Defining Assistive Technology for Decision Making

Individuals who have special needs will use technology to perform a wide range of functions. Some of these will be to allow greater access or independence in everyday life. Others will provide greater opportunities for learning, for recreation and for communication and social interaction.

At times the technological tool chosen will be one that is especially developed to meet the needs of individuals with a specific disability. At other times, the technology is also used by those with no identified special needs. For the individual with special needs, there may then be problems of access that need to be solved using extra, assistive devices.

Review in general low-end and high-end technologies.
This information will be valuable during the decision-making process.

LOW-END TECHNOLOGY

A number of low-end technologies that help students with disabilities achieve independence in daily living, play/leisure as well as learning activities.

AUTOMATED LEARNING DEVICE SYSTEMS

An ALD (automated learning device) is a generic term describing various forms of simple technology that persons with disabilities can use to control electrical appliances and battery-operated devices. (Levin and Scherfenberg, 1990). ALDs are low-end technological tools that increase an individual's ability to actively participate in activities of daily life. For further information about this low-end technology refer to the following resources.

Levin, J. & Scherfenberg, L. (1987). *Selection and use of simple technology in home, school, work and community settings*. Minneapolis, MN: Ablenet inc.

Levin, J. & Scherfenberg L. (1990). *Breaking barriers, how children and adults with severe disabilities can access the world through simple technology*. Minneapolis, MN: Ablenet inc.

An automated learning device (ALD) may consist of the following:

- **Switch or Interface**. This is a device a person contacts to operate an object which is to be controlled. More information about switches is provided in the latter part of this chapter.

- **Control unit.** This is a device used to connect the switch to electrically powered appliances and devices. Some units offer timing and data collection functions.

- **Objects to control**. An ALD system centers around an object of control. Individuals can use ALDs to control electrical appliances (eg. radios, popcorn popper, mixer, toaster) and/or battery-operated devices (eg. tape recorder and toys).

- **Timer**. Once a switch is activated, the timer allows the object of control to stay "on". This is useful for individuals who cannot sustain pressure on a switch for any length of time.

- **Adapters**. Inexpensive adapters which can be purchased at electronic stores (eg. Radio Shack) link components of an ALD system to incompatible connectors.

An electrical ALD system consists of a switch, control unit and an electrical appliance. Caution: When using electrical systems, make sure the appliance does not exceed the total watt capacity of the control unit.

A battery ALD system consists of a switch, battery device adapter and a battery-operated device or toy. When ordering battery device adapters, make sure you specify the size you need (eg. AA, C, D, or 9 volt battery). Note: Alkaline batteries last longer than regular or rechargeable batteries.

Common vendors for switches, control units, battery adapters and switch-activated toys include Ablenet, Creative Switch Industries, Crestwood Company, Don Johnston and Toys for Special Children. See "Assistive Technology: Producers and Distributors" in Appendix E of the handbook for vendor addresses.

ADAPTIVE PLAY & LEISURE TECHNOLOGIES

Play

Play is the primary vehicle of learning for a young child. It is through play that a child learns about the environment. For children who have little or no physical means of interacting with their environment, the experience of learning to control the environment is minimal. Technology enables these children to play and facilitates the development of cognitive, language, motor, perceptual and social skills. When toys and computers are used in play, they become tools for learning. The following sections will describe how children with physical limitations can access toys and other leisure activities.

Toy Selection

When selecting toys and adaptive devices to enable toy interaction, it is important to consider the needs of an individual in the same way as when assessing for more complex technological interventions. An Occupational Therapist may be helpful in the assessment process. Young children with physical and/or cognitive disabilities can engage in active play and learning through battery operated toys controlled via switches. In choosing such toys, consider:

Adaptability
Among the easiest to adapt are the toys with an on/off switch and powered by batteries.

Physical Appeal
Is the toy colorful? Does it have textures? Is it of current interest to the child/peers?

Sound Effects
Ensure that the sound produced is pleasant, and not startling to the child. In addition to battery-operated toys that make sounds, there are also toys available that give sound effects by simply touching or squeezing.

Visual Effects
If a child responds well to visual effects, toys that produce effects such as lights, colors or pictures may be interesting to him/her. Ensure that the visual effects sustain interest.

Action Effects
Action toys may be either stationary or may move in one or more directions. Toys with stationary actions may be more appropriate for independent play, whereas toys that move from one place to another may facilitate interaction with other children.

There are many commercially available battery-operated toys that can provide visual, sound or action effects. Depending on the individual needs and interest of a child, he/she may prefer a toy that produces only one, or a combination of effects.

Adapting Play Things and Materials

Whether a child has physical, cognitive, sensory or a combination of disabilities, there are a number of steps to follow when choosing and adapting toys and other materials for play or leisure activities. According to Church and Glennen (1992), these steps are:

Step 1: Stabilize objects

For children who have difficulty controlling motor movements, make toys and materials stationary by attaching them to a desk, table or wheelchair tray. Do this by lining the surface where the child will be playing with velcro material,and attach velcro to some part of the toy. Dycem, a non-slip matting available through medical and rehabilitation supply outlets is also very useful. Standard C-clamps can stabilize certain toys such as wooden puzzles, activity centres, etc.

Step 2: Attach handles

Children with poor fine motor coordination may need parts added to toys so they are

easier to manipulate. Large foam grips can be added to crayons, markers or pencils for drawing and coloring. Puppets and miniature toys can be used during imaginary play by attaching them to velcro wrist bands.

Step 3: Use concrete play materials

Always try to use objects, toys or actions when playing games. If a child with a cognitive delay is using a computer game where basic concepts (open/closed, few/many, little/big, etc). are presented, using similar real objects in addition to playing the computer game may help the child relate to the activity. For example, when a child is playing "Sticky Bear Opposites" and you ask him/her to show you few or many marbles on the screen, it may help to also use real marbles.

Step 4: Add cues for focusing

When puzzles, board or computer games have very detailed and busy backgrounds you can help a child focus on certain parts of the game by adding cues; by blocking the busy backgrounds with cardboard; by lining the edges of the pathway with bright colored yarn or covering up everything on the board game except the pathway.

Step 5: Make material safe

Keep sandpaper handy to remove any sharp edging on play materials. Check for loose or removable parts and either completely remove the parts or fasten them permanently.

Step 6: Make toys accessible

For children who are unable to reach out and grab their own toys, a system should be put in place so that the selection is carried out by the child. This can be done by having the child point toward toys arranged in separate cubicles on shelves or by pointing to specific pictures of toys arranged on a simple picture symbol communication board.

Battery-Operated Toys

Many battery-operated toys have tiny on/off buttons attached to them for toy operation. These buttons are not functional for students with poor fine motor skills, low vision or for those with severe cognitive delay. However such toys can be adapted using a battery device

adaptor. This will allow the on/off function to be operated by a simple switch action. The particular switch chosen would suit the student's cognitive and motor abilities.

Why Use Battery-Operated Toys?

Switch-controlled battery-operated toys are used to:

- promote independent interaction with toys
- facilitate social interaction using non-stationary toys or battery-operated games with peers
- evaluate a student's ability to control a switch
- train in using a switch
- develop prerequisite skills needed for more complex technology use
- develop the concept of cause and effect
- provide the student with a sense of control over his/her environment

For further information about adapted leisure activities for children with special needs, refer to the following resource:

Levin, J. & Enselein, K. (1990). *Fun for everyone: A guide to adapted leisure activities for children with disabilities*. Minneapolis, MN: Ablenet

SWITCHES

As mentioned above, battery-operated toys are not usually accessible to students with physical disabilities unless connected to a switch. Individuals can use practically any part of their body where there is controlled motor movements to activate the switch (eg. head, arms, hands, knees, feet, eye blinks, eyebrow movements, or breath). A wide variety of adaptive switches are available both commercially or through homemade efforts.

Switches vary in size, color, shape, as well as the motor activity and degree of pressure required for activation. Table 5 lists the most common switch types. Careful perusal of

catalogues will help to inform of the specific features of a given switch. Appropriate switch selection is critical to successful use. Occupational Therapy assessment can be helpful in the selection process.

Appendix E, *Technology Related Books* lists three resources on assessment. For information about homemade battery devices, refer to the following two resources:

Wright, C. & Nomura, M. (1991). *From toys to computers*. San Jose, CA: Chris Wright

Burkhard, L. (1985). *More homemade battery devices for severely handicapped children, with suggested activities*. Eldersburg, MD: Linda Burkhart

Ablenet inc. has published *The Books of Possibilities: Activities using simple technology* (1996). This resource presents curriculum based activities for students with severe disabilities.

SWITCH POSITIONING/MOUNTING

Positioning of a switch for optimal access is critical. The switch should be placed so that it is activated by intentional rather than accidental movement.

Switches frequently need to be mounted (e.g. on a slant board/or head rest) or stabilized. Pony clamps, C-Clamps, suction cups or non-slip matting are some options.

COMMON SWITCH TYPES

TABLE 5

TYPE	USES
Push (most common type) eg. plate switch [Don Johnston] Big Red [Ablenet] Minicup [Tash inc.]	• Can be activated by hand or any part of body • Some have sensitive push switches, useful for severely involved students
Pull (eg. String Switch [Ablenet])	• Student activates switch by pulling away from The switch. Very little tension is required to activate switch.
Leaf or Wobble (eg. Flex switch [Tash inc.])	• Activated with slight pressure using any part of body • Most often used with head movement or minimal hand movement
Squeeze (eg. Grasp Switch [Tash inc.])	• Student activates by grasp • Encourages grasp movement
Toggle or Joystick (eg. Wobble Switch [Prentke Romich])	• Student activates by hand movement push or pull
Mercury	• Primarily used for head control or with individuals who have minimal movement

HIGH-END TECHNOLOGY

COMPUTERS AND STUDENTS WITH SPECIAL NEEDS

Hierarchy of Technology Access

Computers are widely used in schools today. Almost all students are familiar with the standard keyboard and computer. However, not all students can access the computer in the traditional way; many students with special needs require adaptations or assistive technology for access purposes. Since the range of assistive technologies and computer adaptations is very broad, selecting the appropriate access method can be a challenging process. *The Hierarchy of Technology Access* (Figure 1) is presented in this chapter to assist educators, students and parents with decision-making in the area of computer access.

The hierarchy lists computer adaptations from minimal, relatively easy ones, to maximum, relatively complex adaptations. **As a rule of thumb, the aim should be to have students use standard computer systems to the maximum degree possible and modify only to the degree needed by the student.**

Additional hierarchial viewpoints which consider the cognitive and motor areas are presented in Figure 2. These hierarchies should be used as general guides rather than as exact prescriptions. Following a discussion of these access/input methods is a section on Computer Output Methods since it is equally important that the student can "retrieve" information from the computer as it is to "enter" information.

Note: Reference can be made to the glossary for definitions of any unfamiliar terms.

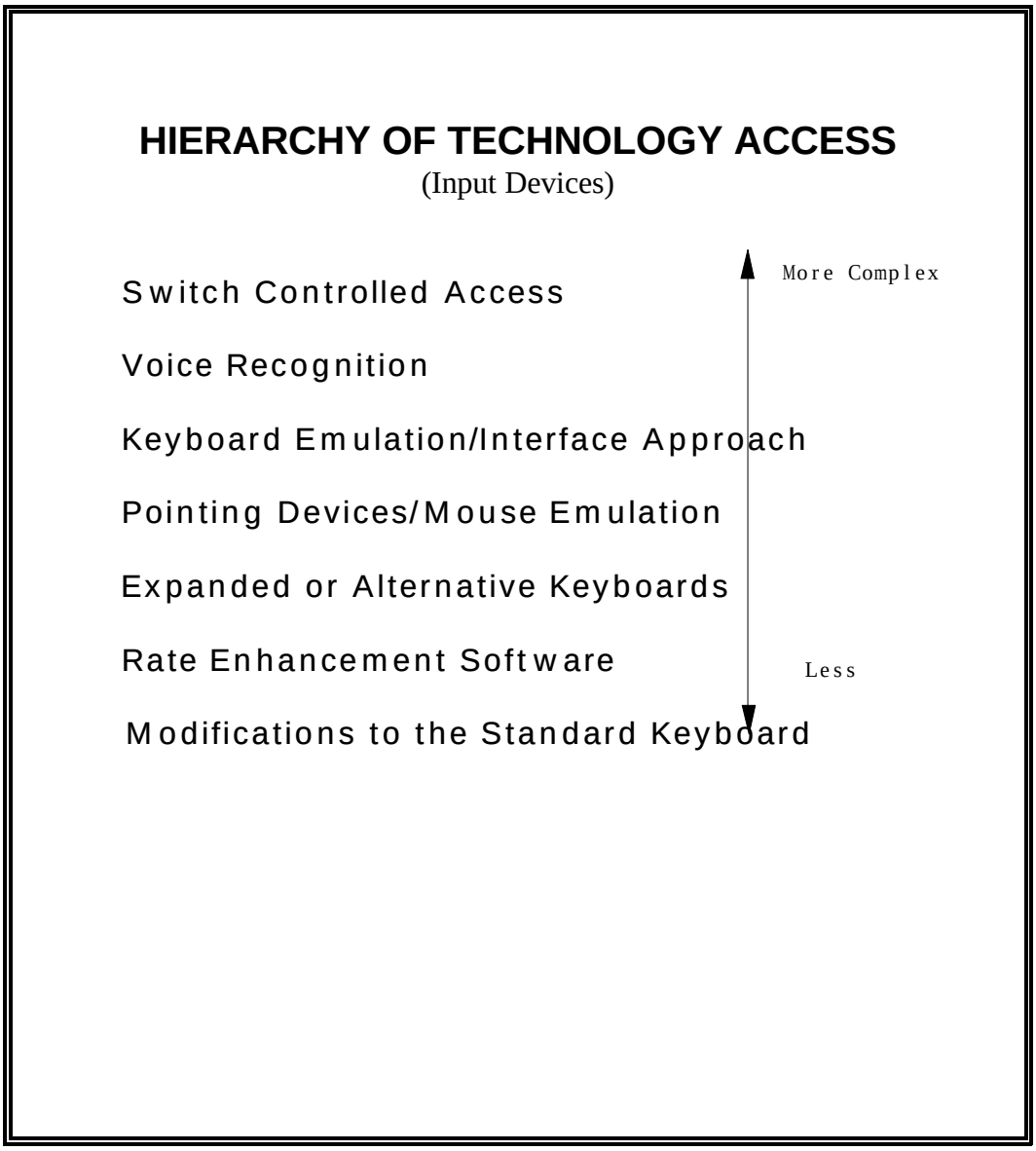

Figure 1

NOTE:
*This hierarchy lists computer input methods (methods for entering information into the computer) by degree of removal/from the standard keyboard. It lists from the bottom, less complex (modifications to the standard keyboard), to more complex (switch controlled access). The simple solutions are usually less expensive, more available and often easier to operate for a student and adult.

HIERARCHIES OF TECHNOLOGY
ACCESS BY
COGNITION AND MOTOR SKILLS

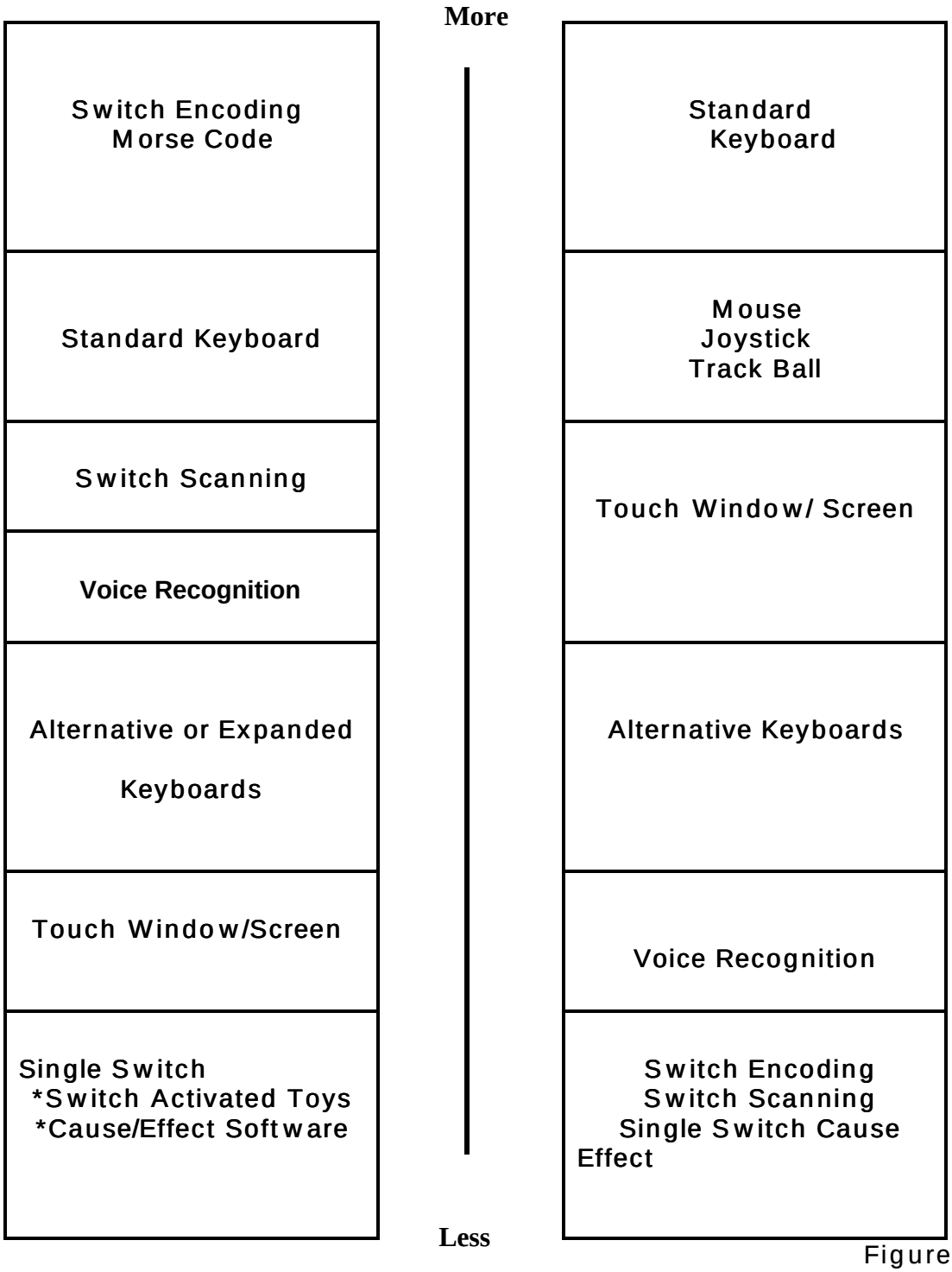

Figure 2

Degree of **Cognitive** Complexity of Required for Access Method

Degree of **Manual Motor Skills** Access Method

(Adapted from Church and Glennen 1992, p.134)

HIERARCHY OF TECHNOLOGY ACCESS - (Input Devices)

Modifications to the Standard Keyboard

For students experiencing minor difficulty using the standard keyboard, it is important to consider the following modifications before choosing to use an alternate keyboard. Minor modifications are generally less expensive, easier to understand and use than modifications which are more involved.

- Occasionally the only keyboard modification needed is ***positioning.*** Observe the slant, angle, height of computer keyboard and monitor. Detached keyboards offer more flexibility. *NOTE: An Occupational Therapist may be needed to assist with positioning and seating, for some students.

- Protect the keyboard from student drooling by using a clear plastic overlay called a ***moisture guard***.

- A ***keyguard*** can help prevent unwanted keystrokes as the student moves his hands across the keyboard. It is a hard keyboard covering which has an opening for each key.

- ***Mark special keys*** with coloured, tactile or enlarged keyboard letters and numbers, eg. Zoom Caps ™ [Meeting the Challenge].

- Offer an ***alternate point method*** (mouth stick, head stick, keyboard cuff or mitten or other pointer), to the student to allow him/her to type directly onto the keyboard.

- Use ***utility software*** or hardware control panel to remove auto-repeat features of keyboard keys to prevent unwanted keystroke repetitions. The SHIFT, CONTROL and ALT. keys can also be locked to help one handed typists to hold two or more keys down at the same time.

- ***Keyboard redefinition software*** offers the ability to rearrange the keys on the keyboard. This software is especially helpful to students with limited range of motion who cannot move their hands across the keyboard, and for one-handed typists. This is a feature of some common word processing programs.

Rate Enhancement Software

Rate enhancement software speeds up typing and increases accuracy by reducing the number of keystrokes needed.

> ***Word Prediction Software*** - is an example of rate enhancement software. It speeds up the data entry process for individuals who use a keyboard, adapted switch or other type of alternative input device. Word prediction allows the student to choose words from an on-screen list of words which is generated as the student begins to spell the word. The program speeds up text entry by predicting the word to be typed from the student's first one or two keystrokes.
>
> ***Abbreviation Expansion Programs*** - these allow the user to assign a series of letters, words, or sentences to one or more keystrokes. When the assigned keys (the abbreviations) are hit, the program automatically inserts the expanded text. These features are integrated into some word processing programs; or can be purchased separately to use with another program.

Expanded or Alternative Keyboards

If modification of the standard keyboard does not result in improved access and use, the next adaptation in the hierarchy is an alternative keyboard.

- **Alternative keyboards** are used when the student requires a different size, layout, sensitivity and complexity. For example:

  > **Expanded keyboards** provide enlarged keys which are useful for students having difficulty targeting the keys on the standard keyboard. These boards often can be customized to meet individual needs.
  >
  > **Mini keyboards** are small boards containing smaller surfaces than the standard keyboard. They are often used with students having limited range of motion.

An alternative keyboard may provide *transparent* or *specific* access. When a keyboard provides transparent access, it works with standard "off the shelf" software (e.g. Intellikeys). When a keyboard provides specific or nontransparent access it can only be used with

software specifically designed for the alternative keyboard (e.g. the Muppet Keyboard). At this level, these keyboards plug directly into the keyboard port.

Pointing Devices/Mouse Emulation

When individuals do not have sufficient fine motor control to successfully use a keyboard or mouse, alternate input methods are used. The devices offer cursor control on the screen using a button or switch for item selection. Combined with an on-screen keyboard they serve as a keyboard alternative.

- **Mouse Alternatives** eg. joystick, trackball, rollerball, switch adapted mouse.
- A **touch window/screen** enables a student to select items by touching a screen placed in front of the monitor.
- An **optical pointer** can control the cursor through tracking a tiny optical sensor places on student's forehead or glasses.
- A **headpointing system** controls the cursor by tracking lateral and rotational head movements.
- **Alternate keyboards** can be programmed to control cursor movement.

Keyboard Emulation/Interface Approach

A *keyboard emulator* is a hardware device which works the same as or "emulates" the computer keyboard. It is required to connect the computer to certain alternative keyboards or switches and allows students who cannot physically access the standard keyboard to use alternative devices to run standard "off the shelf" software. A keyboard emulator provides transparent access.

Examples of keyboard emulators:

- Adaptive Firmware Card [Don Johnston, Inc.] for Apple Computers
- Ke:nx [Don Johnston, Inc.] for Macintosh Computers
- DADA Entry [TASH Inc.] for IBM or compatibles
- DARCI TOO [WESTEST Engineering Corporation] for Apple, IBM and IBM compatibles

Caution:
Always ask the specific computer system requirements when considering alternative keyboards. Not all alternative devices work on all computer platforms.

Voice Recognition

Speech or voice recognition is a somewhat expensive input method for students who cannot physically operate the computer in any manner but who can operate it via voice. Once a student trains the computer to understand his/her voice, the student operates the computer by speaking commands into a microphone. It is important to speak precisely each time since the computer responds to a saved voice pattern. Examples of voice recognition software include Dragon Dictate [Dragon Systems, Inc.] and IBM Voice type Dictation [IBM Canada Ltd.].

Switch Controlled Access

Switches are often used when no other modifications are successful. A switch operates the computer without directly using the keyboard; it bypasses it. This method is for students who are able to press a switch but have no other accurate, efficient way of accessing the keyboard.

- There are several software programs specifically designed to accept switch input. They are often used for cause and effect learning or for switch evaluation. Review the Software: Publishers and Distributors list in Appendix E of handbook for vendors who provide cause and effect software.

- A switch can also be used with **all** software using a keyboard emulator. Software which comes with a keyboard emulator allows one to display a scanning array of alphabet letters or numbers at the bottom of the screen. The student selects the target by pressing a switch when the desired item is highlighted. A student can scan visually or auditorily using this method.

- Morse code can also be used with switches to operate computer programs. Using one or two switches send a sequence of DIT and DAH signals and a keyboard interface translates signals into computer keyboard characters which are sent to the computer as if they had been typed on the keyboard.

COMPUTER OUTPUT DEVICES

In addition to using various methods to input information into computers, students with differing needs may also require various methods for retrieving computer information or output. Alternate methods for successfully retrieving information from the computer are presented below.

Voice Output

Speech Output - software reads aloud text which appears on the screen.

For students who rely more on auditory learning (eg. learning disabled, visually impaired) software which reads aloud text on the screen is often required for effective learning. **Screen Reading Software** reads everything on the screen including letters, words, lines, menus, icons and windows. eg. Outspoken for Macs and Outspoken for Windows [Berkeley Systems, Inc.]. **Talking Word Processing Programs** provide speech feedback during the writing process, eg. Write:Outloud for Macs [Don Johnston, Inc.] and WriteAway for DOS [Institute on Applied Technology] and Intellitalk for PC-compatibles [Intellitools]. Speech feedback can be either synthesized (robotic-type speech) or digitized (human-like speech).

Voice Output or Alternative Augmentative Communication Aids

As an option to a dedicated device, a computer with voice output can be used as an Alternative and Augmentative Communication Aid. Unless a laptop is used, the lack of portability is a drawback. Examples of some programs are: Windows Computers with GUS software [GUS Communications Inc.] and Macintosh Computer with Speaking Dynamically [Mayer-Johnson Co.]

Visual Output

Screen Enhancement

For students with visual or perceptual difficulties, adjustments in the size, colour and clarity of text and/or graphics may be useful. For example, a student with low vision can use a larger monitor and a larger font size in word processing programs or use screen enlargement programs such as Closeview [Apple Computer Inc.], a utility included with Macintosh Computers, Screen Magnifier/2 [IBM Canada Ltd.] or

Zoom Text Plus [Ai Squared] for DOS and Windows.

Braille Text

For students who are totally blind, text can be printed in braille with the aid of a Braille printer and/or software.

Optical Character Recognition (OCR)

Students who are visually impaired and/or have learning disabilities can also access printed text by using a scanner to convert print into an electronic format and then special OCR (optical character recognition) software to translate this information into text which can be understood, saved and read aloud by the computer. The Arkenstone Reader "An Open Book" [Arkenstone, Inc.] is one such reading system.

There are already many books that have been digitized in this way. Some are available through the internet.

SOFTWARE FOR STUDENTS WITH EXCEPTIONALITIES

A computer is only as effective as the software it runs. The guidelines below should assist educators to select software more systematically and thus increase the overall effectiveness of computers for students with special needs.

CHOOSING SOFTWARE FOR STUDENTS WITH SPECIAL NEEDS: GUIDELINES FOR EDUCATORS

1. Identify student needs and decide on what type of software will meet those needs.

2. Find out what software is available. (See Software Selection Checklist in Appendix B)

3. Obtain a preview or demo copy, evaluate the software using the following categories:

Content

- Compatible with student's cognitive, physical and sensory abilities
- Addresses classroom curriculum
- Supports goals and objectives of class and/or individual
- Suitable to target population (eg. age-appropriate, reading level)
- Accurate
- Complexity level is appropriate
- Compatible with other materials
- Feedback of program is positive not negative

Program Design

- Has clear and easy to understand instructions
- Has well-designed screen displays
- Instructions are provided on screen and in manual
- Facilitates student independence
- Selection of activities, pace and level of difficulty can be controlled
- Program is free of bugs
- Promotes active student participation
- Instructions and help screen can be accessed at any time

- Tutorial is provided
- Branches to appropriate level of difficulty based on student responses
- Has interesting graphics, sound and animation for content enhancement
- Accommodates various learning styles
- Fun and motivating
- Records and tracks student progress

Special Features For Students With Special Needs

- Clear, uncluttered screens
- Access features which enable student to use input devices other than the keyboard such as single switch, alternate keyboard, joystick, touch screen, etc.
- Mouse alternatives which allow student to operate program using the arrow keys if necessary.
- Rate of presentation or response which can be modified
- Speech feedback
- Enlarged display (large print)
- Rate enhancement for writing (word prediction/abbreviation expansion)
- On-screen instructions; can control length of time these remain on screen
- Auditory prompts or signals helpful for student whose attention wanders quickly from the program
- Visual cues provided at various times during program. For example, some programs may have prompted writing features, or step-by-step written instructions which appear in a box on the computer screen to assist students in sentence and story creation
- Customizable features allowing content to be personalized (eg. spelling lists, math problems)
- Adjustable difficulty levels, vocabulary, sound, timing, speed, graphics and text

Documentation

- Easy to read and understand software manuals
- Alternate format manuals available (eg. large print, braille, audio cassette, computer disk or print that is easily read by a reading machine)

4. Once software is found, check out the following:

- software warranty
- software updates. Are they automatically supplied when released? Are there additional costs?
- guarantees and return policies
- back-up copies
- availability of technical support. Does the company have a toll free number?

Note: A software selection checklist, provided in Appendix B should assist the team to choose appropriate software for students with specific needs. Once the software is chosen the team may wish to have a software review committee consisting of both students and teachers complete a software evaluation using the *Software Evaluation Form* provided in Appendix B. The team and/or school computer committee may find the completed forms helpful in deciding upon which software will be purchased.