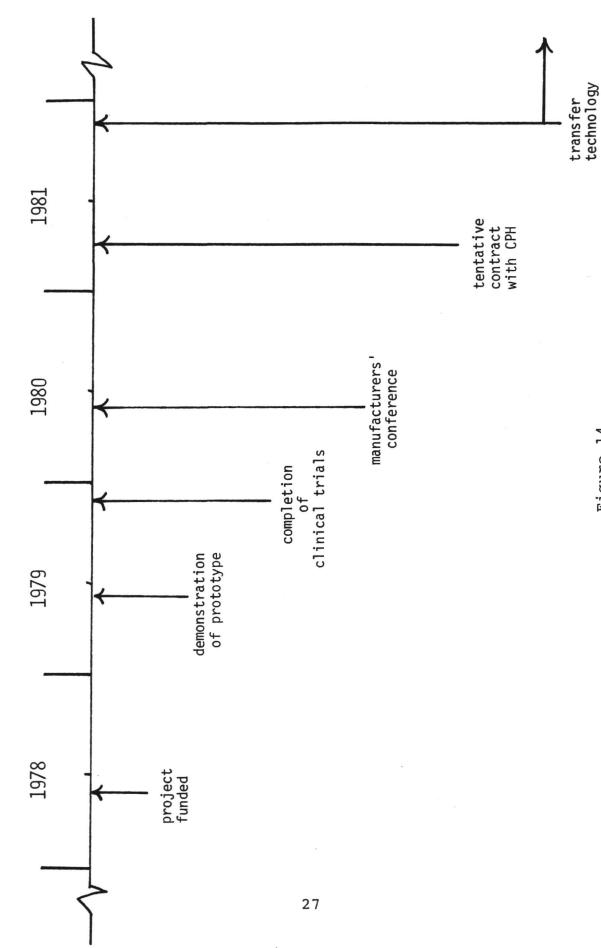
Figure 14.
VPSP Project Timeline

1978   1979   1980   1981

project
funded

demonstration
of prototype

completion
of
clinical trials

manufacturers'
conference

tentative
contract
with CPH

transfer
technology

27

Figure 15.
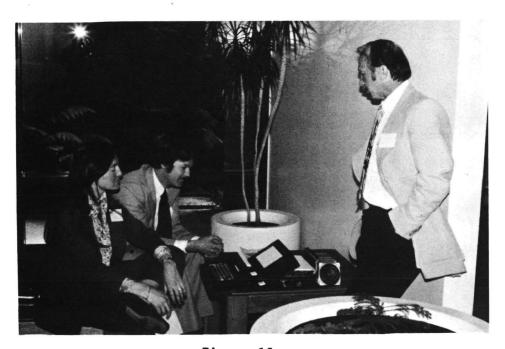Dr. Williams demonstrating VPSP at Manufacturers' Conference

Figure 16.
Dr. Simpson and Mr. Lingel discussing mock-up of brief-
case-size VPSP (setting on table) with Mr. Vargo of
NASA Headquarters.

Benefits of VPSP Project

While the VPSP itself is not currently ,being produced, it has generated a great deal of sympathetic publicity for a population of people who are generally ignored. In many cases, the connection of the project with NASA was mentioned, for it is not widely known that NASA participates in projects which are not aviation or space related. A number of spinoffs which are very significant have also been unforeseen benefits of the project.

One of the observations documented during the clinical evaluation of VPSP was that spastic cerebral palsy (CP) patients had difficulty dealing with row-column scanning displays. Many of the devices available to these patients are only available with such scanning schemes. This led to a proposal to do research on scanning methods, which was funded by the Office of Special Education, Department of Education.

Children's Hospital at Stanford and PLRA are now working on a Spanish-English Voice Output Communication Aid (SEVOCA) which--while not portable, using software for a different microprocessor, and lacking many VPSP features--is an attempt to use some of the knowledge gained in developing the more capable VPSP to speed development of the bilingual SEVOCA.

The VPSP was based on 1977-era technology, and as the project has progressed, so has the technology. The VPSP team decided to propose that the newer technology be used in a smaller, cheaper, more capable version which would be easily carried by the ambulatory non-vocal, and to make it as small and light as possible. (See Figure 17). This proposal is now under consideration by NASA.

And, the original VPSP is still working and is used at Children's Hospital at Stanford as an all-purpose communication aid for patients who come for communication evaluations. If a discussion with the patient is appropriate, they can be quickly taught to use the VPSP and may easily participate in the decision about which commercially-available aid or options are most suitable for them.

PORTABLE VPP CONCEPT

Labels on diagram:
- HANDLE
- SHOULDER STRAP
- LCD DOT MATRIX DISPLAY
- SPEAKER
- FULL FLAT PANEL KEYBOARD
- TOOTH LATCH

Figure 17.

Future Plans

Efforts will continue to find a manufacturer for the VPSP. Meanwhile, a feasability study is underway by NASA-Ames to determine the possibilities for a lighter, more portable VPSP which would retain the essential features of thecurrent one.

Several non-vocal individuals in the local San Francisco Bay Area have been identified who could benefit from a custom VPSP. Study has been made of components for custom VPSP's that would be built one at a time by Children's Hospital at Stanford to run the VPSP software. A list of modifications to the VPSP software, generated by trials with users, has been compiled. This list was originally intended for the VPSP Manufacturer. It will now be used to guide the custom VPSP design.

APPENDIX I

VPSP USER TEST WITH SINGLE-SWITCH CONTROL

Introduction

During the initial evaluation of the VPSP reported in LeBlanc, et. al., 1980, the single-switch version of the system was not tested fully. The two subjects for whom the single-switch control was the most appropriate had extreme spasticity which caused them difficulty in using the control switch; also, there seemed to be an interaction of the cursor motion with their disability such that they often activated the switch just before or just after the desired item. Research is now underway to attempt to solve the problems of a control and display combination for these people (Children's Hospital, 1981), but the VPSP was not properly tested by the two single-switch users who were in the evaluation trials. For this reason, a subject was selected who could only operate a single switch but who had no spasticity. She was given the VPSP to use for several weeks, and observations and measurements of her performance were taken at intervals.

Subject

The subject was a 37 year old female who had been paralyzed from the neck down by ultrasonic trauma to the spinal cord in July, 1979 and who had been unable to communicate except by yes-no questions since then. At the time of this study (February to March, 1981), she was in Mission Skilled Nursing Facility, Santa Clara, California.

She is unable to talk and only able to make a few sounds. Two fingers of the left hand are able to exert 5-10 grams of force quickly and accurately, but her hand and arm must be placed in position and supported because she cannot move them. Her wheelchair could not be easily adapted to the VPSP hardware, so the VPSP was modified.

Equipment

The VPSP display was moved to the back of its chair and clamped to one of the handles. The rear of the display was supported on plastic foam blocks resting on the top of the computer box. Thus, the user could sit in her wheelchair behind and beside the VPSP and see the display at about eye-height. The control switch selected was a standard Zygo switch which could be adjusted for a very light touch. It was backed with Velcro hooks which stuck to the subject's clothing or lap robe. Several methods of positioning her hand were tried, all with limited success until she got a new wheelchair with adjustable arms, which could be set to prevent her own arm from falling off her lap.

Procedure

Since the subject could only communicate very laboriously and did not regularly use any communication aid, the comparison of the VPSP with the subject's customary system would be meaningless. After a 1/2 hour instruction period at the Rehabilitation Engineering Center interspersed with the two-hour process of finding a suitable switch and switch location, she was able to use the basic VPSP functions of selecting items from pages to compose messages for talking, cancelling errors with the VERIFY Mode, and going from one VPSP page to another.

Four days later, after the necessary physical modifications to the VPSP had been made, it was delivered to her for testing. She was able to construct messages on it immediately without any review of training. Instruction was given on the functions for storing messages for later use. She began exploring the system on her own, looking at the contents of the different pages. Later that day, after a total of 3 hours of system use, she used the system to ask questions about the operation of the message storage functions. She had assumed the user storage pages could be given messages longer than one line with the *UADD command when in fact there is a 27 character limit currently on the message length for the user pages. She was told that she could use the user text pages to store longer messages. Another question involved a misunderstanding of the append nature of the *FADD command. These misunderstandings were cleared up and, at the next visit a week later, it was observed that she had created several user pages with one-line messages and three text pages of multiple line length. One of the text pages was a message for bystanders asking that they not ask her to demonstrate the VPSP by making it speak their requests when she was busy programming what SHE wanted to say.

After this week of using the VPSP with mostly self-instruction, it was obvious that she would be able to easily master all of its functions, so it was decided to record her speed of communication in running conversation, with observations at intervals. Her usage of the User and Text pages would be noted, and of course any criticisms or suggestions she had would be noted.

The speed was recorded in words per minute, where a word is defined as 5 characters. Space was counted as a character. (See Figure 18 for the results of several testing sessions). Data for this subject is summarized and plotted in Figure 8 as subject "SS" along with the data for the

subjects previously evaluated and reported on in detail in
LeBlanc, Simpson, Williams, and Lingel, 1980.

Besides improving her communication rate, this subject was
able to increase her amount of communication from simple
basics that could be transmitted as answers to yes-no
questions to complicated discussions on what she wanted to
do, her personal goals, and long involved conversations with
family and friends. In the month that she had the VPSP she
filled all nine text pages several times and periodically
erased those she no longer needed to make room for new
material. She also filled approximately 75% of the space in
the user pages that each hold 14 lines of up to 27
characters each. We interpret this as strong support for
the need for as much user non-volatile storage as possible
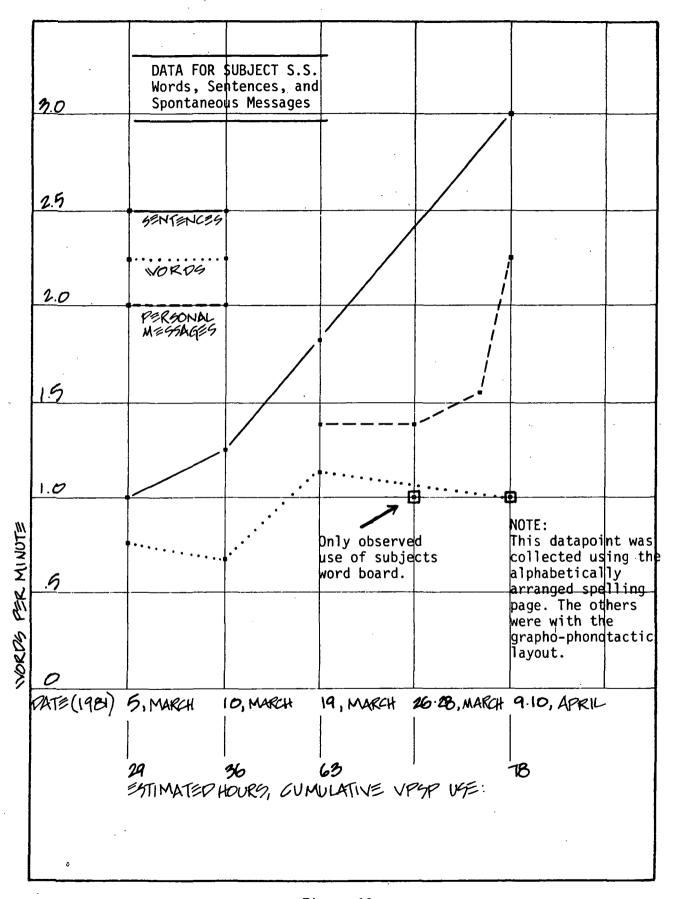in a production VPSP.

Figure 18.

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APPENDIX II

COMPARATIVE INTELLIGIBILITY OF VPSP TEXT-TO-PHONEME SPEECH AND HANDIVOICE PRE-STORED AND PHONEME SPEECH

by

Douglas H. Williams, Carol A. Simpson, and Claudia Nordinger

The Versatile Portable Speech Prosthesis (VPSP) is a microprocessor-based, battery powered voice communication aid for non-vocal persons which has been developed at Childrens Hospital at Stanford with the aid of funding from Ames Research Center, National Aeronautics and Space Administration. A stated goal of the VPSP project was to improve the intelligibility of speech generated by speech prostheses. To determine if the VPSP had met this goal, comparative word and sentence intelligibility was obtained for the VPSP and for the only commercially available speech prosthesis with unlimited message capability, the Handivoice.

Test Materials

Test materials were chosen from standard intelligibility testing materials and were selected by author (DW) because he is not familiar with the capabilities of either system for pronunciation of specific words. (Author CS developed the VPSP text-to-speech rules and was thus disqualified from selecting the testing materials.) The materials included short sentences from Campbell in 1965 , a CNC list of phonemically balanced monosyllabic words by Lehiste and Peterson in 1959 and one of the Modified Rhyme Test word lists described by Fairbanks in 1958 and by House, Williams, Hecker, and Kryter in 1965.

Diverse test materials were chosen to test intelligibility in situations with various levels of linguistic context. Of the three types of materials, sentences have the most linguistic context and are thus easiest to understand.

Next in amount of context are the words in the Modified Rhyme Test. In this test each word is pronounced in a carrier phrase and the subject is supplied with a list of possible responses consisting of the correct response plus five other words that differ from the stimulus word by one phoneme. The response set is thus closed.

Because of the small, closed response set, intelligibility for the Modified Rhyme Test words is higher than for the third type of materials, the Phonemically Balanced CNC word lists. The CNC word lists each contain 50 words that as a whole contain the vowel and consonant phonemes of English in the same relative frequencies as those

measured for a corpus of the 1263 most frequently occurring monosyllabic words in written English according to Thorndike and Lorge in 1952. The CNC words are presented in isolation with an open response procedure. Context is thus greatly reduced. Subjects know only that the words they are hearing are existing words in English. Of the three types of materials, then, CNC words are most difficult and least intelligible. However, they provide the most rigorous test of phonetic and phonemic accuracy of the speech.

Subjects and Procedure

Subjects were linguistically naive college students and had no prior experience listening to digitized or synthesized speech except perhaps the Texas Instruments Speak and Spell (digitized human speech). The test materials were recorded on high fidelity audio recording equipment on reel-to-reel tape at 7 1/2 ips. The stimuli for the VPSP were generated by using exact spelling, i.e. with no phonetic spellings for exception words. The stimuli for the Handivoice were generated by a speech therapist who has extensive experience with the Handivoice and with teaching phonetic "sound-spelling" and "sound-blending" to Handivoice users.

10 subjects heard VPSP speech only. The other ten heard Handivoice speech only. They were tested in pairs or alone. Each subject heard the taped stimuli via a high-fidelity headset. Assignment to type of speech was random. Subjects knew only that they were listening to synthesized speech, not which system they were hearing. The experimenter who administered the testing also did not know which system was being tested, only that "system A" or "system B" was on the tape in use.

Results

Means and standard deviations of intelligibility for the two types of speech for each of the three types of test material is given in Tables 1-3. Intelligibility is basically the percentage of words correct out of the total number of words presented. Depending on the test materials, the computation of this percentage varies slightly.

The sentence intelligibility shown is the percent of words correct out of the total number of words in the sentence. Sentence intelligibility is sometimes based on the percent correct of five selected key words in the sentence. We chose to use all words in the sentence because the Campbell sentences have only four words each. Sentence intelligibility for the VPSP was 71% compared to 26% for the Handivoice. This difference was statistically significant (t=12.39, df=18, p << 0.001 (two-tailed)).

Modified Rhyme Word Intelligibility is defined as the

percentage of words correctly identified from the list of 50 words, after correction for guessing. A correction factor adjusts the score for the guessing that is possible in a multiple choice situation. The formula for the correction factor is:

$$\text{corr fac} = \frac{\text{number of words wrong}}{5}$$

This correction factor is subtracted from the actual number of words correct to obtain an adjusted number of words correct. The corrected percent correct or intelligibility is then:

$$\text{corrected \% correct} = \frac{\text{adjusted no. correct}}{50} \times 100$$

$$= \text{adjusted no. correct} \times 2$$

As with sentences the VPSP with 68% was more intelligibile than the Handivoice with 43%; and this difference was also statistically significant (t=7.66, df=18, p < 0.001 (two-tailed).

CNC word intelligibility is the percent words correct in the list of 50 words. Because of the open response set there is no need for a correction factor for guessing. Again, the VPSP with 44% intelligibility was better than the Handivoice with 10% and the difference was significant (t=13.81, df=18, p << 0.001 (two-tailed).

Table 1. Sentence Intelligibility

	VPSP	Handivoice	
Mean	71.22	25.70	t=12.39, df=18,
			p << 0.001 (two-tailed)
SD	8.44	8.49	
N	10	10	

Table 2. Modified Rhyme Word Intelligibility
(closed response set/multiple choice)

	VPSP	Handivoice	
Mean	68.32	43.36	t=7.66, df=18,
			p < 0.001 (two-tailed)
SD	8.82	5.33	
N	10	10	

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Table 3. CNC Word Intelligibility (open response set)

	VPSP	Handivoice
Mean	44.22	10.40
SD	12.22	5.40
N	10	10

t=13.81, df=18
p << 0.001 (two-tailed)

Discussion

Any discussion of the large differences in intelligibility between the VPSP and the Handivoice must take into account the very different ways in which the the user generates speech with the two systems. The user programs the Handivoice in one of two ways. If the desired word, phrase, or morpheme (word part) is pre-stored in the fixed vocabulary, the user may select it. Other words are sound spelled by the user using a set of phonetic segments that are a mixture of English phonemes, and segments of English phonemes. If the sound spelling is accurate, the pronunciation will be phonemically correct and may be phonetically more or less correct, depending on the skill of the user. In this study, a skilled user did the Handivoice programming to give it its best advantage phonemically and phonetically. The term phonetics refers to the physical or acoustic aspects of the speech while the term phonemic refers to the cognitive linguistic concept of the phoneme. Phonemes are technically the smallest segments of speech that can change the meaning of a speech message. In lay terminology they are speech sounds--the consonants and vowels. A given phoneme is pronounced differently in different phonetic contexts. Physical variations in the pronunciation of phonemes are said to be phonetic variations. (See Simpson 1980 for discussion of this distinction and its importance for the programming of phonetic segment synthesizers like the Handivoice.) To achieve good phonetic pronunciation for novel words, the Handivoice user must program the phonetic variant of a given phoneme for the phonetic context in which that phoneme occurs. The pre-stored words were coded by the manufacturer with attention to phonetic accuracy and with built in intonation.

The VPSP, on the other hand, has no pre-coded words. All words are generated from scratch by the text-to-phoneme rules. The text-to-phoneme rules and the phoneme-to-phonetic segment rules automatically produce the correct pronunciation for the words in the text. The user can select pre-spelled words, but these words go through the text to phoneme conversion in the same manner as the rest of the text. The user may choose to improve on the

pronunciation of exception words by spelling them phonemically or "sound-spelling" them. However, in order to put the VPSP at its greatest disadvantage, only correct spellings of the stimuli were used. Another major difference exists between the speech of the Handivoice and the VPSP. The user-created words on the Handivoice have fixed intonation for each phoneme. The VPSP text-to-phoneme rules, on the other hand, adjust intonation on the individual phonemes as a function of their phonetic and morphological environment. This intonation gives the listener additional important perceptual cues in understanding the VPSP speech. Finally, the phonetic segment set in the Handivoice is more limited than that of the ML-1 Votrax used in the VPSP. This would make the VPSP speech phonetically easier to understand if the text-to-phoneme rules indeed take advantage of the ML-1 phonetic segment set.

Clearly, the VPSP project has attained the goal of improved intelligibility for speech prostheses. Also, the normal spelling entry of text for speaking requires less training for the linguistically naive user who is familiar with English spelling. But, the relative contribution, positive or negative, of the different features of the speech of the two systems cannot be determined from these data. A much more extensive intelligibility study would be required to make such an assessment. A practical but time-costly next step would be to implement the VPSP rules, minus intonation but including stress and phoneme-to-phonetic segment rules, on the Handivoice to determine the contribution of the VPSP text-to-phoneme rules themselves to intelligibility. Finally, it must be noted that the data presented are relative intelligibility data and cannot be used to derive the intelligibility of the VPSP and the Handivoice in actual conversation. All of the test materials used are more difficult than conversational speech which has the advantage of occurring in a pragmatic or real world context.

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March 10, 1980

Maurice LeBlanc
Rehabilitation Engineering Center
Children's Hospital-Stanford
520 Willow Road
Palo Alto, CA 94304

Dear Maury,

On January 14 and February 17, 1980, I had the opportunity to work closely with Dr. Carol Simpson and consequently view the Versatile Portable Speech Prosthesis(VPSP). I have also viewed the video tape of its use and observed it at the Southern California Communication Group 4th Annual Communication Aids Fair. Perhaps the most useful time spent evaluating this instrument was 2 hours in the home of a consumer/user. Interviewing this young woman was the highlight of my experiences with the VPSP.

The unit appealed to me as a valuable communication system for the non-oral individual for several reasons:

- The speech output was remarkably intelligible (testing done on 2/17/80).
- The page storing capabilities allow the device to be highly person-alized and convenient.
- The English spelling to speech transition through a keyboard greatly speeds up the message transmission process (trials completed 2/17/80).
- The small CRT screen enables the sender to monitor his/her message and the receiver to verify the speech he hears. I see great applicability for this dual mode in training sessions and for children.
- Corrections are made easily from the keyboard.
- The unit also has a single switch operation, which although slow makes it adaptable for the person more severely physically limited.
- The volume of the unit is surprisingly good in large or noisy groups (observation during Fair with approximately 50 people in the room.)

- The present wheelchair mounting allows it to be operated off the battery for portability.

Areas/aspects of the VPSP that may need continued work are judged by this consultant to be:

- Continued work with size reduction to enable it to be used by an ambulator.
- Refinement of text to speech rules to cover more English spellings.
- Re-arrangement of level and shift buttons for speech and convenience.
- Consider tactile or auditory feedback mechanism on keyboard to reduce typing errors and double entries.
- Continue to explore other power and memory storage alternatives.

These are my impressions of the VPSP to date. I am very pleased to have spent the time working with the unit in several settings and to have taken part in the speed and intelligibility testing. Combined with the clinical trial data and other reports, this evaluation may serve to help others recognize the potential of the VPSP. It is an approach in voice output communication aids that many non-oral consumers can utilize.

Sincerely,

Judy Montgomery
Non-Oral Communication Center
9675 Warner Avenue
Fountain Valley, CA 92708

JM:ks

STANFORD UNIVERSITY

April 15, 1980

Maurice LeBlanc
Director, Rehabilitation Engineering Center
Childrens' Hospital at Stanford
520 Willow Road
Palo Alto, CA 94304

Dear Maury,

During the past year, I have had the opportunity to observe the development
of the Versatile Portable Speech Prosthesis (VPSP), to meet some of its
consumer "test pilots", and to confer periodically with Carol Simpson and
Doug Williams.

The VPSP represents an exciting advance in the field of communication aids,
and I strongly advocate its continued development into a commercial product.

Here are some of the features of the VPSP which make it important and which
distinguish it from currently available aids:
1. The user can personalize his/her vocabulary.
2. Text and vocabulary can be stored in a very convenient manner,
   and similarly be accessed with ease.
3. The VPSP is modularly designed to accept single switch, joystick,
   and full-keyboard entry.
4. The orthographic-to-phonetic conversion feature provides access
   to speech for anyone who can spell.
5. Messages can be edited easily, so the user can visually confirm
   an utterance's integrity before releasing it to speech.

In a truly portable form, the VPSP can serve non-speaking individuals who are
literate, linguistically intact, sighted, and who experience varying levels of
motoric ability. The quality of "portability" is relative. By reducing the
dimensions, power requirements, and susceptability to mechanical trauma of the
current design, the VPSP can be configured into both wheelchair-portable and
person-portable models using present technology. I know that Carol and Doug
have studied their options with respect to these considerations and can be of
great benefit to any manufacturer in the incorporation of human factors research
into the transition from prototype to commercial product.

The VPSP, as an intelligent speech prosthesis with dynamic visual display,
high-quality spoken output, and modular input options, is a long-awaited
contribution to the arsenal of communication aids.

Sincerely,

43

JOHN BRYSON EULENBERG

3-17-67

DEAR CAROL AND DOUG,

I'M SILL COMING DOWN FROM YESTERDAY. BOY, THAT WAS THE MOST
EXCITING THING I'VE DONE IN A LONG TIME. I PARTICULARLY
ENJOYED THE VERBAL JOUST WITH COMPUTALKER. IN CASE YOU
COULDN'T TELL, I ENJOY ENGAGING IN THAT KIND OF QUICK
REPARTE. AND THE TALKING WHEELCHAIR (YOU SIMPLY MUST THINK
OF A BETTER NAME FOR THAT GADGET!) ENABLED ME TO DO IT WITH
A FLUIDITY AND FORCE I NEVER THOUGHT POSSIBLE BEFORE.

AS PROMISED, HERE IS A BRIEF CRITIQUE OF THE V.P.S.P. FIRST
OFF, YOU NEED A BETTER SCREEN CLEAR. I DIDN'T LIKE BEING
STUCK WITH A SHORT SENTENCE ON THE CRT AND HAVING TO MAKE
FOUR MOVES IN ORDER TO CLEAR IT. IT SLOWED DOWN MY STYLE,
MAN. AND YOU KNOW HOW IMPORTANT STYLE IS TO A BLOKE, DON'T
YOU?

POINT NUMBER TWO: WHY ARE THE CURSOR CONTROLS UNDER THE
CONTROL OF THE CONTROL KEY? (NO, I'M NOT TRYING TO POSE
THIS QUESTION IN THE MANNER OF GERTRUDE STEIN.) IS IT TO
PROTECT THE INTEGRITY OF THE CURSOR POSITION FROM THE
UNWARANTED INTRUSIONS OF FLAYERS? ("FLAYERS": A TERM USED BY
M.B.W. TO DEFINE THAT GROUP OF CEREBRAL PALSIED INDIVIDUALS
WITH POOR MOTORIC CONTROL OF THEIR UPPER EXTREMITIES.) IF
SO, WHY NOT PUT THE F KEY UNDER THE CONTROL COMMAND? OR THE
U KEY? OR EVEN THE C AND K KEYS? I WANT TO RUN THAT CURSOR
'ROUND THAT LI'L OL' SCREEN ANYTIME LI'L OL' ME FEELS LIKE
IT. LIKE I DO ON MY SOL. I DON'T WANNA MESS WITH NO CONTROL
KEY!

POINT THREE: IT WOULD BE NICE TO HAVE A WAY OF SAYING BITS
AND PIECES OF A LONG TEXT. FOR EXAMPLE, IF I'M GIVING A
SPEECH WITH THE V.P.S.P.,AND HAVE PROGRAMED IN SEVERAL JOKES
ALONG THE WAY, I WOULD LIKE SOME METHOD OF STOPPING IN
MID-TEXT IN ORDER TO GIVE MY AUDIENCE AMPLE TIME TO VENT
THEIR MIRTHFUL FEELINGS UPON A GREATFUL SPEAKER.

POINT FOUR: BEFORE OFFERING THE V.P.S.P. TO ANY POTENTIAL
MANUFACTURER, YOU MUST DO SOME TESTING ON SOME EXTREMELY
MOBILE DISABLED PEOPLE. IF YOU DO NOT DO THIS, IT COULD LEAD
TO SOME UNPLEASANT CONSEQUENCES FOR THE PROJECT. WHEN I
LIVED IN BERKELEY, I USED TO USE MY CHAIR AS A CAR. ON THE
AVERAGE I'D BE ON THE STREETS AT TEN IN THE MORNING AND COME
TOOLING HOME AT TWO THE NEXT MORNING. I CAN JUST SEE A
PERSON STUCK ON TELEGRAPH AVENUE AT TWO IN THE MORNING WITH
NO POWER FOR THEIR CHAIR, NO WAY OF COMMUNICATING AND SOME
WEIRDO COMING TOWARDS THEM WITH A GLAZED LOOK IN HIS EYE.
WOW MAN! SOUNDS LIKE A PLOT FOR A TV MOVIE. BUT SERIOUSLY

FOLKS, A LOQUACIOUS, MOBILE CRIP WOULD SUCK THOSE BATTERIES OF POWER IN NO TIME.

I FOUND OUT I WILL BE SPEAKING TWICE AT THE COMMUNICATION FAIR---IN THE MORNING AND AFTERNOON. IF YOU WOULD LIKE, I COULD SPEND PART OF MY FREE TIME HELPING TO DEMONSTRATE THE V.P.S.P.

I WOULD ALSO LIKE TO HELP DEMONSTRATE THE THING TO POTENTIAL MANUFACTURERS, IF MY BUDGET AT ALL ALLOWS IT. I KNOW THIS IS A PRETTY GUTSY THING TO SAY AFTER SEEING YOU ONLY ONCE, BUT I'M THE MOST POWERFUL DEMONSTRATION YOU COULD HAVE.

THANK YOU AGAIN FOR A MOST BEAUTIFUL DAY. HOPE TO TALK WITH YOU SOON.

SINCERELY,

MICHAEL B. WILLIAMS

APPENDIX IIII

A. MEDIA COVERAGE OF THE VPSP--PARTIAL LIST
(Numerous other articles have appeared in sources
not listed here, picked up from wire services.)

15-minute radio interview via telephone from New York of
Carol Simpson and VPSP trial user Jim Renuk, speaking via
VPSP, by Andy Barrie, CFRB Radio, Toronto, Canada, June 6,
1979.

Woodruff, Jay. Micro-based aids for disabled shown,
Computerworld, June 18, 1979, page 61.

Biomedical Electronics, The session on personal computers
as an aid to the handicapped at National Computer Conference
(report described VPSP), July 10, 1979, p. 2.

Tannenbaum, Jeffrey A. Computers: A special report; The
handicapped may soon benefit from new computer-based aids,
The Wall Street Journal, Thursday, August 2, 1979, p 1.

Hershberger, Robert D. Palsied patients freed from prison
of silence, on page 66 of Computers: Physician's tool,
patient's friend, Medical World News, September 3, 1979,
pp. 57-68 (w/ picture).

5-minute video segment by Sunde Smith on Newsweek
Broadcasting, December, 1979.

A touching communication, Silicon Gulch Gazette, Vol. 5,
Number 1, January 1980, page 11.

Snyder, Bill. Stanford University Medical Center News
Bureau Press Release on the VPSP, mailed Tuesday, March 4,
1980 (w/ photo available).

"Talking chair" for handicapped, The Peninsula Times
Tribune, Thursday, March 6, 1980, page B-5 (w/ picture).

One-minute segment by Maralee Beck on 6:00 Channel 5 KPIX-TV
(CBS) News, San Francisco, March 10, 1980.

Two-minute segment by Lloyd LaCuesta on 10:00 Channel 2
KTVU-TV News, Oakland, March 10, 1980.

Three-minute segment by Rigo Chacon on 6:00 Channel 7 KGO-TV
(ABC) News, San Francisco, March 11, 1980.

Julien Loewe, These Wheelchairs Talk, Pasadena Star News,
March 12, 1980.
Karen Klinger, Computer gives Mom a new voice, San Jose
Mercury-News, Sunday morning, March 16, 1980, page B-5 (w/
picture on B-1).

30-minute live radio interview of Carol Simpson and Douglas Williams with VPSP speaking on syndicated show, "Coast to Coast", by the Woodruff Organization, San Francisco, March 18, 1980.

Wheelchair speaks for those who can't, Campus Report: A Publication for Stanford University Faculty & Staff, Volume XII, Number 25, March 19, 1980, page 10 (w/ picture).

Omni Magazine: Bob Brody, freelance writer, called from New York for telephone interview (and to listen to VPSP via phone) for article for Omni Magazine, April 2, 1980.

'Talking Wheelchair' designed, The Stanford Daily, Thursday, April 10, 1980, page 5 (w/ picture).

A talking wheelchair, Science News, Vol. 117, No. 14, April 5, 1980, page 221.

Computerized Wheelchair Talks for California hospital patients, Dayton Daily News, April 13, 1980.

Mark McMackin, Latest in Health: Talking Wheelchair..., U. S. News & World Report, April 14, 1980, page 84.

Talking Wheelchair Aids Handicapped, Knight-Ridder Wire, Dallas Times Herald, ca. April 20, 1980.

Talking Wheelchair allows disabled users to speak, Modern Healthcare, April, 1980, page 116.

First Talking Wheelchair, De Anza College Student Newspaper, Cupertino, CA, May 1980.

Computer Instrument Opens Up a New World of Speech for the Nonspeaking Person (article about HC Electronics HANDIVOICE mentions VPSP prototype), San Francisco Business Journal, July 28, 1980, p. 13.

The Versatile Portable Speech Prosthesis (VPSP), Communication Outlook: A Publication of the International Action Group for Communication Enhancement, Vol 2, No. 3, August 1980, p. 9.

De Spraakprocessor (article written in Dutch), De Microcomputer, THE NETHERLANDS, ca.1980, pp.38-40.

Family Practice News, August 15, 1981, p. 56 "Talking Wheelchair gives mute handicapped a voice."

Human Development News, U.S. Department of Health and Human Services, Sept. 1981 "Spinoff" section led off with VPSP.

ABC National Television Show "20/20" spent the entire week of February 11- 15, 1980 shooting footage for a story on the problems and solutions to problems for the non-oral. One and a half days were devoted to filming the VPSP in use by Sally Melanephy in her home and to interviews at Children's Hospital at Stanford and PLRA. A twenty-minute segment was broadcast February 1981.

Williams, D. H. A Versatile, Portable, Speech Prosthesis, in Proceedings of the Johns Hopkins First National Search for Applications of Personal Computing to Aid the Handicapped, IEEE Computer Society, P. O. Box 80452, Worldway Postal Center, Los Angeles, California, 90080, October 1981.

Catherine Caffrey, NASA's Life-Enhancing Spinoffs, Fusion, September 1981.

American Medical News, March 28, 1980.

Acta Mediocotechnica, November 5, 1980.

Omni, Talking Wheelchair, Robert Brody, July 1980, p.41.

Accent on Living, Bloomington, Illinois, Ray Cheever, October 30, 1980.

KGNR Radio, Sacramento, California, Jerry Grisham, News Anchorman, September 15, 1980.

Dallas Times-Herald, Talking Wheelchair Aids the Handicapped, April 20, 1980, Knight-Ridder Wire.

Barbara Deane, "The Talking Wheelchair: a Computer Age Prosthesis for People with Communication Handicaps," Creative Computing, March 1982, pp. 62-66.

Up Front, The Newsletter for Handicapped and Disabled Persons, Eric Sandahl, 1980 (day unknown).

B. Interviews and/or information given to the following journalists are listed here if we do not know when or where their story was published.

Science Digest: gave telephone interview to Diana Ingham who called from Chicago for details on the VPSP, April 14, 1980.

Gregg Vanderheiden, Trace Center, 922 ERB, 1500 Johnson Drive, University of Wisconsin, Madison, Wisc. 53706.

Science 80: VPSP demo given to Edward Edelson, Science Editor for article on use of electronics in treating deafness, aiding blind persons, and in other prostheses,

January 8, 1980.
Stephen Brugler, Vice President, <u>Telesensory Systems Inc.</u>
3408 Hillview Ave, Palo Alto, Ca. 94304.

<u>"What will they think of next?"</u>, 30-minute weekly TV show:
Sent copy of VPSP video tape to Gay Goodfellow, Science
International, Buffalo, February 22, 1980.

<u>Canadian Broadcasting Company (CBC)</u>: telephone interview on
VPSP given by Maurice LeBlanc to Leslie Kruger and Barbara
Frum, February 21, 1979.

<u>New Scientist</u>: CBC says they learned of the VPSP from an
article in the New Scientist, dated prior to February 21,
1980.

<u>Atlantic News Association</u>, San Jose: requested photo of
VPSP to accompany press release (via Stanford Medical Center
News Bureau), March, 1980. Attn: Paul Swart, 2429 Greengate
Dr. San Jose.

<u>Plus 60</u>: Reporter called from New York for interview on
VPSP and request for photo of a senior citizen using the
VPSP, March 15, 1980.

<u>Echo On</u>: Newsletter for H.C. Electronics Handivoice Users,
Alan Schwartz, Editor, was given demo of VPSP and interview
for article in Echo On, February 25, 1980.

<u>A Rumanian broadcast</u> journalist delegation interviewed and
videotaped Sally Melanephy, 31 July, 1980. The VPSP
produced intelligible Rumanian.

<u>A. Sylvestre Centre de Reeducation</u> et de Readaptation
Fonctionnelles De Kerpape 56270 Ploemeur B.P. 241 56321
Lorient Cedex, FRANCE

Ms. Carolyn Stone, <u>German Television</u>, PO Box 40827 Palisades
Station, Washington, D.C. 20016.

<u>Science Report</u>: Sent requested VPSP info sheet to Mr. Norm
Kagen, with offer to supply 16mm copy of VPSP video tape for
their science newsreel, July 23, 1979.

<u>German Television</u> sent a team who spent several hours
taping the VPSP and interviewing Dr. Simpson (and VPSP) in
German. Aired in Europe, Spring, 1981.

Ms. Marscha Krone writing article on appl. of mp to
handicapped 2e Willemstraat 32 8725 JK Groningen HOLLAND,
May 13, 1981

Miss Yin-kwan Leung 2255 Northrop Ave. #35 Sacramento, CA
Requested information for entry into TECTRA--the Federal
Laboratory Consortium online databank of successful

technology transfer cases.

David Ball, Editor, _Remedial Therapist,_ The Newborne Group, Recorder House 91 Stoke Newington Church Street, London, N16 OAU Requested VPSP demo and article for magazine (in preparation).

Handisoft, 30 rue Pasteur Vert-Sent-Denis F7240 CESSON (France) Dr. Paul Eschstruth was given information and a VPSP demo as he is working on a similar device for French patients.

Spastic Society 669 Waverley Rd., Glen Waverley, Victoria, Australia.

Prof. Hiroyasu Funakubo, D. Eng. University of Tokyo, Faculty of Engineering 3, 7 - Chome, Hongo Bunkyo - Ku, Tokyo, Japan.

Mr. Norman Kagen, Science Report, 210 North 52nd. St., New York City, N.Y. 10019.

Mr. Kevin O'Connor, Editorial Specialist American Speech-Language Hearing Association, 10801 Rockville Pike, Rockville, Maryland 20852.

Donna Haupt, _Life Magazine,_ 1271 Avenue of the Americas, New York, NY 10016.

Swedish Educational Broadcasting Company, Stockholm, Sweden, Sven Stegfors, November 4, 1980.

German Television, Wiesbaden, Germany, Rudolf Schwarz, June 4, 1980.

German Television, Scientific Program, Erich Vogt, February 19, 1981.

Leah Wallach, free lance writer, New York City, NY, March 30, 1981.

Pediatric News, Rockville, Maryland, Jon Simmons, April 8, 1981.

Science International, Ontario, Canada, M. Marchand.

Spastic Society, Victoria, Australia, Andrea Goldsmith, June 27, 1980.

French Television, Paris, France, James Naceda, June 16, 1980.

American Physical Therapy Association, Washington, D. C., Phyllis Quinn, April 28, 1981.

<u>Medical Products Sales</u>, Northfield, Illinois, Connie Heard,
November 4, 1981.

<u>America Illustrated</u>, USA International Communication Agency,
Gwen L. Johnson, November 4, 1980.

C.   More than 200 requests for information from individuals
have been answered since the start of the project, and they
continue to come to Children's Hospital at Stanford
Rehabilitation Engineering Center.   In many cases these are
people who are, or know of, someone who could use a VPSP if
it were availilable for a reasonable cost.

D.   Formal presentations or shows where VPSP was presented:

National Computer Conference, New York City, June 4-7, 1979.
VPSP was demonstrated several times by Dr. Simpson and
Charles Lingel (after an airline trip across the country).

Human Factors Society, Bay Area Chapter.   VPSP was the
topic of the Oct. 22, 1979 meeting at The Center for Design,
227 Forest Ave., Palo Alto, Ca.

Bay Area Non-Oral Communication Group.   VPSP demonstrated
by a user and Drs. Simpson and Williams, Dec. 4, 1979.

California State University, Long Beach. Disabled Day 1980,
February 6, 1980. VPSP videotape was shown continuously.

Southern California Communication Conference Rancho de los
Amigos, Downey, Cal., March 1, 1980.   VPSP was demonstrated
continuously all day, and a special design seminar was given
on it.
Bay Area Non-Oral Communication Faire, April 19, 1980.   VPSP
was demonstrated by Sally Melanephy, a non-vocal member of
the VPSP team, and used by several non-vocal persons.

De Anza College, Cupertino, Ca.   Access to Communication in
the 80's Workshop, May 16, 1980.   Dr. Simpson, Sally
Melanephy, and VPSP were featured speakers.

Conference on Daily Living for the Speechless.   Dr. Guy
Hamilton invited Drs. Simpson and Williams to demonstrate the
VPSP and talk about its design at this conference, London,
England, June 1981.   Several successful demonstrations were
done for practitioners and government officials over the
course of a week.

Voice Output Communication Aid (VOCA) Conference, Center for
Independent Living, Berkeley, California, May 22-23, 1980.

E. Awards Received by VPSP

National Computer Conference, May 19-22, 1980, Anaheim, California. A videotape of VPSP was shown. VPSP was awarded seventh place in the personal computer competition. A computer and case of disks were awarded as prizes.

VPSP was a regional winner in the Johns Hopkins First National Search for Personal Computing Aids for the Handicapped.

NASA Headquarters Citation for Accomplishment during Ames Research Center Performance Review, January 18, 1981.

APPENDIX V

A. VPSP USER'S MANUALS FOR THREE VERSIONS

Users's Manual for the Single Switch VPSP

Introduction

The Versatile Portable Speech Prosthesis (VPSP) or "Talking Wheelchair" is designed as a speech prosthesis for individuals with severe motor impairment but who have good cognitive linguistic skills and/or abilities.

One version of the VPSP is designed for user control by a single switch. It presents possible selections to the user on a small television screen. It moves a small rectangular block (called a "cursor") from one item to the next. When the cursor gets to the item the user wants, the user presses the selection switch. Using this one switch, the user can put items in a Talkspace for later talking, display any of 78 different screenfuls of selections (called "menu pages") and command the system to perform any of 16 different functions.

The system itself incorporates several levels of linguistic sophistication and corresponding capability. At the simplest level, the user can select from among several pre-spelled phrases and command the system to talk the selected phrase. At the most sophisticated level, the user can generate any desired message, edit it, talk it, and/or store it for future use. Depending on the linguistic abilities and acquired skills of the user, one or more of these levels may be used. A user need use only as much of the VPSP capability as he/or she is able. The different levels, in order of increasing sophistication, are listed below.
1. SPEAK A PRE-SPELLED PHRASE.
2. FILL IN A BLANK IN A PRE-SPELLED PHRASE WITH A CONTENT WORD AND SPEAK THE PHRASE.
3. COMPOSE A NEW PHRASE FROM PRE-SPELLED WORDS AND SPEAK IT.
4. COMPOSE A NEW PHRASE FROM SOME PRE-SPELLED WORDS AND SOME WORDS SPELLED BY THE USER. Note: Phonetic misspellings are usually pronounced correctly by the VPSP.
5. STORE A COMPOSED MESSAGE FOR LATER USE AND LATER RETRIEVE IT FOR TALKING. Note: The VPSP "remembers" the user's stored messages even if turned off.
6. GIVE A NAME TO A SET OF ONE OR MORE STORED MESSAGES TO AID MEMORY IN RETRIEVAL.
7. EDIT, THAT IS CHANGE, DELETE, OR ADD TO STORED MESSAGES AND/OR CHANGE THE NAMES UNDER WHICH THEY ARE STORED.

At all levels, the VPSP is designed to let the user erase mistakes or correct them before they are implemented. Also, should the user change her or his mind, it is easy to stop one operation and begin another.

Besides the capability for custom vocabulary and message generation, the VPSP lets the user "personalize" it in other ways. The user can set the speed at which the VPSP functions to match what is most comfortable. Also, the user can choose between two modes of system operation. With "Verify Mode" turned ON, the VPSP hesitates for a short period after the user has made a selection to see if the user really intended that selection. After the waiting period, it carries out the selection. Should the user want to correct an erroneous selection during this interval, he or she presses the selection switch a second time during the waiting interval, and the VPSP then ignores the original, erroneous selection. With "Verify Mode" turned OFF, the VPSP carries out the user's selection immediately and the user must use the *ERase, *DElete, or *CLear commands to correct errors (see section on Commands below).

How to use the VPSP

VPSP Rules
1) Use the pushbutton switch to turn the VPSP on and off.
2) Use the paddle switch, or whatever "selection switch" you are using, to stop the cursor (the little square light that moves across the screen) at the item on the screen that you want.
3) YOU CANNOT HURT THE VPSP USING THESE TWO SWITCHES.

VPSP Special Symbols

The VPSP has some special symbols. You will see them as you follow this tutorial step by step.

1. "█" is called the "cursor". It moves around the screen at the speed you have selected on the "STARTUP" page. (The "STARTUP" page comes on automatically when you turn the VPSP on.)

2. The ">" at the tops and bottoms of the columns means "go on to the next column". If you select it with your switch, it will cause the cursor to get out of the column it is scanning and start scanning the next column. There is an example of ">" on the STARTUP Page.

3. A "[" in front of a word or string of letters means that that word or string of letters is the name of a page in the VPSP that you can go to, simply by selecting that item. You will see examples of "[" on the

Table of Contents page and almost all of the
other VPSP pages. For example, [END is the
name of a page that has word endings on it,
i.e. -ing, -ed, -tion, -ally.

4. A "*" in front of a two-letter abbreviation
means that the abbreviation is a command that
the VPSP will perform if the user selects it.
For example *RE is not the word "re"; it is
the command to the VPSP that tells it to REturn
to the previous page, whatever that page was.

5. If there are none of these special symbols in
front of the words, letters, or phrases you see
on the VPSP screen, then that means these
words, letters, or phrases are available to use
to build your speech messages, by spelling
them out in a special area of the screen called
the "Talkspace".

VPSP Tutorial

Turn the VPSP on with the pushbutton switch. You will see
the STARTUP page appear on the screen after a short wait
- about as long as it takes for your TV set to come on. Now,
use the STARTUP page to select the speed that you want the
cursor to move at. When the cursor gets to the speed that
you want to try (one of the numbers in the first
column), press the selection switch. Once you select a
speed, the cursor starts over at the top of the column. The
number you selected appears below the "D" in "SPEED". The
cursor will move at the speed selected. If you don't
like that speed, you may select another.

If you are satisfied with the speed, select either of the
">'s" in the "speed" column. ">" always means "start
scanning columns" or "next column". The cursor will
therefore move to the "VERIFY" column and move between "on"
and "off". If you select "on" for "verify on", it will make
the cursor blink for a while when you make your following
selections. While it is blinking, it is doing nothing
else; it is just waiting for you to see if you really meant
to choose that item. If you really meant that item, then you
just wait till the cursor stops blinking, and the VPSP will
do whatever you selected. If, however, you made a mistake
and didn't really want the thing you selected, then you can
hit the selection switch again while the cursor is blinking.
This will make the VPSP ignore your mistake and make the
cursor start scanning on the next item. Using "Verify On"
makes the VPSP take a little longer to respond to your
commands, but, if you make a lot of accidental selections,
it can save you time in the long run.

If you find you are pretty accurate with the selection switch
and hit it only for items you want, then you will want to

choose "Off" for "Verify Off". That will make the VPSP immediately do your bidding - no blinking cursor; as soon as you select something, the VPSP will act. If you make a mistake, or just change your mind, there are still ways to undo your selection. These include the commands *ERase, *DElete, and *CLear, which will be explained later on. So, once you have chosen either "ON" or "OFF", the VPSP will automatically go to the Table of Contents page. From there you will be able to go to any other page in the VPSP.

The Table of Contents

On the Table of Contents page, you will see the names of lots of other pages. You can tell they are names of pages because they all start with "[", meaning "page name". [TIME means a page called "TIME" with time words on it. [SPEL means a page called "SPEL" with letters on it for spelling new words. You will see the name of the Table of Contents page at the top: [TOC, standing for Table of Contents. Every page has its own name on it, at the top.

Now, when the cursor gets to [USEFUL PHRASES, hit the selection switch. The VPSP will go to the [USEFul Phrases page. Actually, the VPSP only uses the first four letters in a page name. Take a look at this page.

There is a blank area above the line on the page. This is the "Talkspace", and it is always there, even when you change pages. This is where you will put the message you want to talk.

Notice the column on the right. Everything in it starts with a "*". "*" means "a command to the VPSP to do the action named by the two letters after the "*". Some commands are:

     *CO "go to the Table of COntents page"

     *SP "go to the SPelling page and tack a space onto whatever is in the Talkspace so as to start a new word".

     *ER "ERase the last entry that was put into the Talkspace" Then, if *ER is used again without making any new selections, it means, "ERase the last letter in the Talkspace" and can be used over and over again to erase one letter at a time.

     *ST "go back to the STARTUP page" - so you can change the speed or switch "Verify" on or off.

The ">" means "move the cursor along the tops of the columns on this page. To see how it works, notice that the cursor is moving along the tops of the columns when you first come

to this page, or any other page.   Pick a column you
want, and hit the selection switch when the cursor gets to
the top of that column. Now the cursor moves down the
column. When it gets to the bottom, it starts over again at
the top. Experiment with ">" by selecting it to see what
the cursor does.

Now, select the first column of words and phrases from
the [USEFul Phrases page. Now the cursor will move down
that column. When it gets down to "Listen to me", hit the
switch. Now, "Listen to me" will go into the Talkspace,
and the cursor will go back to moving across the tops of the
columns.

Now, select the third column, the one with the commands.
When the cursor moves down by "*TA" for, TAlk the
Talkspace, press the switch. Did it say, "Listen to me!" ?
You can repeat your message by using *TA again. Or, you
can clear out that message and put something else in your
Talkspace. To clear the Talkspace, select *CL for CLear.
Maybe you want to say something that is not already spelled
on the VPSP pages. Select the *SP command, and the VPSP will
go to the Spelling page.   Here you have all the letters
of the alphabet, arranged in columns according to the general
order that you use them to spell words in English. There are
also punctuation marks such as ".", "?", and also a "space",
shown by a tiny dot in the center. And, the last column
on the page has all the commands, just like the other pages.
There's an extra command on the [SPEL page called *DU for
DUplicate the last entry. This is handy for words that
have double letters in them.   Say you select "T". Then
you can select *DU, and the VPSP will add another "T" to
the Talkspace. Try spelling something. When you want to
talk it, select the *TA.

If you make a wrong selection or change your mind, use the
*ER to erase the last entry. To delete a whole word at a
time, use *DE to delete the last word in the Talkspace.
To clear out the Talkspace, use *CL. Actually, you
could use nothing but the [SPEL page and say anything you
want. But, it takes time to spell things out letter by
letter. So, the VPSP has a lot of pages with words and
phrases already spelled out for you.   You can then select
them for the Talkspace as a single item.

As you feel the inclination, explore the VPSP pages. You
do this by selecting the name of the page you want to go to.
Remember that you can tell if something is a page name by
whether it starts with "[". You might want to start by
looking at these pages:

[ASK "Ask a question" This page has words that you use
for asking questions, such as "what", "who", "when"; and
"are", "is", "can", "do".

[MAKE "Make a new phrase" This page has words for making up a new phrase, such as "I", "you", "he", "she"; "am", "are", "will", "won't".

[CONN "Connector words" This page has the little connector words that you put between the main words in your messages, such as "the", "a", "to", "of", "that", "because", "unless".

[TIME "Time words" This page has time words such as "now", "then", "before", "after", "today", "week".

[NUMB "Numbers" This page has the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, and special endings such as -rd, -st, -th.

[DICT "Dictionary" This is the "Main Dictionary Page". It has the names of all 25 pages in the Dictionary. The Dictionary pages contain 925 of the most frequently used words in English. When you go to the [DICT page, you will see on it page names such as [ABSO, [DEVE, [ELEM, etc. Each of these pages is named for the first word on it, in alphabetical order. So, the page named "[DEVE" starts with the word "develop" and has words all the way through the word "electric". Next comes the page "[ELEM". Spend some time exploring the Dictionary pages to see what's in them. Notice that you can "thumb through" the dictionary because each page in it has on it the name of the previous page and the name of the next page. Anytime you want to return to the Main Dictionary Page, select the *RE command for "Return to Previous Page". The VPSP "knows" that you don't mean to go back to one of the individual dictionary pages but rather that you want to return to the Main Dictionary Page, called [DICT.

There are other pages in the VPSP that you can discover on your own. Also, in the back of this manual is a list of all the VPSP pages. Altogether, the VPSP has 78 pages, including 29 pages that you can put your own messages on to store them until you need them. These pages, called "USER PAGES", since you are the "User", will be remembered by the VPSP even when you turn it off and back on again.

Summary of the Basic VPSP Commands

Here is a handy list of the VPSP commands you have learned. Each of these 9 commands always appears on any VPSP page that has words or letters or phrases on it that you can put into the Talkspace. These commands with their meanings are also on your VPSP pages called [DIRE, which you can get by going to the Table of Contents with *CO and then going to page 2 of the Table of Contents by selecting [PG 2. On [PG 2 you will see [DIRE, which stands for "Directions to use the Talker". (Talker is another name for the VPSP.) Select it and you will see this display:

[DIRECTIONS TO USE TALKER

```
MOVE CURSOR TO NEXT COLLUM    >
GO TO TABLE OF CONTENTS       *CO
GO TO SPELLING PAGE           *SP
RETURN TO PAGE YOU WERE ON    *RE
ERASE LAST ENTRY/LETTER       *ER
TALK THE TALKSPACE            *TA
GO TO USER COMMAND PAGE       *UC
DELETE LAST WORD              *DE

CLEAR TALKSPACE               *CL

GO TO START-UP PAGE           *ST

DUPLICATE LAST ENTRY          *DU
```

The first nine commands in the display above appear on every
VPSP page, including your own pages, which have letters,
words, or phrases that you can select and put into your
Talkspace. The last command, *DU, appears only on the
[SPEL page and on the [SOUN (for Soundspelling) page since
that is the only place you are likely to use it. It is
handy for making double letters for spelling words like
"letter".

Special VPSP User Commands

Besides the *DU command, there are seven other special
commands. These seven commands are the ones you use to create
your own VPSP pages. With them you can put what you have in
the Talkspace onto your own pages. You can rename your pages
to names that have special meaning for you. You can erase
what you have on your pages and put something else
there instead. You can even put the names of pages on your
pages so you can get to them more quickly. As you use your
VPSP, you will find that you can change it in many different
ways to suit your needs and that as your needs change, you
can change the VPSP to keep up with you.

Storing Your Own Messages on your Own VPSP Pages

Suppose you have a short sentence in the Talkspace that you
have spent some time composing. Now you would like to
save it so you don't have to compose it all over again the
next time you want to talk it. If your sentence is no
longer than 27 letters, including the spaces, then you can
store the whole thing on one line of one of your "user pages"
(You are the user, remember?)

To add what you have in the Talkspace to one of your
"user pages", select the *UC command (for User Commands).

The VPSP will go to the [UCOM page. In the first column of the [UCOM page, select *UADD (for U Add to your page). You will see "*UADD" appear on the screen. Then select the page to which you want to add your Talkspace message. For now, how about selecting the page called [MY 3. The VPSP will go to page [MY 3. You will see there are two columns on page [MY 3, or any other "user page" you may have selected. The first column has a lot of blank space in it, and the second column has all the familiar 9 commands that you've seen on the other VPSP pages. Select the first column so that the cursor starts moving down that column of blank lines. When the cursor gets to the line where you want to put your message from the Talkspace, press your switch. You will see a copy of your message appear on that line of the page. Then the VPSP will automatically go back to the [UCOM page. This all happens sort of quickly. You might want to go back to the page where you put your message and see that it is really there. It will be. Just select that page again and the VPSP will take you there. Now you can use your selection switch to get your message from that page and put it into the Talkspace. You can treat your own message just like any other item on the VPSP pages that can be put into the Talkspace.

Remember that you can only put one line at a time from your Talkspace onto these "user" pages. You can put up to 14 1-line messages on a single "user" page, but you have to do them one at a time. If you want to put together longer messages to store, then you must use the [TCOM page. You will notice that you can get to the [TCOM page from the [UCOM page.

Suppose you have a message in the Talkspace that is three lines long and you want to store it. Use *UC to get to the [UCOM page, and from there select [TCOM (for "Text Commands"). The VPSP will take you to the [TCOM page, and the cursor will start moving down the first column automatically. When it gets to the *FADD command, press your switch. You will see *FADD appear on the screen and the cursor will start moving down the second column. These are the names of nine different pages upon which you can write up to 100 words each. Choose one, say the TXT2 page. The VPSP will automatically add the message you have in the Talkspace onto this page. If there was already something on the page, the VPSP will add the Talkspace message onto the end of what was already there. This way build up a long speech by composing a sentence at a time and adding it to the same page.

After the VPSP has added your message to the page, it will go back to the [TCOM page. If you want to talk what is on any of the "text" pages, use the *FTALK command from the [TCOM page and then choose the "text" page that you want to talk.

Suppose you have put several messages on one of your user pages. Perhaps this page is called [MY 9, or some other number. The name [MY 9 doesn't tell you very much about what you have put on it. You can make up your own name for that page and change its name from [MY 9 to your new name for it.

You build your new page name in the Talkspace. Start by clearing out the Talkspace with the *CL command. Then go to the SPEL page using either the *SP command or by selecting the [SPELpage.

There are a couple of rules to follow when you make up new page names. Remember that the "[" means to the VPSP that the letters after the "[" are a page name. You should always start page names with "[" so the VPSP will know they are page names. Now, select a "[" from the column of punctuation marks. You will see "[" as the first letter in the Talkspace.

The other rule about names of pages is that they have to be four letters long. So, think of a four letter name for your page - one that hasn't been used for any other page. Maybe you decide to call it [NEWS. Spell it out in the Talkspace.

Now go back to your "user" commands with *UC. When you get the the [UCOM page, select the *UNAME command. Then select the page that you want to rename. We'll use [MY 9 as an example. So, you select [MY 9, and you will see on the screen that the VPSP goes to page [MY 9 and changes its name to [NEWS, then comes back to the [UCOM page and changes the [MY 9 page there to [NEWS, too.

You can change the name of any "user" page you want as many times as you want just by putting the new name in the Talkspace and then using the *UNAME command. If you forget the "[" at the beginning, the VPSP will just not change the name at the point where you try to use *UNAME. Also, if you try to use the same name more than once, the VPSP will remind you of this by printing "Filename in use", which is its way of saying you are already using this name for another page.

If you want to change the name of one of your text pages, do just as you did for changing a "user" page, except you go to the[TCOM page and use the *FNAME command.

Erasing Messages You Don't Want Anymore

Some of the messages you store away may be for a particular person or event. Later you'd like to use the

space for a different message. If you want to change one of
the 1-line messages in a "user" page, just compose your
new message in the Talkspace and use *UADD as you always
would. When you get to the page with the message you
want to replace, just select the line of that message and
your new message will be written on top of the old one and
will make the old one go away.

If you don't have a new message to put there but still want
to get rid of an old message, you can play a trick on the
VPSP to get rid of the old message. Use *CL to clear the
Talkspace. Now it is full of nothing. Actually it is
full of blanks (different from spaces) which you can't see.
Now you use *UC as always and go to the page with the
message to be erased. Select that message, and the VPSP will
write the blanks from the Talkspace on top of the
message and the old message will go away.

Getting rid of mesages in the text pages is a little
different. You must use the *FCLEAR command (on the [TCOM
page). Use *UC to get to [UCOM page and then select
[TCOM to get to the [TCCM page. Then select *FCLEAR from the
first column. Next select the page you want to clear out.
The whole page is going to be cleared, not just one line.
When you select the page, the VPSP will show it to you and
ask you if you really want to clear it. On the screen it
will show you a "Y" and an "N". If you decide you don't
really want to clear that page select the "N". If you
really want to clear it, then select the "Y" and the VPSP
will clear the page for you.

That's all the special VPSP commands. There is a list of
them below that you can refer to if you forget how they work.

Summary of VPSP User Commands

Here is a list of all the special User Commands that you get
to with the command *UC. The ones for the 1-line messages on
the [UCOM page all start with the letter "U", and the ones
for the longer, "text" pages all start with the letter "F".

[UCOM page commands:

    *UNAME   NAME THE PAGE YOU SELECT WITH THE NEW
                     PAGE NAME THAT YOU HAVE PUT IN THE
                     TALKSPACE. Start page names with "[",
                     which you can find on the [SPEL page.
                     Names have to be exactly 4 letters long.
    *UADD   ADD WHAT YOU HAVE IN THE TALK SPACE TO THE
                     USER PAGE THAT YOU SELECT. Remember, you
                     cannot add messages that are longer than
                     27 letters (including spaces). You won't
                     hurt the VPSP if you try to add something
                     longer than 27 letters; the VPSP will just
                     cut off the part of the message that won't

```
                         fit.   The message will still be intact in
                         the Talkspace.
[TCOM                    The Text Command Page, which has the
                         *F... commands for the "text" pages.


[TCOM page commands:
*FVIEW                   VIEW (LOOK AT) THE PAGE THAT YOU SELECT.
                         To get back to [TCOM, press your switch.
*FTALK                   TALK THE PAGE THAT YOU SELECT.
*FADD                    ADD THE TALKSPACE TO THE PAGE YOU
                         SELECT.
*FNAME                   NAME THE PAGE YOU SELECT WITH THE NEW
                         NAME THAT YOU HAVE PUT IN THE TALKSPACE.
*FCLEAR                  CLEAR OUT THE PAGE YOU SELECT, I.E.,
                         ERASE THE WHOLE PAGE.
                         When you get to the page, the VPSP will
                         ask if you really want to clear the
                         page.  The cursor will move between "Y"
                         and "N".  If you really want to clear
                         it, select "Y".  If you did not mean to
                         clear the page, select "N".
```

B. User's Manual for the Joystick (or 5-Switch) VPSP

Introduction

The Versatile Portable Speech Prosthesis (VPSP) or
"Talking Wheelchair" is designed as a speech prosthesis for
individuals with severe motor impairment but who have
good cognitive linguisticskills and/or abilities.

One version of the VPSP is designed for user control by
a joystick plus a selection switch (or 5 switches). It
presents possible selections to the user on a small
television screen. The user moves a small rectangular
block (called a "cursor") from one item to the next by means
of a joystick or 4 separate switches. The joystick (or 4
directional switches) provide for moving the cursor up,
down, right, or left on the screen. When the cursor gets to
the item the user wants, the user presses the selection
switch. Using these switches, the user can put items in
a Talkspace for later talking, display any of 78
different screenfuls of selections (called "menu pages")
and command the system to perform any of 16 different
functions.

The system itself incorporates several levels of
linguistic sophistication and corresponding capbility. At
the simplest level, the user can select from among several
pre-spelled phrases and command the system to talk the
selected phrase. At the most sophisticated level, the user
can generate any desired message, edit it, talk it, and/or
store it for future use. Depending on the linguistic
abilities and acquired skills of the user, one or more of
these levels may be used. A user need use only as much of
the VPSP capability as he/or she is able. The different
levels, in order of increasing sophistication, are listed
below.
1. SPEAK A PRE-SPELLED PHRASE
2. FILL IN A BLANK IN A PRE-SPELLED PHRASE WITH A
CONTENT WORD AND SPEAK THE PHRASE.
3. COMPOSE A NEW PHRASE FROM PRE-SPELLED WORDS AND
SPEAK IT.
4. COMPOSE A NEW PHRASE FROM SOME PRE-SPELLED WORDS
AND SOME WORDS SPELLED BY THE USER. Note:
Phonetic misspellings are usually pronounced
correctly by the VPSP.
5. STORE A COMPOSED MESSAGE FOR LATER USE AND LATER
RETRIEVE IT FOR TALKING. Note: The VPSP
"remembers" the user's stored messages even if
turned off.
6. GIVE A NAME TO A SET OF ONE OR MORE STORED
MESSAGES TO AID MEMORY IN RETRIEVAL.
7. EDIT, THAT IS CHANGE, DELETE, OR ADD TO STORED
MESSAGES AND/OR CHANGE THE NAMES UNDER WHICH THEY
ARE STORED.

At all levels, the VPSP is designed to let the user erase mistakes or correct them before they are implemented. Also, should the user change her or his mind, it is easy to stop one operationand begin another.

Besides the capability for custom vocabulary and message generation, the VPSP lets the user "personalize" it in other ways. The user can set the speed at which the VPSP functions to match whatis most comfortable.

How to use the VPSP

VPSP Rules:
1)Use the pushbutton switch to turn the VPSP on and off.
2) Use the joystick (or the 4 directional switches) to the screen) up, down, right, or left to put it in front of the item on the screen that you want.
3) Use the paddle switch, or whatever "selection switch" you are using, to choose the item next to the "cursor" that you want.
3) YOU CANNOT HURT THE VPSP USING THESE SIX SWITCHES.

VPSP Special Symbols

The VPSP has some special symbols. You will see them as you follow this tutorial step by step.

1. "_" is called the "cursor". You move it across the screen with your joystick or your four directional switches at the speed you have selected on the "STARTUP" page. (The STARTUP" page comes on automatically when you turn the VPSP on.)

2. The ">" on the STARTUP Page means "go on to the next thing". Once you are satisfied with the speed you've chosen on the STARTUP Page, you use the ">" to tell the VPSP to "go on". On the other pages of the VPSP, it just indicates the tops and sometimes bottoms of the columns, but otherwise it does nothing if you select it.

3. A "[" in front of a word or string of letters means that that word or string of letters is the name of a page in the VPSP that you can go to, simply by selecting that item. You will see examples of "[" on the Table of Contents page and almost all of the other VPSP pages. For example, [END is the name of a page that has word endings on it, i.e. -ing, -ed, -tion, -ally.

4. A "*" in front of a two-letter abbreviation means that the abbreviation is a command that the VPSP will perform if the user selects it. For example *RE is not the word "re"; it is the command to the VPSP that tells it to REturn to the previous page, whatever that page was.

5. If there are none of these special symbols in front of the words, letters, or phrases you see on the VPSP screen, then that means these words, letters, or phrases are available to use to build your speech messages, by spelling them out in a special area of the screen called the "Talkspace".

VPSP Tutorial

Turn the VPSP on with the pushbutton switch. You will see the STARTUP page appear on the screen after a short wait - about as long as it takes for your TV set to come on. Now, use the STARTUP page to select the speed that you want the cursor to move at when you are holding down your directional switches (or holding your joystick in the same direction). Use the joystick (or the "up" and "down" switches to put the cursor in front of the speed that you want to try (one of the numbers in the first column). Press the selection switch. Once you select a speed, the number you selected appears below the "D" in "SPEED". Now, if you hold your joystick "up" or "down", the cursor will move at the speed selected. If you don't like that speed, you may select another.

If you are satisfied with the speed, select either of the ">'s" in the "speed" column. ">" means "go on". So, once you have chosen ">", the VPSP will automatically go to the Table of Contents page. From there you will be able to go to any other page in the VPSP.

The Table of Contents

On the Table of Contents page, you will see the names of lots of other pages. You can tell they are names of pages because they all start with "[", meaning "page name". [TIME means a page called "TIME" with time words on it. [SPEL means a page called "SPEL" with letters on it for spelling new words. You will see the name of the Table of Contents page at the top: [TOC, standing for Table of Contents. Every page has its own name on it, at the top.

Put the cursor in front of [USEFUL PHRASES and hit the selection switch. The VPSP will go to the [USEFul Phrases page. Actually, the VPSP only uses the first four letters in a page name. Take a look at this page.

There is a blank area above the line on the page. This is the "Talkspace", and it is always there, even when you change pages. This is where you will put the message you want to talk.

Notice the column on the right. Everything in it starts with a "*". "*" means "a command to the VPSP to do the action named by the two letters after the "*".

Some commands are:

    *CO   "go to the Table of COntents page"

    *SP   "go to the SPelling page and tack a space onto whatever is in the Talkspace so as to start a new word"

    *ER   "ERase the last entry that was put into the Talkspace." Then, if *ER is used again without making any new Talkspace, it can be used over and again to erase one letter at a time.

    *ST   "go back to the STARTUP page" - so you can change the speed.

The ">" just indicates the tops of the columns on this page. If you select it, nothing happens and the VPSP just waits for you to do something else. Pick a column you want with the joystick by moving it right or left and watching the cursor move right or left, too. Experiment with moving the cursor from one column to another. Then try moving the cursor up and down in a column by moving your joystick up and down (or by pressing your "up" and "down" switches). Notice that if you are going "up" and the cursor gets to the top of the column, it "wraps around" the back of the screen and starts coming up from the bottom. The same sort of "wrap around" happens for all four directions: right, left, up and down.

Now, put the cursor in the first column of words and phrases from the [USEFul Phrases page. Now move it to "Listen to me" and hit the selection switch. Now, "Listen to me" will go into theTalkspace.

Now, move the cursor to the third column, the one with the commands. Then move the cursor to "*TA" for, TAlk the Talkspace, press the selection switch. Did it say, "Listen to me!" ?

You can repeat your message by selecting *TA again. Or, you can clear out that message and put something else in your Talkspace. To clear the Talkspace, select *CL for CLear.

Maybe you want to say something that is not already spelled on the VPSP pages. Select the *SP command, and the VPSP will go to the Spelling page. Here you have all the letters of the alphabet, arranged in columns according to the general order that you use them to spell words in English. There are also punctuation marks such as ".", "?", and also a "space", shown by a tiny dot in the center. And, the last column on the page has all the commands, just like the other pages. Try spelling something. When you want to talk it, select the *TA.

If you make a wrong selection or change your mind, use the *ER to erase the last entry. To delete a whole word at a time, use *DE to delete the last word in the Talkspace. To clear out the Talkspace, use *CL. Actually, you could use nothing but the [SPEL page and say anything you want. But, it takes time to spell things out letter by letter. So, the VPSP has a lot of pages with words and phrases already spelled out for you. You can then select them for the Talkspace as a single item.

As you feel the inclination, explore the VPSP pages. You do this by selecting the name of the page you want to go to. Remember that you can tell if something is a page name by whether it starts with "[". You might want to start by looking at these pages:

[ASK "Ask a question" This page has words that you use for asking questions, such as "what", "who", "when"; and "are", "is", "can", "do".

[MAKE "Make a new phrase" This page has words for making up a new phrase, such as "I", "you", "he", "she"; "am", "are", "will", "won't".

[CONN "Connector words" This page has the little connector words that you put between the main words in your messages, such as "the", "a", "to", "of", "that", "because", "unless".

[TIME "Time words" This page has time words such as "now", "then", "before", "after", "today", "week".

[NUMB "Numbers" This page has the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, and special endings such as -rd, -st, -th.

[DICT "Dictionary" This is the "Main Dictionary Page". It has the names of all 25 pages in the Dictionary. The Dictionary pages contain 925 of the most frequently used words in English. When you go to the [DICT page, you will see on it page names such as [ABSO, [DEVE, [ELEM, etc. Each of these pages is named for the first word on it, in alphabetical order. So, the page named "[DEVE" starts with the word "develop" and has words all the way through the word "electric". Next comes the page "[ELEM". Spend some time exploring the Dictionary pages to see what's in them. Notice that you can "thumb through" the dictionary because each page in it has on it the name of the previous page and the name of the next page. Anytime you want to return to the Main Dictionary Page, select the *RE command for "Return to Previous Page". The VPSP "knows" that you don't mean to go back to one of the individual dictionary pages but rather that you want to return to the Main Dictionary Page, called [DICT.

There are other pages in the VPSP that you can discover on your own. Also, in the back of this manual is a list of all the VPSP pages. Altogether, the VPSP has 78 pages, including 29 pages that you can put your own messages on to store them until you need them. These pages, called "USER PAGES", since you are the "User", will be remembered by the VPSP even when you turn it off and back on again.

Summary of the Basic VPSP Commands

Here is a handy list of the VPSP commands you have learned. Each of these nine commands always appears on any VPSP page that has words or letters or phrases on it that you can put into the Talkspace. These commands with their meanings are also on your VPSP pages called [DIRE, which you can get by going to the Table of Contents with *CO and then going to page two of the Table of Contents by selecting [PG 2. On [PG 2 you will see [DIRE, which stands for "Directions to use the Talker". (Talker is another name for the VPSP.) Select it and you will see this display:

DIRECTIONS TO USE TALKER

MOVE CURSOR TO NEXT COLLUM	>
GO TO TABLE OF CONTENTS	*CO
GO TO SPELLING PAGE	*SP
RETURN TO PAGE YOU WERE ON	*RE
ERASE LAST ENTRY/LETTER	*ER
TALK THE TALKSPACE	*TA
GO TO USER COMMAND PAGE	*UC
DELETE LAST WORD	*DE
CLEAR TALKSPACE	*CL
GO TO START-UP PAGE	*ST

The first nine commands in the display above appear on every VPSP page, including your own pages, which have letters, words, or phrases that you can select and put into your Talkspace.

Special VPSP User Commands

Besides the basic VPSP commands, there are seven other special commands. These seven commands are the ones you use to create your own VPSP pages. With them you can put what you have in the Talkspace onto your own pages. You can rename your pages to names that have special meaning for you. You can erase what you have on your pages and put something else there instead. You can even put the names of pages on your pages so you can get to them more quickly. As you use your VPSP, you will find that you can change it in many different ways to suit your needs and that as your

needs change, you can change the VPSP to keep up with you.

Storing your Own Messages on your Own VPSP Pages

Suppose you have a short sentence in the Talkspace that you have spent some time composing. Now you would like to save it so you don't have to compose it all over again the next time you want to talk it. If your sentence is no longer than 27 letters, including the spaces, then you can store the whole thing on one line of one of your "user pages" (You are the user, remember?)

To add what you have in the Talkspace to one of your "user pages", select the *UC command (for User Commands). The VPSP will go the the [UCOM page. In the first column of the [UCOM page, select *UADD (for U Add to your page). You will see "*UADD" appear on the screen. Then select the page to which you want to add your Talkspace message. For now, how about selecting the page called [MY 3. The VPSP will go to page [MY 3. You will see there are two columns on page [MY 3, or any other "user page" you may have selected. The first column has a lot of blank space in it, and the second column has all the familiar nine commands that you've seen on the other VPSP pages. Put the cursor in the first column and then move it down the column of blank lines. When you get the cursor to the line where you want to put your message from the Talkspace, press your selection switch. You will see a copy of your message appear on that line of the page. Then the VPSP will automatically go back to the [UCOM page. This all happens sort of quickly. You might want to go back to the page where you put your message and see that it is really there. It will be. Just select that page again and the VPSP will take you there. Now you can select your message from that page and put it into the Talkspace. You can treat your own message just like any other item on the VPSP pages that can be put into the Talkspace.

Remember that you can only put one line at a time from your Talkspace onto these "user" pages. You can put up to 14 1-line messages on a single "user" page, but you have to do them one at a time. If you want to put together longer messages to store, then you must use the [TCOM page. You will notice that you can get to the [TCOM page from the [UCOM page.

Suppose you have a message in the Talkspace that is three lines long and you want to store it. Use *UC to get to the [UCOM page, and from there select [TCOM (for "Text Commands"). The VPSP will take you to the [TCOM page. Put the cursor on the *FADD command and press your selection switch. You will see *FADD appear on the screen. Now put the cursor in the second column. There are the names of nine different pages upon which you can write up to 100 words each. Select one, say the TXT2 page. The VPSP will

automatically add the message you have in the Talkspace onto
this page. If there was already something on the page, the
VPSP will add the Talkspace message onto the end of what was
already there. This way you could build up a long speech by
composing a sentence at a time and adding it to the same
page.

After the VPSP has added your message to the page, it will go
back to the [TCOM page. If you want to talk what is on any
of the "text" pages, use the *FTALK command from the
[TCOM page and then choose the "text" page that you want to
talk.

Changing the Names of Your Own VPSP Pages

Suppose you have put several messages on one of your
user pages. Perhaps this page is called [MY 9, or some
other number. The name [MY 9 doesn't tell you very much
about what you have put on it. You can make up your own name
for that page and change its name from [MY 9 to your new name
for it.

You build your new page name in the Talkspace. Start
by clearing out the Talkspace with the *CL command. Then
go to the [SPEL page using either the *SP command or by
selecting the [SPELpage.

There are a couple of rules to follow when you make up new
page names. Remember that the "[" means to the VPSP that
the letters after the "[" are a page name. You should always
start page names with "[" so the VPSP will know they are
page names. Now, select a "[" from the column of
punctuation marks. You will see "[" as the first letter in
the Talkspace.

The other rule about names of pages is that they have to be
four letters long. So, think of a four letter name for
your page - one that hasn't been used for any other page.
Maybe you decide to call it [NEWS. Spell it out in the
Talkspace.

Now go back to your "user" commands with *UC. When you get
the the [UCOM page, select the *UNAME command. Then select
the page that you want to rename. We'll use [MY 9 as an
example. So, you select [MY 9, and you will see on the
screen that the VPSP goes to page [MY 9 and changes its name
to [NEWS, then comes back to the [UCOM page and changes the
[MY 9 page there to [NEWS, too.

You can change the name of any "user" page you want as
many times as you want just by putting the new name in the
Talkspace and then using the *UNAME command. If you
forget the "[" at the beginning, the VPSP will just not
change the name at the point where you try to use *UNAME.
Also, if you try to use the same name more than once, the

VPSP will remind you of this by printing "Filename in use", which is its way of saying you are already using this name for another page.

If you want to change the name of one of your text pages, do just as you did for changing a "user" page, except you go to the [TCOM page and use the *FNAME command.

Erasing Messages You Don't Want Anymore

Some of the messages you store away may be for a particular person or event. Later you'd like to use the space for a different message. If you want to change one of the 1-line messages in a "user" page, just compose your new message in the Talkspace and use *UADD as you always would. When you get to the page with the message you want to replace, just select the line of that message and your new message will be written on top of the old one and will make the old one go away.

If you don't have a new message to put there but still want to get rid of an old message, you can play a trick on the VPSP to get rid of the old message. Use *CL to clear the Talkspace. Now it is full of nothing. Actually it is full of blanks (different from spaces) which you can't see. Now you use *UC as always and go to the page with the message to be erased. Select that message, and the VPSP will write the blanks from the Talkspace on top of the message and the old message will go away.

Getting rid of messages in the text pages is a little different. You must use the *FCLEAR command (on the [TCOM page). Use *UC to get to [UCOM page and then select [TCOM to get to the [TCOM page. Then select *FCLEAR from the first column. Next select the page you want to clear out. The whole page is going to be cleared, not just one line. When you select the page, the VPSP will show it to you and ask you if you really want to clear it. On the screen it will show you a "Y" and an "N". If you decide you don't really want to clear that page select the "N". If you really want to clear it, then select the "Y" and the VPSP will clear the page for you.

That's all the special VPSP commands. There is a list of them below that you can refer to if you forget how they work.

Summary of VPSP User Commands

Here is a list of all the special User Commands that you get to with the command *UC. The ones for the 1-line messages on the [UCOM page all start with the letter "U", and the ones for the longer, text" pages all start with the letter "F".

[UCOM page commands:
*UNAME   NAME THE PAGE YOU SELECT WITH THE NEW
                        PAGE NAME THAT YOU HAVE PUT IN THE TALKSPACE.
                        Start page names with "[", which you can
                        find on the [SPEL page. Names have to
                        be exactly four letters long.
*UADD   ADD WHAT YOU HAVE IN THE TALK SPACE TO
                        THE USER PAGE THAT YOU SELECT.
                        Remember you cannot add messages that
                        are longer than 27 letters (including
                        spaces). You won't hurt the VPSP if you
                        try to add something longer than 27
                        letters; the VPSP will just cut off the
                        part of the message that won't fit. The
                        message will still be intact in the
                        Talkspace.
[TCOM   The Text Command Page, which has the
                        *F...commands for the "text" pages.

[TCOM page commands:
*FVIEW   VIEW (LOOK AT) THE PAGE THAT YOU SELECT
                        To get back to [TCOM, press your
                        selection switch.
*FTALK   TALK THE PAGE THAT YOU SELECT
*FADD   ADD THE TALKSPACE TO THE PAGE YOU
                        SELECT.
*FNAME   NAME THE PAGE YOU SELECT WITH THE NEW NAME
                        THAT YOU HAVE PUT IN THE TALKSPACE
*FCLEAR   CLEAR OUT THE PAGE YOU SELECT, I.E. ERASE
                        THE WHOLE PAGE.
                        When you get to the page, the VPSP will
                        ask if you really want to clear the page
                        by showing you a "Y" and an "N".
                        If you really want to clear it, select "Y".
                        If you did not mean to clear the page,
                        select "N".

There are two rules to remember when using the VPSP:
1) You cannot hurt the VPSP by anything you type
2) Whenever the VPSP gives you a message at the top
   of the screen, you can either do as it says or,
   if you don't want to do that, you can type any
   other key and return to exactly where you were.
   Sometimes it tells you of a mistake you made.
   These "mistakes" don't hurt the VPSP. They just
   tell you that it didn't "understand" what you
   typed. Just hit another key to make the message
   go away and get back to what you were doing.

When the VPSP first comes on, you will see the Directory of
all the pages that currently exist, listed in alphabetical
order.   To get to any page so you can talk it, edit it,
clear it, or kill it, just type the 4-letter name of the page
and then press the <Go> key.(In these directions, whenever you see a
enclosed within < >'s, it means that is the name of the
key, not that you should type the < >'s.)

Try going to the page named "KEYS".
Type <K> <E> <Y> <S>
Now press <Go>

Now the screen displays the page named "KEYS".   This is one
of the special pages in the VPSP because it tells you
what the different control keys for the VPSP are and what
they do. This page cannot be changed accidentally; so you
can always come here to refresh your memory on which keys
do what. Now, to get back to the Directory, you use what we
call "Control D".   "D" stands for Directory. "Control"
refers to the fact that you have to have the VPSP keyboard
in "control mode", sort of like "shift" on a
typewriter so as to get a "control" "D" rather than a
regular "D". We abbreviate "control" "D" like this: <^D>.
Here are two ways to get <^D>; use whichever you prefer:

Way Number 1

Hold down the key labeled <CTRL>.
(notice the yellow light on the keyboard in upper left
    corner).
While holding <CTRL> down, press the <D> key.
You will see the Directory come back on the screen.
Release the <CTRL> key. (notice the yellow light go
    out).
Now you are back in regular typing mode.

Way Number 2

Press the red button labeled <Control Cursor> in the
    upper left corner. (notice the yellow light beside

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it come on).
This shows you that you are in "control mode".
You will stay in "control mode" until you press
the red button again.
Now press the <D> key.
You will see the Directory come back on the screen.
Now press the red button labeled <Control Cursor> again.
(notice the yellow light go out)
Now you are back in regular typing mode.

There are two other special pages that give you directions
to use the VPSP. They are called "DIR1" and "DIR2". Try
going to them by typing their 4-letter name and then <Go>.
First go to "DIR1" andread it.

Now you can go directly from "DIR1" to "DIR2" by typing <D>
<I> <R> <2> and then <Go>. You don't HAVE to return to the
directory before going to another page.

Well, by now you probably want to say something. Think of
a four-letter name that abbreviates the idea you want to
say. As an example, I'll use "ISAY". "ISAY" (or whatever
name you choose) is going to be the name of a new page that
you will create.

        Type <I> <S> <A> <Y>
        Type <Go>
        Read the message that appears at the top of the screen.
        Follow its instructions.
        Next you should see a blank page named "ISAY",
            or whatever name you chose.
        Now type in anything you want to say.
        Whenever you want to say it, press <Talk>.

Whatever you have typed on a page will be automatically
stored there as soon as you go to another page or go back to
the Directory. The VPSP will "remember" it even if you turn
the system off and backon again.

Of course sometimes you will want to clear out a page and
type something else. To do this you use "control C", for
Clear, and then use one of the arrow keys at the top of the
keyboard. We will use "->" to stand for the right arrow key
and "<-" to stand for the left arrow key. Say you have just
typed something in and talked it. And now you want to clear
it out.

        Notice where the white square or "cursor" is on the
            screen.
        It is the glowing square that moves right each time you
        type a letter.
        Type <^C>, as follows:
            Either hold down <CTRL> while you press <C>

Or, press <Control Cursor>, then <C>,
then <Control Cursor>.
Either way, you will get a message
at the top of the screen.
Read it.
If you press the left arrow key, i.e. "<-", you
    will see everything to the left of the cursor
    cleared.
If you press the right arrow key, i.e. "->", you
    will see everything to the right of the cursor
    cleared.

Suppose you want to clear out only the first part of
your message. Use the arrow keys, "Up", "Down", "Right",
"Left", to put the cursor just after the last letter of the
part that you want to clear out. Type <^C> and then press
the Left Arrow. Everything in front of (to the left of) the
cursor will disappear, but everything starting with the
letter the cursor is on top of will remain.

If, on the other hand, you had wanted to clear out the
last part of your message but keep the first part, you
could put the cursor on the first letter of the part you
want to clear out. Thentyping <^C> and then pressing the Right A
clear out everything starting with the letter the cursor
is sitting on and going all the way to the end. But the
beginning would be saved.

Experiment with this to see how it works.

Suppose you just want to rub out or erase a few letters.
Use the arrow keys to put the cursor just after the letter
you want to rub out, and press <RUBOUT>. You can rub out
one letter at a time this way, like the "backspace" on a
typewriter.

Suppose you want to insert some letters or words in the
middle of your message. Put the cursor just after the
letter where you want to start adding on. Now type whatever
you want to insert and watch it appear in the middle of
your message. The message that was there "opens up" to
let your new letters be inserted. Experiment with this.

Now, suppose you are finished with the "ISAY" page, and
you don't want it cluttering up the directory. You want to
"KILL" that page. In order to kill a page you are on, you
just type <^K> <^I>. Remember, this destroys the page
whether there is anything on it or not, so be sure you
don't want to keep anything on it before "KILLING" it.
Try killing the ISAY page you just made.

Of course, if you wanted to keep this page and go off
to another one, you would just go to that other page and the
VPSP wouldautomatically save the page you were on.

Every time you create a new page, the VPSP puts the name of that page in the Directory. Then, when you type <^D> to display the Directory, you will see the new page listed there, too, and in alphabetical order. Also, when you kill a page, the VPSP takes that page name out of the directory. So, when you look at the directory, the name of the page you killed will no longer be there. The Directory can hold up to 78 pages.

You can rename a page, if you want. Say you have a page called "MATH" and you decide you would rather call it "ALGB", or Algebra. Start by going to the page you want to change the name of:

> Type <M> <A> <T> <H> and then <GO>
> Now that you're on the page, type in the new name for it, inthis case, "ALGB":
> Then, Type <PAGE> (The "Page" key is on the top row of the keyboard on the far left)

You will see a message appear at the top of the screen. Do as it says, and you will have changed the name of your page from "MATH" to "ALGB", or whatever names you used. If you look in the Directory, you will see the new name in alphabetical order and will see that the old name is no longer there.

That is everything you need to know about controlling the VPSP. You can create pages, change them, talk them, rename them, and kill them depending on your communication needs. The VPSP will remember everything you do to your pages and save them just as you left them until you change them.

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