DEVELOPMENT OF A BLISSYMBOL TERMINAL: AN INTERACTIVE TV DISPLAY TO ENHANCE COMMUNICATIONS FOR THE PHYSICALLY HANDICAPPED

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ABSTRACT

A symbolic language called Blissymbolics has been gaining in popularity in recent years as an alternative means of communication for verbally impaired, cerebral palsied children. Since many of these children are also severely physically handicapped, some means of indicating and storing symbol selections must be provided. This paper describes a collaborative project to develop a graphics terminal which will display Blissymbol messages on a home television set. The microprocessor-based equipment is being designed to accept a variety of input controls and output devices in order to match individual needs. The user makes selections interactively from a "page" of symbols displayed on two-thirds of the TV screen. The remaining one-third of the screen is available for the user's message, which can then be transmitted to other terminals in a classroom, for example, or over the telephone. The rationale for selection of the 500-symbol vocabulary, and its division into pages, will also be described.

DÉVELOPPEMENT D'UN TERMINAL POUR BLISSYMBOLES: AFFICHAGE TÉLÉVISÉ INTERACTIF POUR RÉHAUSSER LES COMMUNICATIONS POUR PERSONNES PHYSIQUEMENT HANDICAPÉES

RÉSUMÉ

Dans les années courantes, un langage symbolique surnommé "Blissymbolics" a atteint une hausse en popularité comme un moyen alternatif de communication pour les enfants aphysiques atteints d'infirmité motrice cérébrale. Puisque plusieurs de ces enfants sont gravement handicapés physiquement, des moyens pour indiquer et emmagasiner des sélections de symboles doivent être prévus. Cette communication décrit un projet, exécuté en collaboration, qui a pour but de développer un terminal graphique qui affichera des messages en "Blissymbols" sur un écran de télévision. Le système qui est entrain d'être mis à point est basé sur un micro-processeur. Celui-ci acceptera une variété de contrôles d'entrée et des appareils à la sortie afin de satisfaire aux besoins individuels. L'Opérateur fait des sélections réciproquement à partir d'une page de symboles affichée sur les deux tiers de l'écran de télévision. Le dernier tier de l'écran sert à l'affichage du message sélectionné par l'opérateur qui peut ensuite être transmis à d'autres "Blissterms" dans la salle de classe ou même encore par téléphone à des usagers éloignés. La raison fondamentale pour la sélection du vocabulaire comportant 500 symboles ainsi que sa pagination seront aussi décrits dans cet ouvrage.

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INTRODUCTION

Severely disabled persons having a combination of both verbal and motor impairments find communication extremely difficult, if not impossible. The ability to communicate is one of man's most fundamental needs and if it is missing from birth, or lost at an early age, normal intellectual and social capabilities usually do not develop. One alternative which is having widespread application with a growing number of disability groups is Blissymbolics, a graphic meaning-based communication system (Fig. 1). Originally published in Semantography,[1,2] in 1949, the purpose for Blissymbols envisioned by their creator Charles K. Bliss was that of an international language. Through developing a non-phonetic symbolic system, he hoped to offer a means of bridging the barrier between men of different languages.

In 1971, at the Ontario Crippled Children's Centre, Toronto, Blissymbols were first used as an augmentative communication medium with a small group of cerebral palsied children who lacked the motor coordination to produce functional speech.[3] In the following few years Blissymbol usage has spread throughout the world.[4] Programmes providing Blissymbol instruction have been established in all the provinces of Canada, throughout the United States of America, in Great Britain, Sweden, Norway, Holland, Australia, New Zealand, France and Israel. The disability groups for which Blissymbols have been utilized include: physically handicapped, retarded, multiply handicapped, autistic, aphasic, and stroke patients. Blissymbols, because of their simple shapes and direct reference to meaning, are learned easily and quickly by many persons lacking experience in traditional orthography (T.O.). They offer a long-term communication system for persons unable to learn to read T.O. They also provide a short-term bridge to T.O. and an enriching experience to those who will eventually communicate in the traditional alphabet (through spelling board, word board, electric typewriter, etc.) but who cannot acquire skill in T.O. quickly enough to meet their early cognitive and language development needs.[5]

Parallel with this spread of Blissymbols to a broad range of users, has been a growing realization of the contribution which could be made to Blissymbol communication by technological aids.[6] On the other hand, the large number of symbols required (100 to 500 or more) creates a challenge to explore some new approaches, especially in the area of display technology. Early devices, developed by the National Research Council of Canada (NRC)[7] and others,[8] consisted simply of

large matrices of LED's (10 x 10 to 16 x 32). With a memory capability, these matrix boards offered immediate, direct, one-to-one communication between a symbol user and a speaking person. Because of the difficulty of seeing the user's message, matrix boards are not functional for communication between two symbol users, for group communication or for communication at greater distances. (Large classroom-size matrix boards have been tried, but they are bulky and costly and still have all the other disadvantages of matrix boards.[8])

A need remained for a more sophisticated communication device which could provide the following capabilities: to store at least 512 Blissymbols; to access these symbols randomly and quickly; to display selected symbols in a normal left-to-right sequence to form messages; to display the messages to more than one viewer; and to transmit the messages across distances when desired. Added to the above capabilities is the need, as in all aids for the handicapped, to accommodate different degrees of physical disability by permitting the use of a variety of input "interfaces" or motion transducers. Typically these interfaces take the form of single pushbuttons, joysticks, "puff and sip" switches, touch sensitive switches, etc. Another requirement is that the device be "modular" in the sense of being capable of both stand-alone operation and interconnection with other input and output devices to form larger communication systems. Finally, there is the requirement to keep the cost of the device within reason and competitive with alternative communication aids for the handicapped. An aid which could satisfy all the above requirements could have wide usage in the home, school, and residential setting -- for daily communication activities, for academic instruction, and for active involvement in certain vocational pursuits.

THE BLISSYMBOL TERMINAL

The Blissymbol Terminal is the result of a collaborative project to develop an aid which would meet the above requirements. Initial research into the possibility of adapting computer techniques to the drawing, selection, storage, and transmission of Blissymbols was conducted by Sawchuk and Bown at the Communication Research Centre, Ottawa.[9] Other collaboratoars are Norpak Ltd., Pakenham, Ontario, the Blissymbolics Communication Institute, Toronto, and the NRC. The NRC has been involved for some time in the development of alternative communication aids for the verbally and physically handicapped, primarily for children with cerebral palsy.[7,10]

The use of an existing home television set as the display unit for the Blissymbol Terminal was a fundamental design decision, in order to keep costs as low as possible. Having to pass the video signals through the television RF stages restricts the useable bandwidth somewhat. It was decided, therefore, that 240 (vertical) by 320 (horizontal) points would be the maximum practical resolution obtainable with this approach. Considering the detail required in each individual Blissymbol, the full screen had to be restricted to a uniform display format of six rows of six Blissymbols per row. Then,

leaving one-third of the screen available as the user's message area meant that only 24 symbols from the vocabulary could be displayed on the screen at one time. The concept of breaking the 500-plus symbol vocabulary into "pages" was thus necessitated, with an Index Page to provide random access to any of the 23 other pages (Fig. 2).

The terminal has been designed for use in three configurations: single user, classroom, and telephone. In the classroom configuration, up to four "single-user stations" can be interconnected via serial ports with a teacher's "classroom station". Messages created at the single-user stations can be transmitted to the classroom station and displayed on a large monitor for the whole class to see. External modems are required, at present, for the telephone configuration.

Another feature of the design is the provision for use of a matrix board as an input device, since some types of users may find it easier to select symbols in this more familiar way instead of via the paging concept. The selected symbols are then displayed in "blackboard" fashion using the whole TV screen. An alphanumeric or Character mode is included in the terminal for those who have progressed beyond Blissymbols. This will be especially useful for school work and vocational situations, while many users will still revert back to Blissymbols for communication because of the speed advantage. Messages prepared in Character mode can be transmitted via the serial port to a conventional teleprinter for hard copy. Finally, one of the most important features from the man-machine or human factors point of view is the correctability of the user's message, both in Blissymbol mode and in Character mode.

HARDWARE DESIGN

Design of the electronic hardware for the Blissymbol Terminal is baded on the Z-80 microprocessor with a custom-designed video interface. Two bit planes, each with 240 x 320 points resolution, are provided in the video refresh memory, by means of ten 16K dynamic read/write memory integrated circuits. The second bit plane permits the use of a half-intensity cursor which can be moved about the screen, in effect, behind the displayed symbols. The microprocessor bus interfaces with the video circuitry via a vector generator which controls: (1) writing short vectors point-by-point in 8 different directions, (2) writing long vectors in fixed directions, and (3) initializing (clearing) the refresh memory. The microprocessor updates the video display only during the horizontal retrace interval, during which as many as 4 data points can be changed.

A standard size symbol block of 36 (vertical) by 51 (horizontal) points is large enough to accommodate the most complex of Blissymbols, plus the alphabetic text which accompanies each symbol. The whole display of 6 by 6 symbol-blocks thus requires slightly less than the 240 x 320 available points, allowing for some overscanning which is common in home television sets. The composite video signal modulates an RF carrier so that connection can be made directly to the antenna terminals of a home television set.

SOFTWARE DESIGN

One of the most challenging aspects of the design of the Blissymbol Terminal was the compression of the data necessary to describe the approximately 540 Blissymbols stored in the terminal's vocabulary. Simply storing the bit patterns for each symbol block would have required over 120K bytes of memory. After studying a number of alternative approaches, it was decided to generate the symbols on a bit plane using "run-length coding" rather than at a character level. This graphics technique required a minimum of data storage and permitted the drawing of the symbols at a speed which was compatible with the bandwidth of home television receivers. In run-length coding, a 4-bit "nibble" of data describes 1 of 8 possible directions for the vector generator and whether to draw a point on the screen or simply to slew to the new location. The Blissymbols were broken into 145 unique symbol segments. The run-length coded data for these 145 segments, plus 96 alphanumeric characters, requires only 2.5K bytes of memory. A symbol assembly table of 8.5K bytes is then used for the assembly of each of the 540 Blissymbols by specifying: the required symbol segments, the displacement of each segment from a reference point in the symbol block, and a character pointer. The character pointer points to a separate character table which actually specifies the string of alphabetic characters corresponding to a particular Blissymbol. This separate character table, of about 3K bytes, makes it easy to interchange the alphabetic language of the Blissymbol Terminal without having to change the whole Blissymbol vocabulary. Besides the need for French and English versions in Canada, other languages are needed for several European countries where Blissymbols are being taught to the handicapped. The total memory space required to store the symbol segment data, character table, symbol assembly table, and two indexes to these tables is 16K bytes.

The terminal operates in several "modes": Blissymbol and Character modes have been mentioned; there is also a Message mode and a Control mode. Control mode contains all the control functions such as scanning speed, editing, sending and receiving of messages, etc. The other modes are accessed through Control mode. Blissymbol mode is further divided into Index mode and Entry mode. The user selects a particular vocabulary page from Index mode. This page is then displayed (Entry mode), from which a particular Blissymbol may be selected and appended to the user's message. The terminal will remain in Entry mode to allow the selection of more symbols from the same vocabulary page. After a predetermined time interval during which no further selections are made, the terminal will automatically return to Index mode. Message mode is used to display entire messages (either the user's or an external message) of up to 30 symbols in length, whereas in the other modes there is only room for the last 12 symbols of a message to be displayed. In all modes of operation, the user interacts with the terminal by controlling the scanning of a cursor on the screen, stopping it on a particular symbol or function when desired. The terminal is capable of several different types of cursor motion, depending on the number of input switches a handicapped user is able to manipulate.

BLISSYMBOL VOCABULARY

The choice of vocabulary for the Blissymbol Terminal is at this time an art rather than a science. In selecting vocabulary we kept in mind that a person who can learn to use the terminal will already be a fairly sophisticated user of Blissymbolics. Such a user can be expected to make use of various strategies to create symbols not built into the vocabulary. For example, one strategy is "opposite-meaning". For one who can use this strategy, it is not necessary to have, for example, both "here" and "there". We have included "here" but not "there", assuming that the user can communicate "there" by indicating "opposite-meaning here". Similarly, the vocabulary contains "up", "sick", "happy", and "correct", but not their opposites. However, in the case of high frequency items, considerations of speed have caused us to include both terms. Thus we have included both "hello" and "goodbye", "yes" and "no", and so forth. Another strategy that a sophisticated Blissymbolics user can utilize to increase effectively his or her vocabulary is the ability to convert one part of speech to another. Thus he or she can convert "see" to "eye", "break" to "broken", "proud" to "pride", and so on. Yet another strategy is to combine the ideas in two or more Blissymbols to create new meaningful units. Such units are marked at the beginning and end by a "combine" symbol. For example, "combine car snow combine" could be used to communicate "snow-mobile". Or "combine treat soft combine" could be used to communicate "marshmallow". Other available strategies include the ability to add intensity, to generalize, to indicate "similar-to" or "similar-in-sound-to", and to make use of metaphor.

Beyond such considerations word frequency entered into the choice, tempered by our knowledge of the environment in which a severely handicapped person lives. Thus "therapist" may be a rare word to the normal person, but not to our population. Similarly, more body terms are available than might be justified by frequency, because if a handicapped person needs to talk about a problem with his or her body, it is important that it be fairly easy to do so.

To facilitate remembering which page a symbol is on, the pages have been organized by semantic categories. For example, motion verbs occur on one page, mental verbs on a second, and existence and stative verbs on a third. Similarly, quantity and dimensional adjectives occur on one page, evaluative adjectives on a second, and descriptive adjectives on a third. Within each page, two considerations entered into the choice of arrangement -- logical progression and frequency. High frequency symbols are arranged on or near the upper left corner where the scan starts. Where they exist, we have followed natural logical progressions -- for example, "much - more - most" or "yesterday - today - tomorrow".

FIELD TRIALS

During this development project a few brief field trials have been conducted using prototypes of the Blissymbol Terminal with handicapped subjects. Extended "clinical" evaluations are planned, however, in order to determine the long term effectiveness of the TV graphics approach compared to other technical aids. Most importantly, the

evaluations will attempt to determine the number of handicapped users who can master the paging concept as compared to those who require a matrix board for vocabulary selection. In addition, the frequency of use of symbols and symbol strategies will be recorded. This information should increase our ability both to design the vocabulary to fit the user better and to train the user to make maximal use of the equipment.

CONCLUSIONS

The development of an entirely new means of communication for the verbally and physically handicapped has been described. Significant in this development is the use of a low-cost home television set where the user can interact with the display at his own speed, creating messages from a large vocabulary of Blissymbols, correcting and/or editing these messages, and then relaying them to other terminals in the same room or over the telephone to more distant points.

Future enhancements of this equipment quickly come to mind. Already under consideration is a "speech-production module" which will connect to the serial port and provide artificial speech equivalents for each Blissymbol in a user's message. The value of this aural reinforcement has already been demonstrated by work done at NRC and elsewhere.[11] A graphics printer for hard copy output of Blissymbol messages would be another valuable peripheral device, if it could be provided at reasonable cost. Vocabularies customized to the individual user and a number of non-volatile message buffers would also be desirable. A user could then pre-program the terminal with several special messages, any of which could be retrieved and displayed very quickly.

More important, perhaps, than any other future enhancements will be the provision for a wider array of input transducers. For those who are physically capable of pointing, a touch-sensitive screen, or a light pen, would permit faster operation. A proportional joystick would accommodate those with fine motor control of head position, say; and an eye-position input transducer would accommodate the most severely handicapped.

As a true communication prosthesis, this equipment presently lacks in portability. Hence we see the initial applications largely in group homes and schools for the handicapped. We are anxiously awaiting, along with the rest of the world, for technology to develop a flat screen display which would make the Blissymbol Terminal truly portable. In the meantime the Blissymbol Terminal is another significant step towards improving the verbally handicapped person's chances for normal intellectual and social development.

ACKNOWLEDGEMENT

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REFERENCES

1) Bliss, C.K., Semantography (3 volumes). Sydney, Australia: Semantography Publications, 1949.

2) Bliss, C.K., Semantography-Blissymbolics, 2nd enlarged edition. Sydney, Australia: Semantography Publications, 1965.

3) Kates, B., & McNaughton, S. The First Application of Blissymbolics as a Communication Medium for Non-Speaking Children: History and Development, 1971 - 1974 Toronto: Blissymbolics Communication Institute, 1975.

4) McNaughton, S. "Blissymbolics". Paper presented at the Council for Exceptional Children, 3rd National Congress, Winnipeg, Manitoba, October 18-21, 1978.

5) Silverman, H., McNaughton, S. and Kates, B. Handbook of Blissymbolics. Toronto: Blissymbolics Communication Institute, 1978.

6) McNaughton, S., "Technical Aids in Blissymbol Communications", Proceedings of the Workshop on Communication Aids for the Handicapped, Ottawa, June 8-10, 1977. Ottawa: Canadian Medical and Biological Engineering Society, 1978.

7) Charbonneau, J.R., Roy, O.Z., Cossalter, J.G., Warrick, A., and Cote, C., "A Symbol Communication System for the Non-Verbal Severely Handicapped, With Audio Word and Sentence Reinforcement, Proceedings 1976 Conference on Systems and Devices for the Disabled, Boston, Mass., June, 1976; pp. 18-19.

8) Iles, G.H., "A Scanning Communication Aid for Severely Handicapped Children", Digest of the 11th International Conference on Medical and Biological Engineering, Ottawa, August, 1976; paper 29.4.

9) Sawchuk, W. and Bown, H.G., "Interactive Graphics Applied to Symbol Communication for Non-Speaking Children", Computers and Graphics, vol. 2, 1977; pp.201-204.

10) Roy, O.Z. and Charbonneau, J.R., "A Communications System for the Handicapped (COMHANDI)," Chap. 11 in Aids for the Severely Handicapped, K. Copeland, ed. London: Sector Publishing, 1974.

11) Warrick, A., Nelson, P.J., Cossalter, J.G., Cote, C., McGillis, J., and Charbonneau, J.R., "Synthesized Speech as an Aid to Communication and Learning for the Non-Verbal, "Proceedings, Workshop on Communication Aids for the Handicapped. (see ref. 6, above)

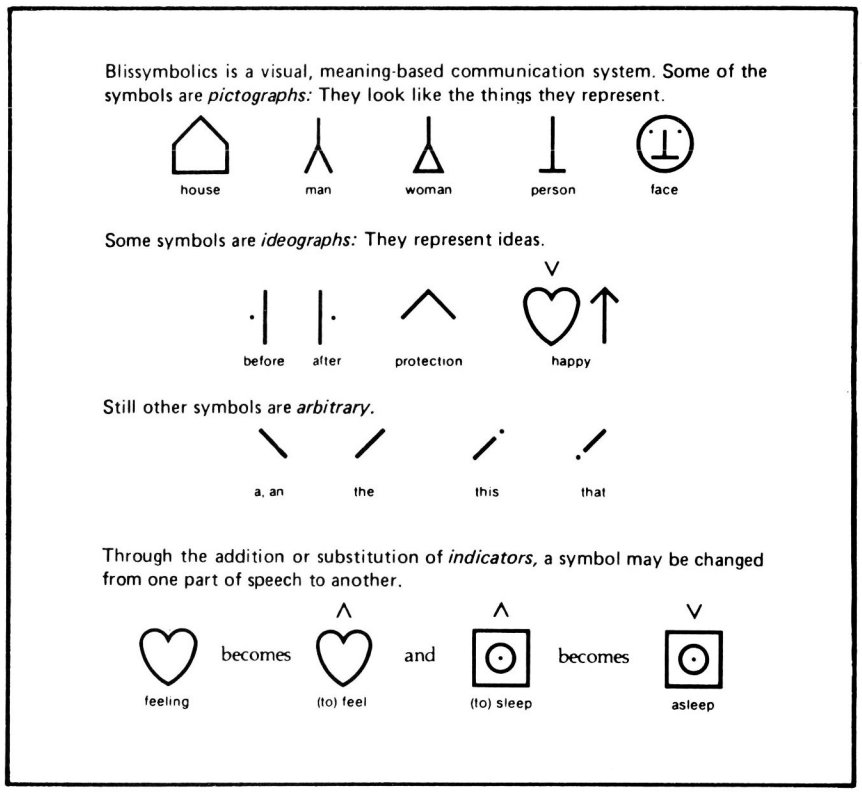

Fig. 1. Examples of some Blissymbols. ©

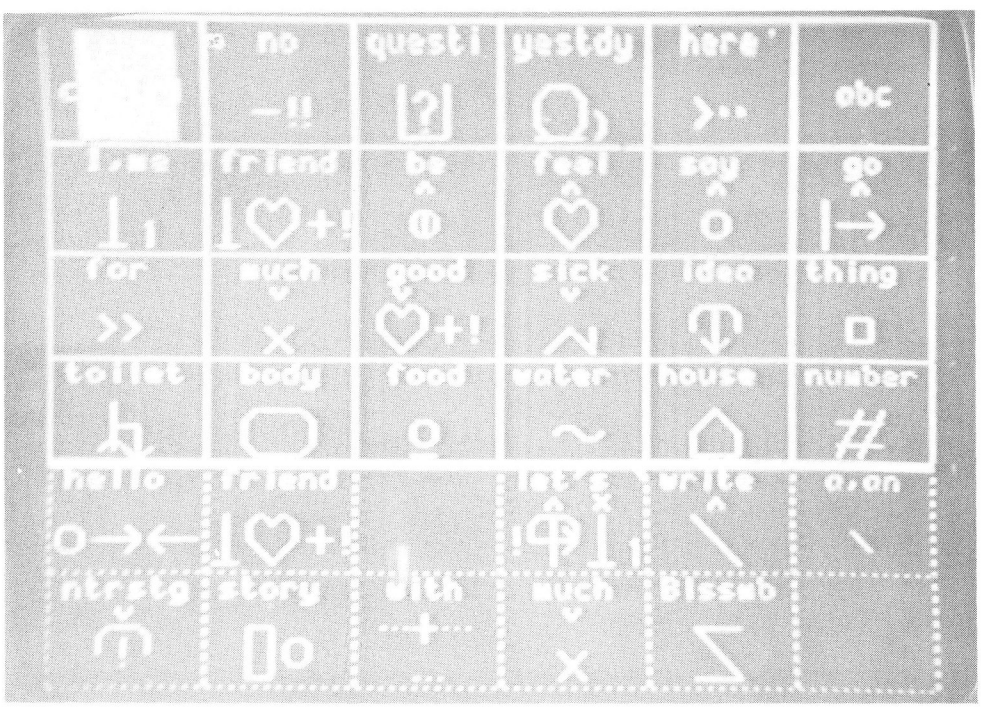

Fig. 2. Prototype display: Index mode with user's message (below).

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