Chapter 8
Make Environmental Accommodations and Use Assistive Technology
Tools That Extend Human Capacity and Promote Learning

CHAPTER GOAL

Develop an awareness of technology that can be used to extend the capabilities of students with special needs, and understand the contributions technology can make to student learning.

CHAPTER OBJECTIVES

1. Learn about assistive technology and resources for more information.
2. Understand ways that the school learning environment may be designed and modified to facilitate access and participation.
3. Explore and recognize low- and high-tech tools that help students with special needs to accomplish many functional tasks—from reading and understanding language to driving a vehicle.
4. Examine how assistive technology may be used in the classroom to the benefit of all students.

Including Cedric, a Student with a Severe Disability, with Help from Assistive Technology

Cedric is a fifth-grade student at Glenwood Elementary School. We really don't know what goes on in his mind or how much he understands. From one perspective, Cedric has several difficulties. His peripheral vision is poor. He has a cognitive disability," has no verbal language, and has difficulty walking, sometimes getting tired in the afternoon and using his wheelchair. He is, however, very social, and he communicates his likes and dislikes in many ways. He's an interesting guy.

We visit Cedric's class to see how technology is being used to assist him. On his desk he has a simple communication device—a rectangular plastic device about four by twelve inches that has two large buttons. The green button has the word yes printed on it; the red one, no. Cedric can use this device to respond to questions. When he presses a button, an electronic voice says the word aloud.

As we enter the room, Cedric is using a computer program that matches sounds to pictures with the help of a paraprofessional. After a few minutes, Pat Squires, the teacher, calls the kids to the rug area at the front of the room. She says, "Tell me something good." Cedric's peer buddy encourages Cedric to raise his hand. When Pat calls on Cedric he presses a button on a device *which announces, "I went to the new library." "You did?" says Pat. "The new one downtown?" Cedric signs "Yes" with his hand. Later, when all go to centers, Cedric uses a tape recorder with headphones to listen to directions for the activity or a story being read.*

"I was nervous at the first of the year," recalls Pat. "I have never had a student with disabilities as severe as Cedric's. Yet he has done fine. He likes my class. His buddies are learning a lot about helping other people. We all are learning how technology can be used to help Cedric communicate." Although Pat was also anxious about these new technological gadgets, she has become more comfortable with experience. "For Cedric," she says, "learning how to use these tools is an important part of his learning." She compared this use of assistive technology to other students' proficiency with computers.

Shannon is a senior at Longview High School and is planning to be a lawyer. She is also blind. As we talk, she says, "The school has really been great! A specialist came to the high school when we moved here, and together we thought about what help I would need." An orientation and mobility specialist familiarized Shannon with the layout of the school. She traverses the campus quite easily with the help of her cane. She describes how she uses assistive technology:

- *Student buddies read books aloud and help her in other ways.*
- *Shannon accesses books on tape, using an MP3 player.*
- *She can read books on CD by using talking software.*
- *She writes her papers on a word processor, and her words are read back to her via a software program called DragonSpeak.*
- *She also has dictation software, but she likes to use the keyboard now that she has learned to type.*

"It's interesting," Terrance, her guidance counselor, says, "how other kids responded to the technology designed to help Shannon. Several are now using the text-to-speech software, and teachers say it is helping them."

We follow Shannon to her American history class, which is studying the civil rights movement. The teacher has broken the students into groups representing different parts of the community in Little Rock, Arkansas, in 1954. Shannon has used a scanning program at the school to put the text from the book on a disk, which she has read at home using speech synthesis software. The groups are developing presentations to be moderated in a "town meeting." Shannon takes notes on a laptop.

Cedric and Shannon represent important examples of how technology can support inclusive teaching. Technology is an important tool for adapting the environment and providing support.

How do we utilize assistive technology in our class? On the one hand, we can accept and encourage use of adaptive tools and learn how to help students master assistive technology. On the other hand, students with disabilities and the technology they bring provide important learning opportunities for all our students. Assistive technology can give all of us a fresh perspective regarding how technology can interact with human beings—an interdisciplinary lesson in science, social studies, psychology, and literacy, which we receive just by interacting with a student with special needs and technology. Throughout the year we could involve students in exploring questions like the following: How is technology being used to help people with their limitations? What is being developed now? What might we like to see? The many positive outcomes can include:

- Increased self-motivation
- Increased independence
- Greater participation
- More accountability
- Expanded learning and life experiences
- New opportunities for interactions and communication
- Changed visions of a child's potential on the part of adults, peers, and the child (Sheets & Wirkus, 1997)

Sights to See

Including Stacey and Shawn with Assistive Technology

Stacey, as 6th grader, has a significant hearing loss. Technology tools helped her in learning and functioning. From the I Can Soar video of the National Center for Technology Innovation. www.nationaltechcenter.org/index.php/2007/03/04/stacey/

Sean, a junior in high school, is blind. Technology makes a real difference in his schooling and life. From the I Can Soar video of the National Center for Technology Innovation. www.nationaltechcenter.org/index.php/2007/03/05/sean/

An Introduction to Assistive Technology

Technology Expands the Capabilities of All

First, comments about language. The phrases *assistive technology, adaptive technology, and enabling technology* are used interchangeably (Cook & Hussey, 1995). Each term refers to technology that helps a person with special needs to learn or perform a task they could not otherwise do. The term **rehabilitation engineering** refers to similarly the skills of an engineer to develop technological adaptations to assist in people's rehabilitation or to enhance ability to function at work, at home, in school, or in the community. When we speak of the modification of physical places, we talk about environmental "accessibility," "modifications," or "accommodations." The Technology-Related Assistance Act of 1988 (PL 100-407) and IDEA define assistive technology as including "any item, piece of equipment, or product system . . . that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Individuals with Disabilities Education Improvement Act, section 602)—capabilities such as " speaking, writing, listening, seeing, eating, drinking, moving around one's home or community, using the telephone or computer, opening and closing doors, turning lights on and off" (King, 1999, p. 13).

Three students read a book aloud together. One student is blind and has a cognitive impairment. Collaborative reading and discussions increases student interest and helps some students access materials that they could not read without support.

Is assistive technology only for individuals with "special needs"? Truthfully, all of us use technology to compensate for our limitations or expand our capacities. No human being, for example, can run at forty miles an hour, even though some animals do. Compared to those other species, we have a physical disability. By the same token, compared to cats, we have a visual disability: Our capacity to see in the dark is much more limited.

Because human beings have limitations, technology has been a powerful force in human history. As human beings developed tools for plowing and cultivating land, for example, they could survive in one location rather than constantly moving to hunt for prey. The rapid development of technology in the nineteenth century produced what we now call the Industrial Revolution. Most people in the United States rely on an adaptive technology device called an automobile, communication devices called telephones, and adaptive writing devices called computers. These are all tools to compensate for human inadequacies.

Once we begin to think about technology in this way, tools used to aid people who have specific types of limitations don't look so different. Given that all of us use technology to help us accomplish valued tasks, adaptations originally designed to compensate for limitations in people with disabilities are often useful to others as well. The rise of the field of universal design recognizes this fact.

Categories of Assistive Technology

We can view assistive technology through many lenses. Categories help us organize information and ways of thinking about how we use technology in our classroom.

First, many find it helpful to distinguish between low and high technology. **Low-tech** solutions are often simple manual adaptations that require little cost or sophistication—though they often reflect great creativity (Cook & Hussey, 1995). Examples include:

- A rubber pad on a desk to help materials adhere more easily, for students with limitations in their control of their arm and hand movements (such as children with cerebral palsy)
- Large pencils or foam blankets for pens to make these implements easier to grasp
- Communication boards that have pictures or simple words to which a student can point to communicate

High-tech devices, on the other hand, involve more sophisticated engineering (Beukelman & Mirenda, 1992; Brett & Provenzo, 1995). Obvious examples include:

- Computers, including scanners and systems that run talking software
- Electronic alternative communication devices with which students use eye gaze or head bands to focus on words or pictures, causing the device to say words aloud in digital speech
- Electric wheelchairs that are guided by a joystick or by "puff-and-sip" commands activated by the person's mouth

This distinction between high and low technology is useful in that it helps us think broadly about the term *technology*—meaning the use of any tool or device that can help a person perform a task or learn.

Software and *hardware* are two other useful categories. When we are talking about computers, *software* refers to the programs that perform the work—word processors, spreadsheets, databases, statistical analysis programs. *Hardware,* on the other hand, is the actual physical structure of the computer—monitor, disk drives, central processing unit (CPU), and so forth. In assistive technology, the actual devices are hardware. However, the information and skills people need to possess in order to use the devices, or the manuals in which information is contained, are the software. The ways in which people can be of assistance, as in reading aloud for people who are blind, also can be thought of as software (Brett & Provenzo, 1995).

We can further categorize assistive technology based on what it helps a person *do*. Assistive technology fills various functional needs of individuals. For each of these functional activities, many different types of devices can be used. Organizing assistive technology based on functional needs is helpful; for example:

1. Numerous devices help people with *communication;* these range from simple devices that record one to three spoken messages to complex communication aids.
2. Other devices such as wheelchairs, adapted automobiles, or leader guide dogs aid people in *mobility,* or getting from one place to another.
3. Some devices may assist primarily in *written communication*—scanners and talking software, books on tape, dictation software.
4. Other technology may help with *hearing or interpretation of sounds*—hearing aids, software that converts recordings to text, sign language interpreters (Cook & Hussey, 1995; King, 1999).

Examples of Assistive Technology

Low-tech	***Mid-tech***	***High-tech***
Post-it notes, erasable highlighter, colored paper, colored overlays, picture schedule, special grips, highlighter tapes, graphic organizer, sentence strips, communication board, large print	Calculator, AlphaSmart, talking dictionary, IntelliKeys, switches, digital voice recorder, tape recorder, word scanners, talking watch or clock, Braille, powered toy	Desktop, notebook and handheld computers, tying software, Write Out Loud, Read and Write Gold, head or eye-gaze control of a computer, scanner, math software, electronic books, voice output device, amplification system, hearing aids

At other times we develop categories of *types* of assistive devices. Examples include: wheelchair, computer, interface between technology and the person (e.g., computer keyboard, touch screen, on–off switch, control panel), automobile, optical magnifying lenses, and augmentative and alternative communication device (AAC). In some cases there is an obvious correspondence between type of device and function; for example, a wheelchair is used for mobility. In other cases, however, a device will be used for multiple purposes. A computer, for example, can be used to access print, to communicate, to control other devices at home or in the school classroom. Similarly, an on–off switch can be used to activate any number of messages, other devices, lights, and so on (Cook & Hussey, 1995; King, 1999).

Adaptive Technology Information and Services

With the growing importance of adaptive technology, numerous efforts are under way to make these available. The cost of developing and producing devices presents a serious hurdle, particularly when the target group is small. Consequently, assistive technology is both funded by governmental programs and marketed for profit by companies that specialize in assistive technologies. As universal design principles become more widely used, separate assistive technology devices for persons with special needs may be needed less and less and costs will go down dramatically (Orkwis & McLane, 1998; Steinfeld, 1994).

Every state in the United States and most countries have resources for assistive technology. In some states these form a comprehensive network and work effectively. In others, resources are more scarce and uncoordinated. Most states have established at least one resource center for assistive technology and are members of the **Alliance for Technology Access.** The federal government provides funds to assist states in developing coordinated assistive technology systems. In some cases centers associate with rehabilitation hospitals that work with injured adults or with hospitals for children with special health care needs. In other cases centers operate as freestanding organizations. In such centers specialists assess individuals and help select wheelchairs, seating devices, and other low- and high-tech solutions to the daily life needs of the individual (Flippo, Inge, & Barcus, 1995; Kelker & Holt, 2000).

Assistive, or adaptive, technology is required under IDEA for students with disabilities and can be written into a student's IEP (Kelker & Holt, 2000). Given this requirement, most state variations on intermediate school districts provide support for assistive technology for students with special needs. Large school districts may have their own staff and center established for this purpose.

In addition, national organizations provide ongoing research and development and information—publications, reviews of hardware and software, and other relevant resources. The *Center for Applied Special Technology (CAST)* has developed a model of universal curriculum design and has produced tools designed to move in this direction. *Closing the Gap* provides both an online and a hard-copy catalogue of hardware and software. A network of "rehabilitation engineering centers" conduct research and development on various types of adaptive technology for both children and adults with disabilities. These organizations often develop new solutions to problems that may then be marketed through private companies.

Many companies produce and sell assistive technology for profit. As with any product, it can be difficult to judge which product is the best or whether a given device really meets a need.

In addition, assistive technology is gradually developing as a professional field in its own right. Assistive technology crosses many traditional fields but is not dominant in any—engineering, occupational therapy, physical therapy, speech therapy, special education. Some university programs, however, now offer courses or even degree programs in assistive technology. Although training and expertise is not as widely available as needed, many people are working in this field, and the number is constantly growing (Cook & Hussey, 1995; King, 1999).

Professionals from different fields specialize in specific types of assistive technology, though this is not a hard-and-fast practice. For example, speech therapists are most knowledgeable about augmentative and alternative communication (AAC) devices. Engineers often work with adaptive use of computers, mobility, and workstation design. Occupational therapists use low-tech devices to aid individuals in activities such as reaching and using a pen—all functions of the upper extremities, the area of focus for occupational therapists (Cook & Hussey, 1995; King, 1999). For teachers, of course, learning to use technology is part of ongoing professional development. Technology is changing rapidly, and new tools are constantly being developed.

Selecting Assistive Technology

With any technological device, we seek to match the person with the most helpful tool. We can do this informally or more systematically. Two models in everyday life serve for comparison—shopping for a car and buying glasses. In the first model, we don't tend to go to experts for a "car–person assessment." Rather, we take it upon ourselves to review car ads, test-drive cars, and study consumer data about different cars. This is true despite the fact that automobile purchases are very expensive. Many people also adhere to this model in obtaining assistive technology. One way to identify helpful tools for our class is to follow a similar strategy. Assistive technology centers often allow people to "test-drive" various technological tools. Similarly, vendors of assistive technology help people select materials of interest and try them out (Kelker & Holt, 2000).

However, another approach is more like when we buy a pair of glass. In this case, we go to a specialist who measures our eyesight and prescribes glasses with the precise lenses that we need to best see. Similar services are increasingly available in both for-profit companies and government funded agencies in which an assistive technology specialist obtains detailed information about the functioning capacity of the person through interviews, observations, or performance testing. The specialist also obtains information about desired uses of technology and may visit the locations in which technology will be used—the home, a classroom, a job site—and conduct a detailed "environmental analysis" of these environments. Specialists then use this information to recommend different technological tools (Cook & Hussey, 1995).

IEPs for students such as Cedric and Shannon cover assistive technology and specify that the students receive assistance from one or more assistive technology specialists. As teachers we may receive assistance from our intermediate school district (or our state's equivalent structure). However, we can decide to use a local or state assistive technology center that is not directly connected with our school system (Flippo, Inge, & Barcus, 1995; Kelker & Holt, 2000; Ryndak & Alper, 1996).

Selecting technology that works for a person turns is complex. Some assistive technology research indicates that almost one-third of devices obtained—at the cost of much time and money—are not used. This occurs for many reasons. Sometimes the devices don't work well or break down. Sometimes, however, a device is hard to learn to use or may be an embarrassment to the individual. Technology specialists refer to these latter issues as "human factors" (King, 1999).

As in Cedric and Shannon's cases, our role as teacher is critical, even when (or maybe especially when) we are new to the technology our students are using. A law for technology use has been developed that can be stated rather simply: Motivation is the key to using technology. Said more fully, when time and physical, cognitive, and linguistic effort required for use of a technology exceed the motivation to learn, the technology will be discarded. The implications are clear. If, even unintentionally, we make a student uncomfortable in using an assistive tool, then we contribute to a failure in learning and growth that the technology could have helped mitigate. However, if we welcome and support the student (thus making effort lower), then we help make the student's chances of success much, much higher (King, 1999).

Modifications to the School and Classroom Environment: *Creating Access*

When designing or retrofitting a school for all learners, we seek to develop an environment that both allows and invites all students to be active participants. We do this with care, for it is certainly possible to make extensive modifications for a specific student in ways that isolate the child from other classmates, even in the same room. Following are key areas for consideration (Sheets & Wirkus, 1997).

Building Access

School buildings and classrooms should provide access for students with different types of limitations. The school must provide ramps with smooth access to the building; doors should be easy to open or be motor assisted so that they open with a gentle push. When the school is an older building, this will necessarily require retrofitting—creating ramps, installing elevators to higher floors. Grab rails throughout the building support students with poor balance or general weakness.

Similarly, *bathrooms* should provide access for students with poor balance or limited strength. For young children, "training" commode chairs may be needed. A light switch extension allows a student in a wheelchair to turn lights on and off; a motion sensor automatically turns water on and off (Sheets & Wirkus, 1997).

We should also consider access of students with physical disabilities to the *playground* or other recreational facilities. In one school, for example, a student was physically challenged and could not hold onto the swing chains. Another student could not use the slide because he couldn't get himself in a safe position. The school purchased an adapted swing and placed rails at the top of the slide that allowed children to stabilize themselves. They also attractively paved the sidewalk through the play area to allow easier access by a student in a wheelchair (Sheets & Wirkus, 1997).

Classroom Modifications

Classrooms also may need modifications. We ensure adequate *floor space* for a student in a wheelchair by organizing students in clusters of tables rather than individual desks, creating pathways in and through the classroom, and organizing spaces for centers. This allows physical access for students with mobility limitations; it also breaks up the space into smaller units, providing a sense of security and focus for distractible students, and establishes a known pathway for students who are visually impaired. We arrange *shelves* so students who cannot stand can access materials on lower levels. Again, grab rails serve as balance supports for students with many kinds of weaknesses.

A *couch* can support a student unable to sit independently on a regular chair because of neurological, muscular, or sensory motor impairments. A couch also encourages cooperative play, because two or three children often sit on it at a time. *Chairs with arms* such as captain's chairs or substitute chairs such as cube chairs or beanbags also offer more support for students with poor posture control, weak sensory orientation, or a very short attention span. Nonslip surfaces for tables and chairs also can provide greater stability (Sheets & Wirkus, 1997).

For students who have difficulties reaching and grasping, *desks* can be difficult. Students may have trouble leaning over to see materials on their desk and may constantly knock pencils, paper, or other materials off. A variety of simple items can help solve this problem. For example (Ryndak & Alper, 1996; Sheets & Wirkus, 1997):

- Paper or object stabilizers include double-sided tape, Post-it tape, clamps, or magnets (if the desk is metal). Also, rubberized pads mounted on a desk help materials move less easily.
- Various-sized drawing utensils include large and regular crayons, magic markers, and sponge brushes.
- Modified grippers attach to the hand and clamp to a pen; pens with enlarged bodies or covers can be easier to hold.
- Adapted scissors include loop-handled scissors and large-handled scissors or regular scissors.
- A portable slant tabletop made to fit an entire table can allow eight children to work at one time. This allows students to see work more easily, reduce fatigue, and help students with poor visual skills get closer to the work.
- Desks and tables can be made adjustable.
- One adapted desk is designed so the top functions like a lazy Susan and students can rotate it to access different objects (Cook & Hussey, 1995).

Journey Into the Classroom
Assistive Technology in the Classroom

Let's visit three classes to see examples of how assistive technology is being used in real classes.

Manuel, a second grader in Sonya Chases's class, uses an Augmentative and Alternative Communication (AAC) device to aid in play during recess. Manuel is a very pleasant boy, but he has some significant disabilities. Manuel contracted a serious illness when he was two weeks old and now is considered quadriplegic (he can move his arms a bit but can't use his hands of fingers to grasp well, and he can't walk) and nonverbal (though he can say yes and no). Manuel needs assistance with self-help skills, which an aide (sometimes with help from another student) provides. He uses a power wheelchair and a Light Talker, an augmentative communication device in which a light beam scans visual icons; when selected, the icons "talk" with synthesized speech.

We arrive for a visit as the class is heading out to the playground for recess. "Manuel has asked Eugene to be his buddy today at recess," Sonya says; "several of the boys have really become friends with Manuel." We watch Eugene wrap his arm around Manuel as he walks beside the buzzing, slightly meandering wheelchair. Manuel and Eugene join a group of children, and we hear Manuel's Light Talker say for him, "I like you Eugene." Eugene beams. Then, "Let's play ball." We're a bit surprised to see the children include Manuel in their softball game. One of his classmates hits for him, and he "runs" in his power wheelchair. He makes it to first base!

In an elementary school Latisha, a minimally verbal student, was having difficulty participating in story time. The teachers could not tell if she was understanding or if she was even involved in the story. When they asked Latisha questions, she would point vaguely and make sounds they could not understand. Another student, Aaron, who had physical disabilities was in a specially designed seat and also was not always involved. To deal with this problem, they used a range of strategies. They put beanbag and cube chairs on the reading carpet where the children sat on the floor in a semicircle around the teacher. These allowed extra support for both Latisha and Aaron. A grab rail mounted near the teacher allowed Aaron to pull himself up to participate, using felt or Velcro boards. They also used a range of augmentative communication and interactive story extensions that included gestures, animated facial expressions, sign language, communication boards, puppets, and Velcro boards. An easily programmable, augmentative communication device allowed both children to comment on the story or to ask or answer questions. They found that verbal students, too, often used the augmentative communication devices as well as talking. In addition, many shy children or those lacking confidence participated more often, using a voice output device that eventually gave them enough confidence to begin speaking more often (Sheets & Wirkus, 1997).

In a middle school, Jena, a student with a severe disability was able to make meaningful contributions by using some simple communication aids—the Speakeasy, BIGmack, and Step-by-Step75 (all produced by AbleNet, www.ablenetinc.com/). These programmable devices allowed students to do the following (and more) (Wise, 1999):

2. Greet classmates
3. Introduce self/classmates/coworkers
4. Respond to attendance call
5. Give directions for activity/assignment/work task
6. Give an individual/group report, with classmates recording student's portion
7. Share joke, riddle, or quote of the day
8. Share weekend activities, with classmates transcribing in journal
9. Answer comprehension question
10. Make announcements over public address system
11. Join in choral reading activity or recite lines of a skit
12. Request assistance in holding/using materials
13. Share the day's events with family, with message(s) recorded by peer

In Nan Sheldon's senior English class, students are working on a project for the yearbook, editing stories and incorporating these with photographs that the graphic arts class will use to design the layout and cover. Nan has a series of computers in her class. Jasmine, a student who is deaf, is at one of these. She has had to work hard to learn to write well and is now working with a partner. "We have our computers networked," Nan says as we watch. "Jasmine and the other kids have figured out that the best way for them to work together is to use the computers to send e-mail back and forth. This way Jasmine can read what is said and doesn't need the help of an interpreter." Nan explains that Jasmine sometimes does use a sign language interpreter and that over the year several of the students have gotten pretty good at basic conversation with her. "Also," she says, "some of the kids take notes for her. It's worked out well."

In her ninth-grade algebra class, Jan Larson has several students who have learning disabilities and one student, Brian, who has a cognitive disability. Jan has students broken into groups and has given them projects that will involve the use of a range of mathematics skills, including algebraic equations and geometry. Brian is working with a group that is designing the size and structure of a radio tower in a valley. (Jan tells us that she has been collaborating on some of these projects with the art and social studies teachers.) The students are building a scale model of the valley and the tower. We're interested to see how Brian is involved with the group. He pulls out a measuring tape and measures the height of the tower and the mountain. The tape speaks the measurement in synthesized speech! Jan explains that she tries to have Brian work with students on projects like this at his own ability level. "However, the other students are helping him to understand the most basic algebraic equations and what they might be used for." When we ask about other uses of technology, she says that Brian especially likes the interactive math and graphics software she has in the class. "The software has been particularly helpful for Sue," she adds, "who has a learning disability. The software engages the students in using mathematics concepts in applied situations rather than having them simply calculate equations they don't understand."

Reflection: Technology makes a huge difference in all of our lives. Assistive technology has the potential to create greatly expanded opportunities for students with disabilities. Rather than being afraid of technology that is new to us, however, such tools can be used valuably by many of our students. Having this technology in our classroom is like having our own science lab to explore the interaction of technology and human capability. Kids love it!!

Functional Applications of Assistive Technology
Using Technology to Live and Learn

In addition to focusing on general environmental adaptations, technology has many specific functional applications. Let's consider the key areas in which assistive technology can aid both children and adults.

Aids to Assist in Understanding and Remembering

A variety of aids are created to help students understand or remember. We already use helpful low-tech tools. For example, on our classroom walls we often have a list of the daily schedule, assignments and due dates, word walls, or lists of technical terms. Similar individualized tools can be created for students (Weisgerber, Dahl, & Appleby, 1980):

- A daily pictorial schedule that shows a clock with a time, a picture of an activity, and the words that represent this activity can be made for one student, several, or posted for the whole class.
- Tape-recorded instructions for an activity can indicate steps to be carried out.
- Checklists (with pictures if needed) enumerate steps for a particular activity.

Manipulating and Controlling the Environment

We rely on technology in our home—we use lights, oven, air conditioner, radio, TV, VCR. The same goes for the classroom, where we depend on, lights, timers, computers, VCR, transparency projector. Children and adults with significant disabilities, however, have difficulty using typical controls—difficulty reaching, turning, moving around the room. A wide variety of low- and high-tech tools for manipulating and controlling the environment can provide assistance (Cook & Hussey, 1995; King, 1999).

Low-Tech Aids for Manipulation Low-tech aids are designed as *general purpose* tools for numerous functions or activities. In contrast, *special purpose* devices are specifically designed for one particular function. In addition, some are designed to *augment* a person's ability to perform a task in a standard way; others use *alternative* means of accomplishing a task. Let's look at ways that devices can help.

Mouthsticks and head pointers are two general purpose aids frequently used for direct manipulation of objects by people who cannot use their hands and fingers well. They are used to turn the pages of books; to write (with a ballpoint pen attached to the end); to pick up objects (by means of a pincher attachment opened and closed by tongue action); and to grip objects (with a suction cup attached). They can also help people dial a telephone, type, and turn lights on and off.

Reachers help a person reach and grasp objects and are useful for a person who cannot stand (or for any of us when an object is on a high shelf). A handle grip is on one end of a pole that has grasping jaws, often covered with rubber or another nonslip material. With this mechanism a person can pick up and move many objects—cans, packages, books, paper, tapes, CDs, and so forth.

Special purpose aids most often involve specialized handles on tools designed for specific purposes. These might include, for example, a brush with an extended handle, a pen or pencil with an enlarged grip, a key holder with a large grip, a spoon with a bent handle for scooping or with a swivel handle. Electronic aids include page turners and feeders; feeders help people with limited use of arms or hands to eat more independently (Cook & Hussey, 1995).

Switches and Environmental Control Units A wide range of adapted switches can control numerous devices. Switches fall into the following categories: (1) direct selection, (2) scanning, and (3) coded access.
Direct selection occurs when the individual directly selects the item—by hand and finger movement, by use of a mouth-stick, or even via an electronic pointer mounted on the person's head. Such switches may be flip switches (like a typical light switch), buttons, or turn knobs.

Scanning involves an electronic device in which choices are provided and a cursor or light moves from one to the other. The switch is activated by the person when the correct choice is indicated.

Finally, *coded access* typically involves the use of Morse code to send signals to units to activate switches. For any switch, selection may include a simple on–off function (called "latching"); variability (as with varied intensity of lighting); or "momentary" function, meaning that the switch is on as long as it is being pressed and off when released. This brief introduction to switches illustrates the potential complexity of what most of us take for granted (Cook & Hussey, 1995).

An interesting application of switches is the development of *environmental control units.* A single environmental control unit, which looks like a small box with multiple switches or controls, can control multiple functions—light switches, oven, tape recorder, VCR. Although these are used mostly in homes, such a unit could be used in a school to give a student with limited mobility the opportunity to control some operations within the classroom (Cook & Hussey, 1995).

How might an environmental control unit work in a classroom? One high school used three units with infrared remote capability that controlled multiple appliances and office machinery. Using these devices, several students with severe disabilities were able to engage actively in classes by turning on the following types of equipment:

- Overhead projector
- Tape player or stereo—to dance, exercise, or hang out
- Book light
- Tape recorder with test questions/answers and books on tape
- Kitchen appliance for class cooking activity
- Office machines such as paper shredder, stapler, or letter opener for a cooperative work task

This helped the students be a real part of the class. Other students were interested in the control units, which helped to prompt positive social interaction (Wise, 1999).

Seating and Positioning

For any of us to work for a length of time, we must have comfortable seating and posture. For students with disabilities affecting body structure, balance, and/or muscle strength, this is sometimes difficult in typical seating. We should pay attention to students' positions on the floor, at a desk or table, or in their wheelchair, as well as to their posture during other daily activities—in the bathroom, at the pool, on the playground, or on the school bus (King, 1999).

Physical therapists can help us select and design adaptive seating for students with severe disabilities and can provide consultation regarding ways to support a student in our class. Working with a team, often in a special clinic, physical therapists conduct a careful assessment of the physical capacities and needs of the person, try various approaches to seating, and help a family obtain needed devices.

In addition to comfort, two major areas of focus are important when we consider seating and positioning: (1) postural control and deformity management and (2) pressure control (Cook & Hussey, 1995). Let's discuss these briefly and explore implications for the classroom.

Posture Control Some individuals have muscle weakness and uncoordinated movements that make it difficult for them to sit upright in a wheelchair or other seating. If not dealt with, these difficulties can, over time, cause general health problems and skeletal deformities that worsen the disability. Students with cerebral palsy most often have this difficulty, as do those with muscular dystrophy and multiple sclerosis. Treadwell and Roxborough (1991) described three levels of postural control ability for which different types of assistance are needed:

- Hands-free sitter: The person can sit without using hands for support. Seating is designed to provide mobility and a stable, comfortable base of support.
- Hands-dependent sitter: Hands are used to maintain support. Seating helps provide pelvic or trunk support to free the person's hands for activities.
- Propped sitter: The person lacks any ability to support himself or herself. Seating provides total body support.

Here are a few examples of types of seating support:

- A seat raised on the outer side to prevent the person from sliding forward
- A seat belt, lap belt, or bar to assist the student in maintaining position and to offer pelvis stabilization
- Foot supports so that feet don't hang too low
- Adjustable supports on the sides of a wheelchair to help a person with severe scoliosis maintain a more erect posture
- Head supports on a wheelchair to help stabilize the neck
- Seat with custom contours specially designed to fit the body structure of the student

What is both tricky and important about developing and using supported seating is that it is vital, on the one hand, to help students maintain good posture to prevent worsening of their disability, and, on the other hand, to provide flexibility so that they can engage in activities—reaching, writing, drawing, reading.

We work with the parents, the physical therapist, and the student in thinking about the physical structure of the class and the various ways the student can participate—sitting at the desk, sitting on beanbag cushions on the floor, moving the wheelchair throughout the room. Start by thinking about a typical classroom day and the many movements of students as they engage in active learning; then enlist the advice and assistance of the physical therapist. Other students also can learn how to help the person navigate the classroom and sit properly.

Pressure Control Students with spinal cord injuries have the greatest difficulties related to pressure. Because they have limited feeling, they may develop sores from pressure at particular points (technically, *decubitus ulcers*), which can be dangerous. Two key strategies are used to assist with this problem. First, good posture is maintained as discussed above. Second, various types of cushions are used. Finally, individuals engage in pressure relief activities—namely, a routine of shifting the weight of the body in different directions or of sitting in a way that relieves pressure, lying down, lying back in a wheelchair, and so on. With some children with significant disabilities, we may periodically help them shift their weight to aid in both pressure and posture control. A physical therapist will help us understand when and how to do this.

Bumps in the Road
Lack of Access

While assistive technology offers many possibilities of expanding the opportunities for all students, including those with special needs, many problems occur that limit it's use. Many educators simply are not familiar with assistive technology. Even if they have some general knowledge, they may be afraid of being overwhelmed.

Unfortunately, assistive technology is not yet a part of the everyday life and structure of schools. While almost all schools use computer-based technology and have staff at their school who work with and maintain this technology, few of these educators are familiar with assistive technology. This is still seen as a province for 'those' children rather than a resource that should be part of the services of the school. For example, one survey found that 87% of parents of students with disabilities said they had access to some form of technology in schools but less than 12% indicated that their children had access to assistive technology (Dalton, 2002). Similarly, in a national survey of individuals with disabilities, 40% indicated that they had received 'some' or 'a lot' of information about assistive technology while 60% received only 'a little' or none (Carlson, Ehrlich, Berland, & Bailey, 2001). Assistive technology centers often report that their resources are underutilized.

So while use of technology in learning is rapidly expanding through the use of computers and the vast amount of information available on the internet, many students with special needs cannot use these tools without access to assistive technology (Dalton, 2002; Kelker, 2000). The result is that learning of all students is diminished.

What to do?

Key is to try to get assistive technology integrated and incorporated into the overall technology plan for the school. Talk with the school principal. Share some tools like an Alpha Smart and dictation and text to speech software and talk about how these could be valuable to all students. Suggest that the principal, several teachers, and technology take a tour of the assistive technology center that serves your school district.

Second, make it a priority to reach out yourself related to the needs of your students. Do an analysis of your class and your student's needs and contact the assistive technology center for your school yourself. Find out how use of the tools they offer works and try to obtain resources for use in your class. Let your principal and some other teachers know you are doing this. Maybe they will also become interested, especially if you begin to have success with your students.

Augmentative and Alternative Communication (AAC)

Many students with more severe disabilities have difficulties talking. In some cases, as with cerebral palsy, individuals have deficits in muscular control; they are able to speak but do so slowly and may be difficult to understand. For students who speak at some level, tools may *augment* or improve their communication abilities. For students who are not able to talk to any meaningful extent, we use *alternative* communication strategies. The *augmentative and alternative communication* (AAC) approaches we use sometimes rely on tools and technology ("aided" communication) and sometimes on use of the body or expression ("unaided" communication) (Beukelman & Mirenda, 1992; Chedd, 1995).

Physical Movement and Gestures Some approaches are not technological but build on typical alternative communication tools. We all use our bodies to communicate in a variety of ways—through facial expressions, gestures, nodding our head, pointing, or touching (Cook & Hussey, 1995). We all use such methods as ways to augment what we say in words. Many students with severe disabilities who cannot talk otherwise communicate much in these ways. *Sign language* is valuable not only for individuals with significant hearing losses but also for students who are unable to talk (see Chapter 13).

Facilitated Communication Facilitated communication is a process in which a facilitator works with an individual, often at a computer, helping to stabilize the person's hands as he or she types messages and information on a computer. Developed by Australian educator Rosemary Crossley, facilitated communication has been heralded by some as a way of giving voice to many individuals with severe disabilities, particularly those with cerebral palsy and autism, who have not communicated effectively before (Crossley, 1994). Biklen (1990, 1992) brought the technique to the United States, where it has spread rapidly throughout the country. The approach has been controversial, however, with many doubting that the communications are the product of the person rather than the facilitator (American Speech and Hearing Association, 1994; Jacobson & Mulick, 1992; Levine & Wharton, 1995; Shane, 1994). Research to date has demonstrated cause for cautious optimism that this strategy may be able to open up a new life for some individuals (Biklen, 1990, 1992). On the one hand, individuals on both sides of the controversy acknowledge that facilitators can and do influence what is said. On the other hand, studies have demonstrated that this technique has been effective in allowing people previously thought to have minimal intellectual abilities to communicate deep and complex ideas, feelings, and thoughts. The websites of the Facilitated Communication Institute (2001) at Syracuse University and of Rosemary Crossley's Australian center (2001), DEAL, offer further information, including links to critics.

Communication Boards ("No Tech") Technological aids vary in their degrees of technological sophistication. At the lowest-tech level are locally or commercially produced communication boards of various sorts. The simplest type of communication board might consist of pictures with words that express a meaning placed on a piece of cardboard. The student would point to the desired message—"Go to the bathroom," "I am hungry," "Yes," "No."

Simple Electronic Communication Aids ("Low Tech") Other communication aids use technology to a limited degree. For example, Versascan is a simple aid that uses a few picture icons arranged in a circular pattern on a square board. A light shines behind each picture in turn. When the light arrives at the desired picture, the individual hits a simple switch and the message is spoken aloud in synthesized speech. A frequently used, simple communication device is the BIGmack, shaped like a large hamburger made of plastic. On this device one message may be recorded at a time and is then activated when the individual presses the top of the apparatus (Cook & Hussey, 1995; Sheets & Wirkus, 1997).

Sophisticated Electronic Communication Devices ("High Tech") *Voice output communication aids (VOCA)* are portable speech output mechanisms, many of which are very sophisticated. VOCA appliances can be thought of as computerized electronic communication boards. Typically the size and shape of a laptop computer, they are often mounted on wheelchairs. Most are divided into rows and columns of squares on which icons for messages are located. In some cases the VOCA instrument is multilevel, which means that more than one message may be stored under each key. Some produce synthesized speech output—the "robot" sound. Many use digital speech, which sounds like a human voice, either male or female. A range of message selection systems are available: In *scanning* a light or cursor moves from selection to selection and the user activates messages using a switch; in *direct selection* the person may use touch, a mouse, a joystick, or a head-mounted pointing device. Some mechanisms support *eye gaze* as a way of selecting choices as well (Cook & Hussey, 1995).

Dynavox (made by Sentient Systems), for example, uses an icon display and is accessed via touch, single- or dual-switch scanning, joystick, or mouse. The Pathfinder (Prentke Romich) provides high-quality speech synthesis with different age and gender options. It also can be used as an alternate keyboard to most computers and operates a variety of environmental controls. The Touch Talker (Prentke Romich) has 128 touch-sensitive keys that can be custom programmed and use additional overlays. The instrument can be hooked to a printer and used as an input device to a computer. A much less expensive, commonly used system is the Wolf (AdamLab). The least sophisticated version of the Wolf looks like a child's portable tape recorder and has four programmable squares for icons and words. It can be turned on via touch or adapted for scanning (Beukelman & Mirenda, 1992; Closing the Gap, 2000; Sensory Access Foundation, 2000).

Adapted Computer Access

Computers are important tools for accessing information and producing work; according to Sheets and Wirkus (1997), various adapted computer formats can help to level the playing field for people with disabilities. Typically, to use a computer effectively, a person must be able to see a monitor screen, read what is on the screen, and type to input information. However, many students, including those with disabilities, have difficulty with one or more of these processes. Assistive technology identifies ways to help with these limitations. One example is to modify the placement of the monitor. Beyond monitor placement and access, three additional considerations are important:

- Computer interface—the way the individual provides input to the computer
- Output—how the person receives useful output from the computer
- Software—programs that are based on best practices and encourage learning at students' own ability levels

Computer input Numerous tools are useful to modify and adapt input into the computer.

Alternatives to typing Some students need alternative methods of providing input to the computer beyond the standard keyboard. The first type of adaptation uses a standard keyboard but alternative methods of typing, rather than hands. For example, a mouthstick or head stick allows head motions to press keys. A similar device attached to the hand with a splint allows hand, rather than finger, movements to press keys.

Adaptations to the Standard Keyboard For some people with disabilities, the standard keyboard causes various problems for which there are software solutions. For example, a student with cerebral palsy might have difficulty pressing a letter in such a way that it does not repeat itself over and over. Both Windows and Macintosh have available software that delays the amount of time required before a letter is repeated (Alliance for Technology Access, 1996; Cook & Hussey, 1995).

Alternative Keyboards Special keyboards are useful for some individuals with limited ability to move fingers. These alternatives include (1) TouchWindow, a program that puts a keyboard on the screen which can be activated through touch; (2) Big Keys, a large-lettered, bright-colored keyboard on which the keys are arranged in alphabetical order; and (3) IntelliKeys, which allows for a single-switch adaptation nad uses simpler, graphic-based commands to help students more easily navigate the use of software programs (Sheets & Wirkus, 1997).

Communication Devices as Alternative Inputs Some of the communication devices discussed earlier can provide input into the computer, thus requiring the person to learn commands for only one device. However, the device must be physically connected to the computer. In addition, there are sometimes technical problems; communication between some devices and the computer can require manual programming, thus complicating this option (Alliance for Technology Access, 1996; Cook & Hussey, 1995). Examples include:

- *Scanning and switch-controlled keyboard:* When an individual cannot use any type of keyboard because of physical limitations, then scanning or Morse code is used. Scanners provide on-screen choices to the individual, either a line at a time or with rows and columns that cover half of the screen (Cook & Hussey, 1995). The individual can employ control switches select items scanned on the screen, using a "sequentially stepping selection cursor" (King, 1999, p. 18).
- *Morse code:* Software is available that allows "sequenced pulses from special switches to operate the computer" (King, 1999, p. 18) in Morse code. Use of Morse code allows more flexibility; however, it also requires the individual to memorize complicated sequences. Additionally, some required commands, such as "space," are not easily conveyed via Morse code (Cook & Hussey, 1995).

***Voice to Text Software**.* Dictation software allows individuals to speak to the computer to control functions and engage the different commands of different software programs (Cook & Hussey, 1995). Students who are not able to write may speak into the computer and the computer will write in an email, word processor, or other software program. Thus, students with significant physical limitations, like those with cerebral palsy, as well as students with significant cognitive limitations, may be able to create written document as well as control typical programs – graphics, presentation, email, spreadsheets, and databases. Both Windows and Macintosh operating systems come with both voice to text and text to speech software built in. Dragon NaturallySpeaking (http://www.nuance.com/naturallyspeaking/) and are programs used with Windows computers and MacSpeech's Dictate (http://www.macspeech.com/) and ViaVoice (http://www.nuance.com/viavoice/) are similar programs for use on Macintosh computers. While text and text to speech software are particularly important for students with special needs, these programs can also be used with all of our students. In fact, many people are using such programs at home and in the workplace to reduce physical stress of typing on a computer and to increase productivity.

Computer Output. We are familiar with typical computer output—words and images on a screen and/or printed materials. However, a variety of other outputs are available.

Text to Speech Software For both Windows and Macintosh operating systems, software is available that converts text to speech on personal computers. Some text-to-speech programs are specifically designed to assist in promoting literacy development with elementary-age students. According to the Sensory Access Foundation (2000), both a voice synthesis card and screen review software are required. Newer computers come with voice synthesis built into the operating systems for both Windows machines and Macintosh (VoiceOver); older computers may require a separate voice synthesis card. In addition, external voice synthesizers may be used. Examples include ReadPlease (http://www.readplease.com/), Natural Readers (http://www.naturalreaders.com/), IBM's Natural Voices, and TextAloud are all programs for Windows computers. Programs for Macintosh include TextSpeech Pro (http://www.digitalfuturesoft.com/) and GhostReader.

Two types of speech output are used with computers and other devices based on the use of microchips: digitized and synthesized speech. *Digitized speech* has been recorded onto some medium such as a magnetic tape, hard drive, or a read-only-memory (ROM) chip and produces a natural human sound. *Synthesized speech,* in contrast, uses complex rules to produce sounds based on spelling and syntax and produces a definitely "electronic" sound (Sensory Access Foundation, 2000).

Screen-reading programs work with the synthesizer to convert information on the screen into spoken words. By means of a screen reader, a blind user can read anything on the screen, from a single character to the entire screen display; and the screen review software can even notify the user that something has "popped up" on the monitor. With a single keystroke the user can command the synthesizer to speak out a word, a sentence, a paragraph, or an entire document. The only such program available for the Macintosh is Berkeley Systems' outSPOKEN, which works with the speech synthesizer built into the operating system. Numerous such programs are available for both DOS and Windows-based computers. Additionally, work is under way, though in its infancy, to convert graphics on the screen (graphical user interface, or GUI) to spoken words (Cook & Hussey, 1995; Sensory Access Foundation, 2000).

Magnified Screen Images For persons with partial sight, enlargement of text on the computer screen can make an important difference. Magnification can be done by means of magnification software or through use of a closed-circuit television (CCTV). Software can be installed that magnifies images on the screen and changes colors and contrast so that materials read more easily. One such program built into the operating system for the Macintosh is Closeview, which magnifies text and graphics two to sixteen times. Similar programs are available for Windows-based computers. This software can also change the color of the text and background. For example, if users are light sensitive but need contrast, they can have the text displayed in bright yellow on a soft gray or powder blue. Many students find this beneficial, particularly students with visual processing disabilities. In addition, optical screen magnifiers placed over monitors or closed-circuit television systems not only magnify printed materials but enlarge information on a computer screen (Alliance for Technology Access, 1996; Cook & Hussey, 1995; Sensory Access Foundation, 2000).

Tactile Output Also available for computers are appliances that produce tactile output in two formats—letter shapes and braille. The *Optacon* is a device that creates a "tactile facsimile" of print, using pins that vibrate in the shape of each letter. Braille output can be accessed either as an electronic display or as hard-copy printed braille. An electronic braille display converts text on the screen to pins that raise and lower so they can be felt. The person can use the device to control access to the computer without switching back and forth. Such units, however, are very costly. Also available are braille printers, which, like any printer, vary in speed and quality. Two frequently used printers sell for as low as $500, although higher-quality braille printers can cost thousands of dollars (Alliance for Technology Access, 1996; Cook & Hussey, 1995; Sensory Access Foundation, 2000).

Computer Software: Scaffolding Learning with Technology Computers and software provide powerful tools for many of our students. What is *not* particularly useful, however, is to use computer programs as automated worksheets. Unfortunately, much educational software, particularly in packages sold to school districts, encourages just this type of use. However, software can provide multiple ways of presenting information to students and multiple ways to allow them to express information, including:

- Text- and graphics-based reference books such as encyclopedias on CDs
- Interactive programs based on best teaching practices
- Speech synthesis software and programs that allow books to be read and accompanied by pictures and graphics
- Games that incorporate skills in literacy, mathematics, science, social studies, and other disciplines (e.g., space exploration programs that require calculations of fuel use, resource use of different colonies, etc.)
- Instructional software that teaches students how to use computer-based production programs—word processors, graphics, and so on. Many instructional programs are designed with graphics and sound to appeal to children.
- Word prediction software will predict the words a student is trying to type. They can select, then, the word they want. This is particularly helpful for students with learning disabilities and students who find it difficult to type, such as students with cerebral palsy

That's just a start. Computers also offer students wonderful opportunities to produce evidence of learning that draws on different intelligences. Many programs have been developed to appeal to children of different ages with different levels of skill and sophistication. Among them:

- Word processors
- Presentation software (PowerPoint; KidPics is a children's version of such a program)
- Graphics software—for drawing, painting, and so forth
- Spreadsheets
- Databases
- Music writing programs
- Website development software

Such programs allow students to develop products. When used with adaptive input technology, these programs can allow students with a wide range of academic abilities to write, draw, develop songs, assemble slide presentations, or create pictures. These productions can be used as a basis for other activities in the classroom; for example, a group might act out a story written by a student, use computer-generated graphics to design props for a play, organize a class sing-along based on songs written on the computer by a student (or group of students), maintain a database of books in the class library, or create a class book that incorporates students' graphics and research on a current topic of study (Alliance for Technology Access, 1996; Center for Applied Special Technology, 2000). The Voices feature describes one classroom in which access to computers provided assistance to students with disabilities—and to their classmates as well.

Schools to Visit

Teaching Students Successfully in General Education

Fulton Elementary School

Lancaster, PA 17603

Fulton Elementary School is home to 472 students in kindergarten through grade 5. Ninety percent of the children come from families with incomes at or below the poverty level; 42 percent are Latino, 33 percent African American, 24 percent white, and 1 percent Asian American.

Over the last eight years Fulton Elementary has made great changes in the last eight years. At that time 25% of its students were in special education, most in segregated classes. Now 4% of students receive special education services and all are included in general education classes. "It's a culture," says principal Drue Miles. "Nobody talks special education or thinks in out-of-my-classroom strategies. We simply use a variety of strategies to make learning available to everyone."

The district and school have traditionally used a three-step process to serve students. Tier 1 is a teacher's requesting individual consultation regarding a student. Tier 2 is the formation of a small team for consultation. Tier 3 is a coordinating council that considers referral to special education. Mr. Miles, however, suspended tier 3 meetings and expected all students to be served by teachers with consultation and assistance.

Once the vehicle for passing a student to special education ("I'm not able to teach this student") was eliminated, the practice of taking what was considered the lower portion of students and recommending special education came to a halt.

Mr. Miles believed that educators in the school had the required talents to keep all children in the classroom. He created a resource bank based on assets-based community development of staff skills, talents, and interests. Today, each time a faculty member approaches Mr. Miles about a student, the principal searches the resource bank for the person with the solution. For example, it has been common that a first grader with phonemic awareness deficits would be referred to special education The Fulton Elementary speech therapist now goes into the classroom to help all students with phonemic awareness.

Drue Miles explains his motivation for inclusion: "I was a special education teacher, and I dealt with the reality of teachers' not wanting children in their classrooms. I wanted to purify special education. Now teachers can do real inclusion, and special education teachers can be a real part of the school community." By Thomas J. Neuville, Millersville University, Millersville, Pennsylvannia;

Aids for Students with Partial Sight or Total Blindness

Students with visual impairments range greatly in their visual acuity, field of vision, and other characteristics. Individuals with partial sight benefit from a variety of magnification tools that can help them make the most of the vision they have. Individuals who have no useful sight also can access information with the help of a growing range of strategies and tools.

Magnification Devices Perhaps the most common form of assistive technology, used by a large part of the population, are devices that help us see better. Many people wear glasses or contacts. As people get older, almost everyone uses some sort of "corrective eyewear" or combinations thereof—contacts with reading glasses, prescription sunglasses, sports glasses, and so on. For people with more extreme visual impairments, other optical devices are available. These include various types of optical or electronic magnifiers of all sorts and sizes—from hand-held to desk magnifiers.

Closed-circuit television (CCTV) can function as an electronic magnifier: A camera focuses on a document or is connected electronically to a computer and sends the image to a television screen that enlarges the image. Different versions are available, including a hand-held camera using an NTS interface that connects to a typical television, other portable cameras that use a table on which documents are placed and are connected to a computer monitor, and stand-alone units (Sensory Access Foundation, 2000).

Recorded Materials For individuals who have no useful vision, a great variety of devices and tools are available. Although these require training to use, technology increasingly provides blind individuals with access to information. Many books are available through commercial companies that provide books on tape, through the Library of Congress, or through local services that often provide access to newspaper and other materials. Materials available through libraries can also be accessed without charge for students who have learning disabilities or other problems accessing written materials (Sensory Access Foundation, 2000).

Braillers *Braillers* operate like small typewriters. Mechanical braillers are as noisy as a manual typewriter; however, more recent versions operate like small laptop computers. The more recent versions, such as the BrailleNote and BrailleLite, allow students to edit work, hear it read back to them, and feel the letters they have typed in a set of pins, as the curser moves. Also, they can be hooked up to an actual laptop computer, so that when the student is typing the teacher can see what is being written on the screen. Additionally, a person may use these Braille devises to record information and then have the computer convert this, if desired, to braille with either hard copy or electronic print (Cook & Hussey, 1995; Sensory Access Foundation, 2000).

Reading Systems Technological devices give persons who are blind more independence in accessing information. Reading systems allow individuals who are blind or visually impaired to access printed material. They consist of a scanner, a computer to which the scanner is connected, and software to turn the scanned image into text that can be read aloud through speech synthesis and/or displayed in electronic braille format. Stand-alone systems consolidate the computer, software, and scanner into a single unit in which one keystroke engages the scanning and text conversion process. Software-based systems require more computer skills but have the capability of editing and printing information. Among reading systems are Arkenstone's Open Book and Open Book Unbound, Telesensory Corporation's Oscar, and Xerox Corporation's Reading Edge (Cook & Hussey, 1995; Sensory Access Foundation, 2000).

Adapted Tools and Measuring Devices A wide range of adapted tools and measuring devices are available. Although designed largely for persons who are blind or visually impaired, they can be useful to our other students as well. They include rulers with raised markings, talking clocks, watches with raised markings, braille labels, light probes (used to determine if lights are turned on), and liquid level indicators that sound a tone when electrodes placed in a container reach a certain level, as in measuring ingredients for cooking (Weisgerber, Dahl, & Appleby, 1980).

Assisted Hearing and Alternatives

Assistive devices to aid people in hearing are among the oldest and most used assistive technologies available. They are used by so many people that we no longer consider them unusual or think of them primarily in connection with people with limitations. For individuals who have partial ability to hear, assistive devices include:

- Hearing aids—electronic aids that are mounted behind the ear, in the ear, or in the ear canal
- Amplified telephones with volume controls
- Headphones that allow students to listen to tapes with increased volume
- Classroom amplification systems in which teachers use microphones and speakers mildly amplify the sound
- **FM units,** in which the speaker uses a microphone and amplified sound is accessed through a receiver carried by the individual with a hearing impairment

For individuals without functional hearing, we need alternative tools. We have discussed sign language. Technological tools are important as well.

Telephone Access The telephone provides an important challenge. People who are deaf can communicate either with other deaf people or with hearing persons using a **TDD (telecommunications device for the deaf),** a keypad device that acts as a modem. If another deaf person has such a device, when the telephone connects, the two TDD users can type messages and send them back and forth to each other. If a deaf person is calling a hearing individual, the telephone company provides a "relay operator," an individual who reads the message from a TDD and then translates this into speech for the hearing person. (Interestingly, AT&T employs blind people in these jobs; the relay operators receive incoming messages in electronic braille.)

Another option for telephone communication involves use of a computer and speech synthesis software with a touch-tone phone. The computer is connected directly to the telephone. As the person who is hearing impaired types messages, the computer converts the text to spoken language. The TDD used by the person who is deaf can function automatically as a bidirectional TDD, allowing the hearing person on the other end to use the keys of the telephone as a simple text input device. This technology has allowed widened opportunities, as it requires neither the use of special equipment by the hearing person nor dependence on a relay operator.

A final option, not yet in wide use, is video transmission—which would allow two deaf people to speak to each other using sign language. Given the enormous memory requirements for such transmission, this technology is not yet used over telephone lines. It can be used, however, with local area networks (LAN); video transmissions can link two persons who are deaf or even link a hearing individual, a person who is deaf, and an interpreter together (Cook & Hussey, 1995).

Speech Interpretation Aids Two types of aids are sometimes used to help people who are deaf interpret oral communications. Lip-reading aids depend on specialized types of glasses. Upton glasses employ a microphone that helps people interpret difficult sounds by means of color codes for different sound categories. This allows people to increase their speech-reading ability (Cook & Hussey, 1995).

Alerting Devices Many sounds are important in daily life—doorbells, ringing telephones, car horns, smoke alarms, a child's cry. For people with hearing loss, devices are available that detect these sounds and cause either a vibration that can be felt or a flashing light or both. Microphones may be placed in key areas—near the front door, near the telephone—to detect sounds and turn either on a flashing light or a wrist-worn vibrator. For smoke alarms a special frequency can be set to provide a unique signal. Alarm clocks or timers can be tactile (under a pillow, on a wrist, or in a pocket) or can activate a light (Cook & Hussey, 1995).

Aids for Persons Who Are Both Deaf and Blind People who are both deaf and blind use tactile input to obtain information and communicate. The oldest method is called the Tadoma Method. Both people involved must know sign language (or have an interpreter). The person feels hand signs and finger spelling with his or her hands. An automated version of the Tadoma Method has also been developed, in which the speaker talks into a microphone and a device converts the sound to vibrating pins, as in the Optacon. An interesting piece of equipment currently under development connects a mechanical hand to a computer, which can receive input from a TDD or a speech-to-text speech synthesizer. The hand moves in finger spelling and sign as a real person's hand would (Cook & Hussey, 1995).

Mobility

By mobility, we mean our ability to move around in our immediate environment as well as our capacity to move safely and efficiently from one location to another. Some people with disabilities have many problems of mobility: It may be difficult or impossible for them to turn over in bed; climb stairs; walk; or access automobiles, planes, or buses. Numerous devices are available to help solve these problems.

Mobility for Persons Who Are Blind A range of strategies are used to help persons who are visually impaired or blind to move around from place to place. The most used approaches are low-tech:

- Professionals who provide training and assistance to support blind people in mobility are called *orientation and mobility (O&M) specialists.*
- *Sighted guides* are persons who can see who help people with visual impairments move safely from one place to the other. The person who is blind typically will grasp the arm of the guide. The sighted guide will alert the person for steps, pausing briefly just before descending or ascending, or for objects or barriers. Sighted guides do *not* take the hand of the person who is blind and pull; this takes away a sense of dignity.
- *Canes* allow blind individuals to independently traverse an area with which they have some familiarity, and *guide dogs* assist individuals in safely moving around and walking.

Electronic travel aids have been developed to overcome limitations of the cane. Each uses some device to sense objects and/or drop-offs and provides feedback to the user in the form of sounds—high- or low-frequency tones or clicks—or vibrations. For example, a *laser cane* extends the range of the standard cane and can detect drop-offs. Three narrow laser beams are emitted, which detect objects and provide different feedback depending on location—a high-pitched tone if the object is upward, a low-pitched tone for a drop-off, and a vibration for an object directly in front of the person (Cook & Hussey, 1995; Sensory Access Foundation, 2000).

Wheelchairs For someone for whom walking is difficult or impossible, a wheelchair provides a way to move from place to place. The history of the wheelchair itself tells us a lot about changing views of disability. The oldest wheelchairs looked much like large wooden rocking chairs on wheels; they were designed so that it was impossible for an individual to propel themselves.

A wheelchair has several typical parts—a seat, armrests, footrest, and brake. Typically, a sling seat allows the wheelchair to be collapsed for placement in a car or closet (Cook &

Hussey, 1995). A person propels a *manual wheelchair* by turning the outer rim of the wheel. In recent years a new breed of wheelchairs has been developed to accommodate individuals involved in sport. *Ultralight* wheelchairs often sport bright colors, do not have armrests, and are made of aluminum alloys, titanium, or similar lightweight materials rather than the steel of the conventional chair. These wheelchairs are often used in wheelchair basketball and in all sorts of sports involving persons with disabilities.

Some children or adults may not have adequate strength or agility to propel themselves adequately in a manual chair. Increasingly, *powered wheelchairs* have become available. The decision to use such a chair must be made carefully, however; as with driving a car, using a powered wheelchair requires training and skill. These wheelchairs have a power unit and may incorporate any of a range of control devices. The most typical control is a *four-way joystick* that controls both speed and direction of movement. Joysticks can be mounted in different locations to be used with the hand, chin, foot, or head. A *puff-and-sip* control is used by an individual who has limited movement of body parts other than the head. Two switches are activated. When both are puffed, the wheelchair moves forward; when both are sipped, it moves backward; and when only one switch is activated, the wheelchair turns. Different settings of speed and rates of braking can be selected for indoor and outdoor use. Oftentimes people who use powered chairs also use other devices that are carried on the wheelchair—a respirator or an augmentative communication device, for example (Cook & Hussey, 1995).

Vehicle Accommodations Automobiles, vans, and other vehicles can now be modified so that persons with very severe disabilities can drive safely. These accommodations open up opportunities for many individuals with physical disabilities and can be funded through state vocational rehabilitation agencies or insurance companies. The first issue is simple *access* to the vehicle. Transfers to and from a car can be assisted with use of sliding boards, bars to grab, and straps. If a person is not able to transfer independently to a car, a *van with a powered lift* can be used to move the wheelchair from the ground to the floor level of the van. Similar types of lifts are available for school and city buses. Once in the van, a *wheelchair tie-down* should be used to stabilize and ensure the safety of the person. Additionally, an "occupant restraint system"—a seat belt or similar device—will hold the individual in the wheelchair in case of an accident.

The primary driving controls of a vehicle govern steering, acceleration, and braking. *Acceleration and braking controls* can manually augment conventional controls so that they require less pressure; or, in the case of a missing limb, controls can be moved from one location to another. A lever arrangement can be placed next to the steering wheel; the person pushes to brake and pulls to accelerate. Variations include push–twist and crank options. *Steering,* too, may be accomplished through a range of adaptive aids.

Back Pack
Assistive Technology Goldmines

Closing the Gap provides comprehensive online resources related to assistive technology. A free trial period is available and yearly subscription is inexpensive.
www.closingthegap.com/index.lasso

The **National Center for Technology Innovation (NCTI)** seeks to foster innovation in use of technology to support individuals with disabilities. www.nationaltechcenter.org/

Embracing Assistive Technology

You have to agree: That's a lot of technology. If you are a technology enthusiast and this was new to you, you likely loved it and want to know more. There's much to learn about technology, and it's an exciting part of the journey. If you're not into computers and other technology, however, this discussion may have seemed a bit overwhelming. When the first personal computers came out, many adults were scared to death of them. Kids took to them naturally. Now, many of us can't imagine managing our jobs or our personal lives without a computer.

Assistive technology professionals talk about the **transparency of technology,** and the more transparent the better. Technology becomes transparent when it is so much a part of our lives that we literally don't think about it. We don't think of driving a car, calling someone on the telephone, typing a report on a word processor, or cleaning our eyeglasses as unusual.

What makes some of the technology described in this chapter different is that it is new and sometimes not so easy to use. In some instances there are many bugs to work out. Also, most of us have had little experience with some of the people who need to use such technology. Yet if we had grown up with these people as children, had known them as adults, and had become familiar with their new augmentative communication device when we were learning how to use our computer, neither they nor the technology would seem strange. They would be part of our landscape—"transparent," so to speak. That, of course, is what inclusive schooling is all about. One of the goals of inclusive schooling is to make the people and the aids and supports they use part of all of our lives.

What will likely help us to truly embrace both assistive technology and the inclusion of students with severe disabilities in our classes, however, will be the moment when we discover the benefit for all our students as we become comfortable with these students and this special technology. By way of analogy, consider one of the key things we know about literacy—namely, the fact that we can always read a passage more easily when we have *background information.* As we develop experience with even one student, our fund of *background information* skyrockets, and we can build on that fund over time. Perhaps, the most clear signal of our own growth and learning will be the change that will occur when we don't think of this technology as "special" at all. When we teach we will simply incorporate a growing range of technology into the ways we share information with students and into the opportunities we give students to demonstrate their own learning—following the guidelines for universal design of the curriculum that we discussed in Chapter 14.

Traveling Notes

Technology makes a difference in all of our lives. From one perspective, we are all disabled, and technology helps us do things we could never accomplish otherwise. What is your own reaction to technology? Do you love figuring out all the new software and video and audio devices? Or do they scare you? How will your responses affect your use of assistive technology needed by students with disabilities? Following are a few notes to remember.

1. Assistive technology uses both high- and low-tech tools to help extend the capacities of students. We'll find that while these tools are particularly important for students with special needs, they will be valuable for all our students.
2. Special education funds can be used to purchase needed assistive technology. Every state has centers for assistive technology where people can explore and try out different types of devices. Specialists can help us understand how to incorporate particular tools into our teaching process.
3. Students who use assistive technology can provide interesting opportunities for learning about the interface of human beings and technology for all our students.
4. Modifications are often needed to school grounds, buildings, and classrooms to ensure accessibility to students with physical or sensory disabilities.
5. Many different types of tools and devices can help students accomplish tasks and extend their abilities. These range from talking computers to devices that convert print to braille and modifications that allow students to use hand controls to drive vehicles. Many of these devices may be used with all of our students, including those with special needs to great benefit.

Stepping Stones to Whole Schooling

Following are some activities that will help extend your understanding and actions you may take to use assistive technology in your school.

1. What technology and tools do you have in your school and classroom to help students compensate for disabilities or to provide additional help? Do an assessment of your classroom and school and identify three or four additional needs that should be addressed. Use the information in this chapter as a guide.
2. Visit a local center for assistive technology and experiment with different tools described in this chapter. Identify several you would like to see in your school and explain how they might benefit all students.
3. Talk with your principal and school technology coordinator about assistive technology. Suggest that a plan be developed to incorporate assistive technology into the technology plan for the school. Perhaps start with attempts to obtain tools you saw in your visit to the assistive technology center.
4. Obtain and install talking software and software that allows students to dictate stories. Watch what happens with student learning over several weeks. What do you see?
5. Contact vendors of assistive technology equipment or a local assistive technology center and arrange a hands-on demonstration fair for children, teachers, and parents. Make it a fun event!