Looking Ahead to a Future With Technology

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Today's literacy programs are unable to meet the current demand, much less projected future requirements, for literacy services. Many learners cannot or will not participate in the literacy programs now in place. It may be impossible to provide enough teachers, classes, and programs no matter how much money is pumped into the current system. Ways must be found to extend the range and increase the impact of existing teachers, programs, and expertise.

This chapter looks ahead to tomorrow, with three scenarios offering a vision of adult literacy for the next 5 to 10 years. The scenarios combine several themes raised throughout this report. First, they reflect a desire to go beyond reliance on school-based programs and classroom-oriented instruction; instead, they assume more flexible ways of providing service. Second, the scenarios present literacy instruction integrated into and reflective of the daily activities of a learner's life. Because adults spend most of their time and energy either at home or at work, family and workplace are both setting and context for much of the literacy instruction in the scenarios. The goals of workplace and family literacy-economic security, professional advancement, and improving the opportunities of one's children-are naturally motivating to learners. Because these goals complement goals held by our society—international competitiveness and personal economic self-sufficiency-workplace and family literacy activities may be able to elicit broad-based support and financial commitment. Finally, the scenarios assume a primary role for technology-increasingly powerful, portable, flexible, and affordable tools that can empower the learner any time, any place, and in a range of applications.

A LOOK INTO THE FUTURE: THREE SCENARIOS

What futures are possible if technology, flexibility, and comprehensive services could be provided to learners in contexts relevant to their daily living and long-term goals? The scenarios provide one way of envisioning these possibilities, using three fictional learners typical of many who need literacy assistance. The technology depicted in them is suggestive of possible applications, based on current trends and developments.[1] They exemplify the kind of changes that *could occur* by the year ***2000*** and are meant to illustrate ideas, not to make specific predictions.

Carla King: Moving Ahead With a Changing Industry

Carla King, a vivacious 32-year-old, lives with her mother and 10-year-old daughter Latanya in a garden apartment on the outskirts of a small midwestern city. Since graduating from high school, Carla has worked in jobs as a cashier, mail room clerk, receptionist, and school bus driver, with her mother providing babysitting. Although they have few extras, Carla has been able to support the family adequately on her income, supplemented by her mother's social security check. Carla hopes her 4-year relationship with her boyfriend, a truck driver, will lead to marriage and greater financial stability.

Carla has worked for the Cobra Alarm Company for 3 years. Cobra sells, installs, services, and monitors alarms for residences and businesses. Working the 3 pm to 11 pm shift, Carla monitors incoming signals that indicate a triggered alarm and responds by contacting the police, fire, or emergency medical departments, and home or business owners or their designees. She also takes requests for repairs, writes work orders, and directs the incoming calls not handled by voice mail.

The company was founded by Scott Webster, a 43-year-old entrepreneur. In the last 6 years the company has grown from Scott, his brother, and two sisters to 35 employees. Scott was able to get his business off the ground with assistance from the Coalition-a collaborative of local businesses and city and State government that helps develop and support small businesses and create jobs for community residents. The Coalition helped Scott obtain low-interest financing, develop a business plan, and recruit employees from the local area. The Coalition provides continuing support and management expertise. The Coalition has been particularly supportive in helping companies develop workplace education programs.

Cobra's 5-year business plan calls for a substantial increase in the number of large commercial customers. This change will accompany the move to a new "smart alarm' system. The company plans to acquire new telecommunications and computer equipment with sophisticated voice-recognition capability that automates telephone operations and monitors alarms automatically. Once smart alarms replace older models, human telephone operators will no longer be needed. Customers will give oral instructions, such as changing the party to be notified in an emergency, directly to their smart alarm. The alarm's computer will recognize, execute, and

[1] The ways in which technology is conceptualized in these scenarios comes from the OTA Workshop on Emerging Communications and Information Technologies: Implications for Literacy and Learning, Sept. 26-27, 1991; and OTA/Annenberg Workshop, "New Visions for Video: Use of Cable, Satellite, Broadcast, and Interactive Systems for Literacy and Learning," Jan. 27, 1992. See also Robert Olsen et al., *21st Century Learning and Health Care in the Home: Creating a National Telecommunications Network* (Washington, DC: Institute for Alternative Futures/conSumer Interest Research Institute, 1992); Julia A. Marsh and Lawrence K. Vanston, *Interactive Multimedia and Telecommunications: Forecasts of Markets and Technologies* (Austin, TX: Technology Futures Inc., 1992); "Newton's World," *MacUser,* August 1992, pp. 45-48. Finally, these scenarios build on previous OTA work including *Linking for Learning: A New Course for Education,* OTA-SET-430 (Washington, DC: U.S. Government Printing Office, November 1989); *Worker Training: Competing in the New International Economy,* OTA-ITE-457 (Washington, DC: U.S. Government Printing Office, September 1990); and *Rural America at the Crossroads:* Networking *for the Future,* OTA-TCT-471 (Washington, DC: U.S. Government Printing Office, April 1991).

verify the owner's request, relaying it directly to Cobra's central computer.

With this change to a more competitive high-tech product, Scott plans to reorganize the company around the principles of total quality management. Each employee will be expected to know several jobs well and understand the entire operation.

Carla's current job will phase out with the changeover. She wants to stay on at Cobra, but she realizes that she has little opportunity for advancement without additional education. As a general track student in high school, she bypassed both challenging academic courses, such as algebra and geometry, and practiced vocational courses. Although her oral communication skills are adequate, her written skills are limited. She is concerned about the new responsibilities she will have as a team member. Carla will be expected to read and comprehend technical material and diagrams, troubleshoot problems for customers. make well-reasoned judgments using technical information. write reports. and make suggestions for change.

As a part of preparing for the reorganization, Scott meets with the State government workplace training coordinator, the community college adult education director. and Cobra's employee committee to design the education and training that will be needed to move the company into its new role. An assessment reveals that one-half of Cobra's employees need to improve their writing and reading skills. One-third need to 1earn (or brush up on) mathematics for technical work and statistical process control.

With help from education advisers at the community college, the company develops a customized skills enhancement program. All employees are given 2 to 5 work-hours per week, company time, to participate in skills enhancement and training, providing they contribute at least 2 additional hours a week of their own time. Profit-sharing credits are offered to employees who spend 4 hours per week or more of their own time at learning activities for their individualized learning plan. Scott admits it is unlikely he would be able to provide these incentives without the recently passed Federal tax credits for companies offering workplace literacy programs like Cobra's.

In part because there is no room onsite to conduct classes, Scott has purchased from the Coalition, at a reduced rate, several lightweight, battery-operated, notebook-sized personal learning devices (PLDs) for his employees to check out. The PLD functions like a combination computer, television, and telephone; it unfolds to show a screen for the display of both video and graphic information. Screen text is as clear and easy to read as a book. With a touch of the network button on the screen, the PLD opens a telephone line to transmit or receive data over a distance. The PLD has a built-in pen-based data entry system and touch screen, microphone and speaker, a detachable keyboard, and an external hard disk drive for extra data storage.

Carla likes the PLD because it is powerful and easy to use. When she first went to her Coalition education counselor, Carla was given a personal interest inventory and skills assessment software package to complete at home on the PLD. Results were downloaded into the Coalition's office, and the next afternoon Carla and her counselor met online and discussed her academic strengths and areas for improvement in relation to the needs of the new job. Carla's learning style preferences were matched to available program resources. Carla's profile indicated she likes to study independently and works well in small groups, but is intimidated by structured classroom settings. Consequently, her counselor suggested self-study modules and distance learning options for her personal learning plan.

The distance learning capabilities of the PLD enable Carla to enroll in a mathematics class, identified through a national database of distance learning classes, that matches her learning needs and time schedule. In this class she has two study partners in two different cities, Using PLDs, all three study together as if they were in the same room. On her PLD, Carla prepares mathematics

assignments by entering data, plotting graphs, and graphically rendering mathematical concepts. This whole process helps demystify the subject matter, and real-world problems show her the practicality of having good mathematics skills. The PLD's calculator helps her avoid arithmetic errors and permits her to concentrate on mathematical concepts.

Carla also signs onto a current events reading club. Based on her interest profile, Carla is matched with seven other young women around the city. They meet for 2 hours on Saturday mornings in the local library, but most of the discussion goes on over the electronic-mail connection of the PLD. While at the library, Carla downloads articles from *The Washington Post, The New York Times*, and weekly news magazines onto her PLD. She shares these with her daughter and mother, and together they compare the different emphases of these news accounts with what they see on the evening television news. The PLD software helps Carla generate, outline, and organize ideas for her written pieces for the club, and the word processor with voice, pen, and keyboard input makes writing easier. Carla reorganizes, revises, and edits with the help of software language aids-spelling, grammar, punctuation and style checkers, and a thesaurus—before sending her reports to other members of the club.

Ten months later, Carla has overcome her school anxieties and now enjoys her education. She has checked out the PLD so often that she has considered purchasing one on her own. She likes the fact that, when she practices skills on her own time, the software records her study time and she receives "educredits" that can be applied to a certificate program at the community college and for reduced-cost purchase of her own PLD through the Coalition's lease/purchase plan for member businesses. After completing the mathematics course, Carla feels ready to tackle a module on basic principles of electricity and electronics. This course uses multimedia software and scientific probes that can be added to the PLD. Course materials have been customized by a team from the Coalition's technology advisers and Cobra technicians. The software simulates the actions of redesigning wiring diagrams, replacing computer chips, and reprogramming a smart alarm.

Carla uses the PLD in many more ways: pursuing her hobby of home gardening by accessing a horticultural database, locating a Spanish tutor for Latanya through a database of local educational resources, and using the multimedia encyclopedia software and other references to assist with her school projects. Carla's mother communicates electronically with new friends on '' seniornet, ' a national network she subscribes to at a reduced rate through her church's senior citizens center.

Carla is making steady progress and plans to enroll at the community college for an associate degree in electronics next year. She will already have several credits under her belt through her self-study modules. Her new confidence is showing up at work, where she is participating more actively in team meetings and suggesting new approaches to tasks. In training sessions that require the use of technical manuals, Carla keeps pace with other workers. Best of all, she has been given a promotion and pay raise to reflect her increased responsibilities.

Dave Decker: Changing a Life, Starting a Future

Nineteen-year-old Dave Decker officially left school when he turned 16, but he dropped out intellectually years before. He always had trouble reading and repeated both the 4th and 7th grades. By the time he was in the 8th grade, when he was a foot taller and several years older than the other kids, he knew he did not fit in. Instead, he found a new circle of fiends-the older guys that hung out at the pool hall, drank beer, and stole cars for kicks. Dave and his friends were arrested several times for car theft and vandalism. After his fourth arrest, this time with a drunk and disorderly

charge, Dave's mother refused to bail him out. The judge ordered him to enroll in a substance abuse program and assigned him to a detention center for juvenile offenders.

His first week in detention, Dave's literacy skills were assessed using a procedure developed by a four-State consortium of correctional educational programs, Dave took a battery of multimedia diagnostic assessments that included a series of science experiments, writing assignments, and social studies miniprojects. The tests required him to read documents: write reports, memoranda, and essays; collect and interpret scientific data to formulate and test hypotheses; draw conclusions from multiple historical source documents and maps; apply mathematics to solve real-life problems; and create charts and graphs in several subject areas. Other assessment software helped Dave learn more about his aptitudes and interests in areas such as music, art, mathematics, mechanics, physical strength and dexterity, leadership, and interpersonal relations. Multimedia materials were also used to help Dave identify possible career directions. When Dave expressed interest in the job of a physical therapist, he called up a database of health career simulations that let him shadow' a therapist for a day, ask questions about the job, and practice providing therapy to patients.

Dave's assessment results—test scores and interpretive analyses-were sent to the State detention education offices for processing and returned to the local staff within 24 hours. An individualized educational plan was developed for Dave by the second week in the program and he signed an education contract, spelling out his goals and the requirements for meeting them. He was given a personal ''educard' containing data on his testing results and plan. As he progressed through his plan, each step was credited on the card, and time was deducted from his open-ended sentence.

Dave worked especially hard on language arts skills. During class he used a small personal multimedia computer connected with the State's online database of courseware and reading material. After class, he downloaded materials he needed extra work onto a notebook-sized PLD he checked out to use in his room and repeat lessons as many times as he wanted. The PLD held Dave's attention, did not make fun of his mistakes, and rewarded him with bonus points for center privileges when he completed a unit. It held no preconceptions about his ability and turned his lefthanded ''chicken scratch' handwriting into fine-looking typed words and sentences, especially when he remembered to use the spell, punctuation, and grammar guides.

Several months after entering the center, Dave received a card with no letter inside, only a picture of a smiling red-headed baby with the word ''Georgette' written in his mother's handwriting. His girlfriend Kathy had given birth to his child. Dave stared at the photograph with a mixture of shock, denial, pride, shame, and tenderness. Until then, Dave had drifted aimlessly through life, his low self-esteem leading him to doubt his ability to succeed at anything. For the first time he felt he had a goal to work toward. Dave resolved to stay sober and assume the responsibility of fatherhood.

After his release from detention, Dave returned home. Because he had received so many educredits while in the center, his high school diploma was finally within reach. But he swore he would never again set foot in the local high school, and he had to work to help support his little girl while Kathy lived with her parents and finished high school. Dave enrolled in a general equivalency diploma (GED) course offered on the local Public Broadcasting Service (PBS) channel, watching at home in the evenings and taping lessons he had to miss when caring for Georgette. He spent his days working in his uncle's feed store, and his uncle let him use the computer to hook up with an electronic mail support group for teen alcoholics. Dave found it reassuring to know that he could use the 24-hour "chat" line whenever he needed support. Each day he also

dialed into the computer's video connect to check in with his probation officer.

One night, when Dave was feeling particularly low, he was thrown out of a local bar for drunk and disorderly behavior. His probation officer realized Dave was at a crisis point and sent Rick Carter over to the house. Rick, also a recovering alcoholic, described the We Are Family (WAF) Program he had created to help other adolescent parents avoid the mistakes he made as an angry young man. While most teen parents entered the program voluntarily, for a few like Dave, participation was a condition of his parole.

Dave was reluctant, but did not want to lose his parole or the delicate relationship he was trying to reestablish with Kathy and Georgette. Rick explained that the goal of the program is to improve self-esteem through increasing literacy skills, working around three themes: parenting, health and safety, and job preparation. Reading, mathematics, science, and writing skills are introduced and reinforced within the three themes by professional teachers, both onsite and through distance networks. Because the community is a rural one, spread across hundreds of miles, they meet electronically through satellite downlinks and telephone/computer connections. Study groups form around multimedia lessons, supported by a library of interactive CDs, which students can order up through touch screens on the television. Those who do not have the necessary hardware are given loaners through the library.

Dave's work on the family skills activities supports his evening GED studies. He recently worked on reading comprehension by trying to infer meaning from context clues, using a CD on child immunization downloaded from the system. While watching the CD, he tries out various options that test his understanding, resulting in scenarios created by his choices. Shocked by the negative effect his response has had on the characters in the story, Dave realizes he has not understood the material sufficiently, and decides to watch a more detailed explanation of the concept. He can repeat portions of the CD, asking for definitions of concepts or terms, pursuing his own interests indepth or just following along with the written student guide. Kathy and Dave work on some modules separately, since he is still living at his parents house. When they get together at Kathy's, they share what they have learned with each other.

Dave spends a great deal of time with his daughter and fully shares child-rearing responsibilities, working from 2 to 9 pm so he can care for the baby while Kathy is at school. Dave is also learning ways to interact with Georgette that will help stimulate the baby's communication skills. He borrows paper and electronic books from the library to read to her. His favorites are interactive books that contain music, animation, voice narration, and video. Georgette's favorites are any books where her father supplies the sound effects.

His affectionate and increasingly skilled parenting of Georgette has won over Kathy's parents, and they see that his commitment to his family is helping him to stay sober. They have given their blessing to their marriage when Kathy finishes high school.

Fifteen months out of the detention center, Dave passes the GED on his second try. He plans to enroll in a laboratory technician certification program through the community college's distance learning network. Later, after he gets his confidence up, he may take some classes on campus, but, right now, without a car and so little free time, the class at the community center is all he can handle. With a certificate, he hopes to work in a new biogenetic laboratory that is located in the area.

Although Dave has finished his parole and no longer has to participate in WAF's teen dad program, he will continue to participate as a volunteer. It has helped him get his life on track.

Tina Lopez: Family Support Through a Multipurpose Literacy Center

Tina Lopez, age 24, lives in a small town in south Texas. She left school in her native

Guatemala to marry Eduardo when she was 15, and followed him to the United States when she was 18. When Eduardo lost his job and became abusive they separated, leaving her to raise her two young children alone on a small welfare check.

Through her Spanish-speaking counselor at the welfare office, Tina learned about the River Family Literacy program. With 5-year-old Jimmy and 2-year-old Maria old enough for school and daycare, Tina has been told that, by participating in the literacy and job preparation activities offered through the center, her check will be increased for each of the educredits she earns toward her high school degree. The program guarantees her a job paying, at a minimum, 10 percent more than her welfare check when she graduates from the program. Her health insurance benefits will be transferred from State support to employer support automatically under the national health assurance program.

Tina did not like being told what she had to do, and was initially reluctant to participate because of unpleasant memories of school. She recognized, however, it was her only choice for a better future. When her girlfriend Dolores showed her the PLDs and other learning tools that participants can check out of the center's library and bragged about how much English she learned in her 6 months at the center, Tina signed up.

River School, the location of the family program, is a center for community life. It houses an elementary school, an after-school program, an infant care and early learning center for children from 6 months, and English as a second language (ESL) literacy classes based around parenting support and job preparation. The building also contains a medical clinic, a mental health center, a buying cooperative, and a Food Stamp outlet. Videoconferencing booths at the school give local residents access to case workers at the county office for other social services not available onsite.

Tina's reception at the River Family Literacy Program is warm and respectful. The director of the program, Elena Martinez, shows great sensitivity in serving this multicultural community. Computer-scheduled minibuses are on call to take participants to and from the River School at all hours.

Tina participates in the program 5 days a week. After getting Maria settled in the early childhood center and Jimmy in kindergarten, Maria goes down the hall to her ESL parenting support group. After the children and Tina have lunch together, she goes to the job training center, where ESL instruction is integrated with all the materials.

Tina and other family literacy participants spend several hours each morning working alone or in small groups, using the multimedia library of parenting materials. Tina is working with simulations helping her understand and handle common childhood conditions, such as tantrums and bed-wetting. Although the material is presented in English, at any point the user can click to an audio assist in Spanish, Creole, Cantonese, or Vietnamese. Materials are presented in stages of reading difficulty geared to the user's responses to questions that routinely check on comprehension. If the user answers these correctly in a certain amount of time, the material gradually increases the vocabulary and difficulty of material. These embedded tests are so low key that Tina moves through them without any of the anxiety she used to associate with testing in school. Since the tutorials are private, each participant is moving at her own pace, but progress is automatically recorded on the system. Tina enjoys this activity, particularly since she can choose the content she wants to study from a huge topic menu. When she asks Elena about how to deal with Maria's tendency to bite her brother when he pushes her around, Elena added a segment on dealing with aggressiveness in children at that age. Tina particularly enjoys the small group discussion sessions held after each of these private tutorials; this is when she can discuss her approach to these issues with the other women and clarify points she found difficult. A trained

literacy tutor acts as a facilitator in these group learning sessions.

"Aggressive," "discipline," "appropriate," and ''sense of humor' Tina adds these words to the electronic pocket translator she checks out of the library each week. Her friend Dolores has bought her own, but Tina has been unable to put aside the money to buy one, and cannot unless she collects enough attendance and improvement credits to qualify for the "top students' discount. " The device has a vocabulary of 25,000 commonly used words. With this device, Tina can speak a word (in English or Spanish) into the built-in microphone, see the word in English or Spanish translation on a small screen, and hear the translated word spoken, defined, and used in a sentence. Since it can be customized by adding vocabulary, Tina, Jimmy, and even Maria add words they are learning together, and play word games with it on the bus to and from the center. Tina now knows the secret of Dolores' English success.

Tina goes to the after-school center to work with the children two afternoons each week. One of her favorite activities is creating slide shows and videos with the children. The center has a full supply of minicameras that the children use for videowriting, and plug-in units for editing and adding sound effects and graphics. Tina works with the children to help them appreciate how carefully they must plan and edit their materials to create the best stories. In one project, Tina works with Jimmy, several of his friends, and some ***6th*** graders from the school and their teacher to create a history of Central American children's games. They record interviews with community residents of all ages and videotape them demonstrating the games they know. Students also graphically illustrate the games step-by-step. The 6th-grade students research the African, European, and Indian origins of the games. The grateful teacher lends Tina her own notebook multimedia sketchpad so she can work on the games project at home. The project becomes a rich family learning experience as Tina and her children talk about it and work together on it after school. After her children go to bed, Tina spends time writing storyboards, sketching graphics, and trying out various animations. She previews supplemental video segments downloaded from the cable station. The county librarian is so impressed with the final product that he requests permission to make copies to place in the library. It is the first real school-related success Tina has ever experienced.

Tina soon has enough English skills to move into the next phase of the program: job search. Although job opportunities in town are limited, the River Family Literacy Program has a' service information kiosk' that Tina has used for information about finalizing her divorce, changing her name back, and other legal concerns. The kiosk also maintains a database of job openings, salary levels, and requirements for positions offered by public and private employers in specified geographic areas in the region. Although Tina first thought she would like to work at the River Family Center, openings there are scarce, so she has been checking the kiosk database on a regular basis. The relatively high pay and opportunity to work outdoors attract Tina to highway construction. Her job counselor sets up a videoconference with women who are already working in this male-dominated vocation so Tina can learn firsthand about working conditions.

Tina learns that to advance in the field, she will need to read technical manuals, operate computers that control the latest road construction equipment, and make decisions that require an understanding of geometry and geology. She signs up for job training to prepare her for highway construction. Several of the courses she needs are not available at the center, but Tina enrolls in a geometry class at the community college. She takes the course via satellite at River School, because she cannot rely on her car to make the 100-mile round-trip to the college twice a week. She downloads mathematics software onto her loaner PLD to help her prepare for the examination.

Through her ESL, parenting, job preparation, and mathematics courses, Tina eventually gains enough credits to earn a high school degree after 2 years. She could have taken the GED sooner to shorten the process, but the concept of a formal examination scared her off. She begins to work for a highway construction contractor. With support from the family literacy program staff, she and her children have tried to prepare for the extended absences her job requires. Her friend Dolores cares for Maria and Jimmy while Tina is away from home, with support from the center should any crises arise. While she is on the road, Tina visits with her children through the videophone at the center and a videophone at her construction office.

After 5 years, Tina has made steady progress on her job and is the first woman in her company to supervise a road construction crew. She has bought her own electronic pocket translator, to which she has added her specialized construction-related vocabulary. She keeps up with the center's parenting classes through a videophone linkup to the computer at work. Tina continues to monitor the children's homework when she is at home and by electronic means when she is on the road. She has also been browsing through several online college catalogs; she and the children have a bet going on who will be the first one to get a degree in engineering.

QUESTIONS RAISED BY THE SCENARIOS: HOW TO CREATE A FUTURE FOR LITERACY

These scenarios show how people, institutions, programs, and technology could come together to increase adult learners' options for learning. They look ahead to the year 2000, and offer an optimistic vision. The challenge lies in turning these visions of the future into a reality for the millions of Americans with limited literacy skills. This view of the future includes several key elements:

- Providing new options for those who wish to participate in literacy programs but are overwhelmed by barriers such as transportation, childcare, and competing demands on their time;
- Motivating people to enter programs, and providing successful learning experiences to help them persevere until they have reached their literacy goals; and
- Offering affordable, flexible technology tools to help people pursue learning in classes or on their own.

The scenarios assume continuing advances in hardware, software, and networking capabilities, along with public commitment and financial support to guarantee access to these resources for those who need them most.

Hardware Advances

The scenarios assume that current trends in telecommunications and hardware development will produce an array of important capabilities. They include:

- more and cheaper computing power;
- integrated video, sound, text, and graphics on the same display;
- smaller, portable hardware;
- higher resolution screens;
- variety in input devices;
- embedded intelligence;
- greater channel capacity for television; and
- interactivity between computers, telephones, and other hardware.

As computing power continues to expand, new capabilities will become increasingly affordable. These hardware advances will take many forms and offer capabilities beyond today's realities. For example, the ability to deliver, process, or display video, text, graphics, and audio from a single box is reducing the number of components needed for multimedia. Additionally, the ability to use natural speech for input and control of

Box 8-A—Computers That Speak, Computers That Listen: Speech Production and Speech Recognition Technologies

There are two forms of speech-related activity on computers: speech production and speech recognition. Speech production has been available for a number of years, and uses either speech synthesis or digitized speech. Speech synthesis is computer-created speech based on a set of algorithms that provide rules for translating letters to sounds, using the 44 basic sounds (phonemes) on which most English words are built, along with rules for considering grammar and context when words are not phonetic. An alternative form of speech output is digitized speech, produced by translating the analog sound waves of human speech into digitized bits of information. Digitized speech is more memory-intensive but more natural sounding than synthesized speech.

As computer chips increase in power and decline in cost, the number of applications using speech is growing and speech output has become a valuable learning aid in educational software. If the learner does not understand a word or phrase, the option of actually hearing it spoken may make it possible to understand the material; the addition of headphones makes this assistance entirely private. The combination of spoken and written cues is particularly important to adults with limited reading skills. It is also valuable for English as a second language or foreign language instruction by reinforcing written and oral language skills at the same time.

Speech recognition, the ability of a computer to respond to spoken language, is a much more complicated process. Speech recognition is categorized by whether it can accommodate a range of speakers and how precisely words must be spoken. A computer that can understand many voices is called speaker independent; these systems are designed to understand certain phrases or numbers as spoken by a range of users. For example, a system is being designed in which policemen will be able to read a car's registration number into a radio, which connects to a computer that listens to the number and checks a database to see whether or not the car has been stolen.[1] If a computer responds only to particular voices, it is known as speaker dependent. Speaker-dependent systems must be "trained" to understand the pronunciation, inflection, and rhythms of a user's voice. These systems provide some measure of security, as the computer, like a trained dog, responds only to its master's voice. Currently, a computer requires about 30 minutes or more of training to be able to respond to a user.

Discrete-word speech recognition systems require clearly enunciated words with a distinct pause between each word. Continuous recognition systems enable the user to string words together naturally. Most speech recognition systems in use today are discrete-word, speaker-independent systems with limited vocabularies. Currently, there is no true continuous speech system commercially available; when users leave less than a 0.10-second pause between utterances, some words are skipped.

In the first step of the speech recognition process, words spoken into a computer microphone are digitized. The computer analyzes the pattern of the data in millisecond chunks, by comparing it to stored patterns of words represented phonetically and by applying a set of grammatical rules and contextual clues. The computer makes the best match possible, guessing where the sounds should be divided into words and choosing specific words. For example, the spoken sounds, "aieewahntoduhpahszeht" (phonetically) could be matched to several word

[1] "Answer Me," *The Economist*, July 25, 1992, p. 7.

computers is a particularly promising development[2] (see box 8-A). Computers, regardless of manufacturer, will be able to share data more easily in the future. Improvements in digital transmission and advances in compression technology will increase channel capacity. The number of captioned television programs will be much greater, because of the standard for closed captioning on all televisions manufactured after 1993. Displays with high resolution will increase text readability and reduce eye fatigue, making applications such as computer-based books more attractive. New switching techniques will make television more like telephones and both of them

[2] Robert E. Calem, "Corning Soon: The PC With Ears,' *The New York Times,* Aug. *30, 1992, sec. 3,* p. *9;* and "Answer Me," *The Economist,* July 25, 1992, pp. 79-80.

combinations including ''eye went toad a posse it'' or ''Aye one toe dub a set,'' but considering grammar and context are displayed as, ''I want to deposit.''[2] Accuracy depends largely on the quality of the comparison database for matching input sounds and the effectiveness of the comparison rules.

Irregularities in the English language, regional accents, colloquial expressions, background noises, and other problems are challenges to the development of speech recognition. Furthermore, developers must take into account the amount of time users are willing to devote to pretraining and the error rate users are willing to tolerate. Many speech recognition developers do not think this technology will gain mass acceptance until it is continuous, speaker independent, self-training, at least 90 percent accurate, has real-time speed (about 135 words per minute), the ability connect to a variety of communications devices, and is priced for the consumer as well as business market. Nevertheless, speech recognition technologies are advancing rapidly, due to research efforts conducted by major hardware, software, and telecommunications companies. Ameritech recently unveiled a ''Voice Controlled Work Station'' that has a 30,000-word dictionary and enables a user to dictate correspondence at 45 to 55 words per minute, read electronic mail, access library databases, and even dial and answer the telephone.[3] The system represents the integrating of a series of technologies developed by a number of companies, including Dragon Dictate. Dragon's system, compatible with most off-the-shelf MS-Dos PC-based applications, is bridging the gap between speaker-dependent and independent systems.[4] Apple Computer plans to release its ''Casper'' advanced speech recognition command and control technology as an option for Macintosh computers by the end of 1993.

The ability to give spoken commands to a computer, or to enter the first draft of a document orally, could be very useful in a multitude of contexts. Speech recognition applications in the workplace today include postal workers sorting mail, brokers on Wall Street barking rapid trading commands into computers, doctors entering patient information, and radiologists scanning x-rays as they read the results into computers. Schools and employers will be able to accommodate the computing needs of physically challenged adults and children and comply with the requirements of the Americans with Disabilities Act. Systems are now being tested with dyslexic children who ''talk their ideas down'' as a way of overcoming their inability to express thoughts in written form.[5] Adults with limited keyboarding and reading skills may find speaking into a computer makes the prospect of writing significantly less daunting and more rewarding. Furthermore, with a keyboard no longer a necessity, computers can be much smaller, making portability a viable feature, with all the benefits of ''go anywhere, use anytime'' computing.

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2 Robert E. Calem, "c-s- The PC With Ears," *The New York Times*, Aug. 30, 1992, sec. 3, p. 9.

3 The basic system requires a *386* MS-DOS computer, *8* meg of RAM, voice platform, a microphone, and a standard modem. The upgraded 12-meg version, packaged with a mouse and Lotus and WordPerfect software, currently sells for approximately $5,000, with distribution rights given to the Central Indiana Easter Seals Society. Dorsey Ruley, Ameritech Information Services, Chicago, IL, personal communication, April 1993.

4 Keith Wetzel, ''Speaking to Read and Write: A Report on the Status of Speech Recognition,'' *The Computing Teacher*, vol. 19, No. 1, August/September 1991, p. 9.

5 Ruley, op. cit., footnote 3.

more like computers, making vast amounts of video, text, and data available instantly to homes and businesses.

All of these trends ***could*** promote greater opportunities for adult learning. It is reasonable to expect that, in the next 5 years, machines with the power of today's high-end personal computers could be sold for prices similar to today's televisions, making them more affordable to literacy providers.[3] Miniaturization of hardware

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[3] The horizon of computing power continues to move forward, however, and today's high-end computing power is unlikely to meet tomorrow's expectations. Nonetheless, the computer industry's product evolution and marketing strategies have kept the price of personal computers fairly level from year to year. For example, computers that sold in 1987 for about $1,000 (e.g., IEM PCjr. and Apple IIC) to $2,500 (IBM MS-DOS 286 and Apple Macintosh) have been replaced by a new generation of vastly more powerful compute-till in the $1,000 to ***$2,500*** price range.

Ameritech Information Services

Advancements in speech recognition technologies allow users to operate a computer and input data by speaking into a microphone. In addition to the importance of this resource for persons with disabilities, speech recognition will make computers easier to use for a range of applications.

components will permit powerful uses of learning technologies in sizes that vary from desktop to notebook to pocket or pocketbook sized. High-resolution screen displays will be flatter. Storage devices will be more compact. As the range of possible sizes increases, the technology will become more flexible and small, portable equipment will expand opportunities for literacy education anytime or anyplace (on the bus, during work breaks, or waiting in a doctor's office) and in places where space is limited, such as in crowded working and living quarters. A researcher notes:

> Ubiquitous computers will also come indifferent sizes, each suited to a particular task. My colleagues and I have built what we call tabs, pads and boards: Inch-scale machines that approximate active Post-it notes, foot-scale ones that behave something like a sheet of paper (or a book or a magazine) and yard-scale displays that are the equivalent of a blackboard or bulletin board.[4]

Speech recognition technology could help people express complex ideas more capably than they can read or write. When commands or information can be entered by speaking into a computer, the learner can focus on content and not be distracted or intimidated by the technicalities of operating a computer. Speech recognition technology could also help boost English proficiency in daily tasks. Speaking into a pocket translator for assistance with unknown or difficult words could facilitate communication in real-life situations when learners might find themselves at a loss for words.

It will be important to assure interconnectivity between various kinds of hardware. Literacy practitioners will need to participate in standard-setting, in order to guarantee that features appropriate for education and adult literacy are assured (see box 8-B).

AT&T

Small but powerful and easy to use, portable computers like this could make it possible for learners to study anywhere, anytime.

[4] Mark Weiser, "The Computer for the 21st Century," Scientific *American*, September 1991, p. 98. The author is head of the Computer science Laboratory at the Xerox Palo Alto Research Center.

Box 8-B-Understanding How Standards Are Set

Three types of standards affect the development of computer, video, and communications technologies.[1] *Product standards* establish product quality, reliability, and compatibility. *Process standards* determine how technologies operate when they are interconnected and set procedures for acceptable, smooth, and consistent operation. *Control standards* relate to how a technology affects health and safety, rights of privacy and free speech, and similar issues of public interest. Standards are important because they can: 1) drive product costs up or down, 2) facilitate or hinder technological advances, and 3) contribute to or obstruct ease of use for teachers and learners.

There is considerable variation in the way technology standards are set. They can be established, *de facto*, by market forces; i.e., developers sell products with different standards and wait for one dominant standard to emerge. In videocassette recorder development, for example, Sony developed the Beta standard and Panasonic developed the VHS standard. The market eventually settled on VHS, the standard that currently prevails industrywide. Some standards are set by governmental action. For example, in 1991, new legislation required closed-captioning circuitry on all new televisions produced in the United States after 1993. This law created a new standard for television. Finally, standards can be established through a voluntary consensus-building process where key technology manufacturers come together and negotiate standards. For example, Sony and Phillips, the two largest and original developers of compact disc technology, negotiated one standard, called the "High Sierra Standards," after the place where they hammered out the details of the agreement.

When market forces work well, a standard emerges at an "optimal" time in the development of a new technology. The standard evolves from the give and take between producer-driven supply factors such as production costs, market share, and profitability, and consumer-driven demand factors such as quality, utility, and affordability.

When the market does not work well, standards can be set too early or late. If standards are set prematurely, the pace of technological advancement can be slowed and improvements in product capabilities, ease of use, and product quality can be retarded. The "qwerty" typewriter key layout is an example of premature standard setting.[2] Conversely, when standards are set too late, consumers suffer from lack of connectivity or correspondence between similar products. For example, a community college with a mix of faculty-selected desktop computers of various types will experience greater costs and technical difficulties when attempting to install a collegewide computing network than if it had set a common computing standard early in the hardware selection process.

Setting optimal standards can be hindered by a number of factors. The size of the installed base of an early standard can restrain market forces from developing a better standard. Lack of consumer information can also prevent market forces from setting a good standard. The government can set standards that are not optimal if heavily influenced by a particular special interest.

Adult learners and educators could benefit from participating in standard-setting processes. By keeping abreast of emerging technical standards, they may be able to influence the content of those standards. Opportunities for adult learners and educators to participate in *de facto* standard setting are likely to remain limited, however. For, example, markets for computer-based technologies have operated efficiently and profitably while ignoring the lowest end consumers. By the time adult learners and educators enter the market, standards are unlikely to be malleable. However, better and more complete information about the options and features of new technologies and discussion of their advantages and disadvantages would enable early adopting users to contribute to the standard-setting process by purchasing products wisely. Additionally, standards for technologies that require startup with a relatively large installed base, for example, computer networks and telecommunications, often involve voluntary standard setting and offer greater opportunity for participation by adult learners and educators.

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[1] U.S. Congress, Office of Technology Assessment, *Global Standards: Building Blocks for the Future*, OTA-TCT-512 (Washington, DC: Us. Goverment Printing Office, March 1992), pp. 5-6.

[2] The "qwerty" layout of the keyboard was established to *prevent* jamming on Charles Latham Sholes' early typewriter. If a standard for key placement had not been adopted until the keys could be placed in any arrangement without jamming, today's keyboard could be easier to learn and faster to use. Donald A. Norman, The *Design of Everyday Things (New* York, *NY:* Doubleday, 1990), pp. 145-1S1.

Networking Advances

Telecomrnunications networks play an important role in all of the scenarios: learners, teachers, and other classmates were able to converse or send text, graphics, or video to each other, and access online databases. Location was no longer a barrier. Books without pages could be sent from libraries without walls;[5] curriculum was distributed from classrooms without doors.

As telecommunications networking grows, it will expand opportunities to reach workers and families by providing:

- greater convenience to learners;
- new ways for teachers to serve larger numbers of learners;
- a broader range of courses and learning modules;
- expanded access to information, expertise, and learning resources;
- more resources for informal, interactive learning; and
- informational resources to meet social, health, and housing needs.

The scenarios assume the availability of some mix of coaxial cable, Integrated Service Digital Network (ISDN), fiber, and satellite transmissions to homes, businesses, schools, and community centers. High-speed, two-way communications for text, graphics, video, and voice in the home could provide the most complete range of instructional options and accommodate a wide range of learning styles, but will require greater broadband capacity than available in most homes today. Fiber optic cable, with its bandwidth capacity far in excess of copper wire or cable, has always been considered the key to more rapid two-way transmission of voice, data, and video.[6] While the expansion of high-bandwidth fiber optic cable has been dramatic, the majority of the new fiber deployment has been for long-distance carriers.

It has been thought until recently that a full range of interactive multimedia networking capabilities would not be available until fiber optic cable could be brought the ''last mile" from the local provider (cable or telephone company) to the home, a task anticipated to cost from $200 to $400 billion and possibly taking as long as 20 years.[7] However, recent research breakthroughs by both cable and telephone companies have created alternative solutions to carry information beyond the bottlenecks of existing systems. With cable, the breakthrough came with appreciation that, for short distances, coaxial cable has almost as much bandwidth as fiber. Using a combination of fiber for the main lines, and no more than one-quarter mile of coaxial wire for the delivery to the home, two-way interactivity over existing cable systems may indeed be practical and affordable. Similarly, research conducted by the telephone companies, using Asymmetric Digital Subscriber Line (ADSL) technology, stretches copper wire to its outer limit, also extending the capabilities of existing networks.

Also important to the fulfillment of this vision of a networked information system are continuing advances in switching or routing. It is switching that "makes the connection" between the user and the information service, data, or product.[8] Efficient high-speed switching is required to move digitized information (a phone call, movie, newscast, teleconference, book, catalog order, financial transaction, video game, software program, medical report, travel order, or any other information product or service) from any one of millions of points on a network to another.

Continuing research is necessary to enhance and expand these and other promising telecom-

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5 See John Browning, "Libraries Without Walls for Books Without Pages," *Wired,* premiere issue, January 1993, pp. 62-65, 110.

6 Olson et al., op. cit., footnote 1, PP. 19-~"

7 Philip Elmer-Dewitt, ''Electronic Superhighway," *Time Magazine,* Apr. 12, 1993, p. 54.

8 Olson et al., op. cit., footnote 1, p. 25.

munications capabilities. Ultimately, the availability of these technologies will be determined by the high capital outlays required to upgrade and expand the overall national communications infrastructure.[9]

Software Advances

No matter how fast, how small, how interconnected the technology, without high-quality courseware-computer software, video, and printed materials-technology will not be used effectively for learning. The scenarios suggest courseware applications that personalize content, heighten the appeal of learning, and help learners monitor their own progress to increase the rate and quality of learning.

Anecdotal evidence suggests that some learners will approach new technologies timidly (see chapter 3). As computer-based technologies become more ''user-friendly, '' like televisions, radios, and telephones, they will be less intimidating. The easier the technologies are to use, the more likely it is that adult learners will accept them. The design of software and person-computer interfaces plays an important role in making computers user-friendly. Such features as consistency across applications, the use of 'windows' to display more than one piece of information at a time, and icons (e.g., a picture of a trash can to represent the concept of deleting material the user has been working on but does not want to save; a picture of a magnifying glass to represent the concept "find out more about") have already made technology easier to use. High-resolution graphics, sound, and video also make information more engaging and understandable. Multiple ways of interacting with the computer (e.g., handwriting and voice input, in addition to today's touch screens, keyboards, and mouse) will improve user-friendliness. Collaborative work spaces are being designed to make it easier for groups of people to create a document, implement a project, or solve a problem in shared computer spaces. 10 Programming and editing tools are making it easier and less expensive for adult educators and learners to create or customize their own multimedia courseware, enhancing the connection between meaningful context and learning.11

Residents in Cerritos, California, can pay bills, get stock quotes, make airline reservations, take SAT preparation courses, or find out about municipal services on Main Street, *an interactive information video service that uses a combination of the telephone network and a local cable channel'.*

Finally, new knowledge about cognitive processes in general, and adult learning in particular, can lead to better educational applications. As instructional theory and design evolve over the

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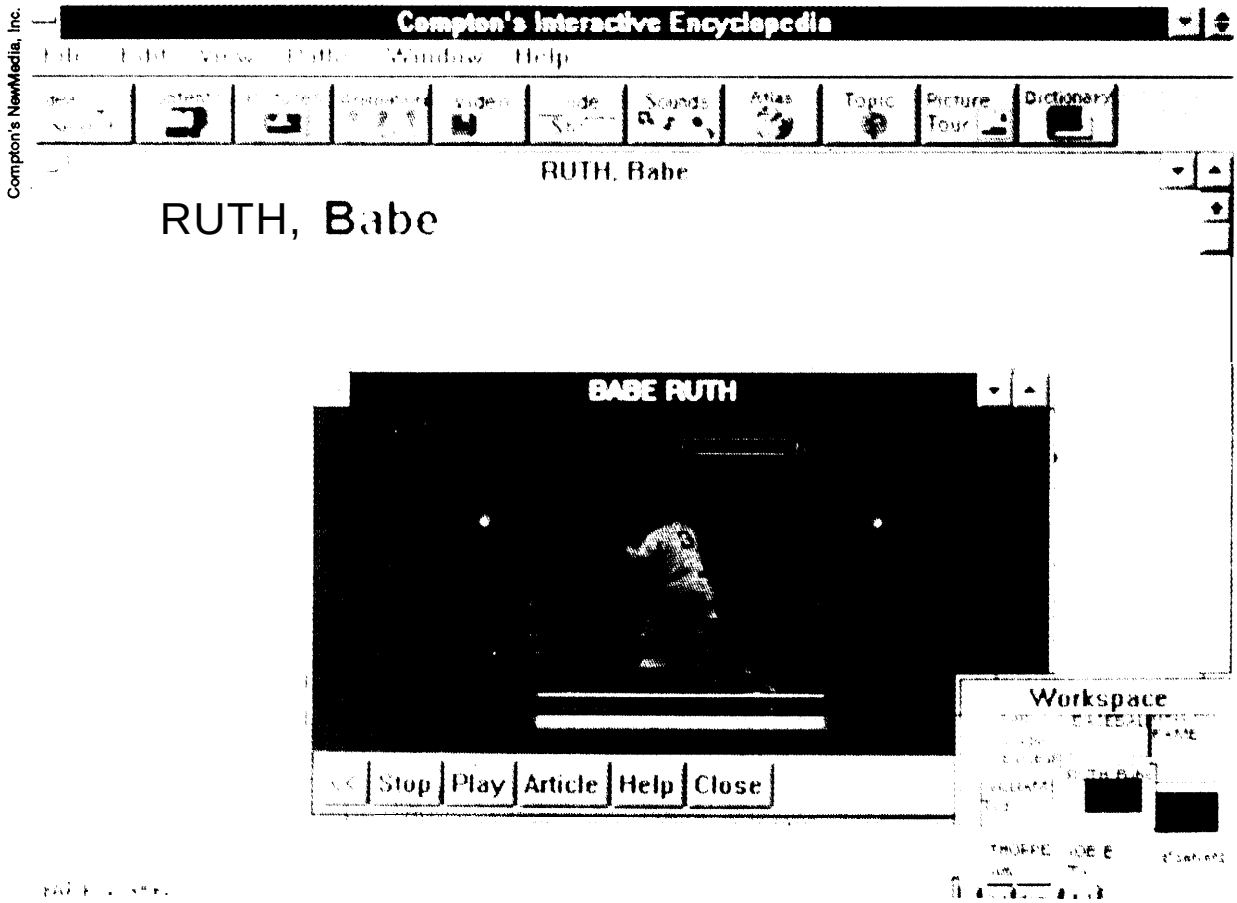
9 See U.S. Congress, Office of Technology Assessment, "Advanced Networking Technologies, " background paper, draft, April 1993.

10 See Denis Newman, ''Technology as Support for School Structure and School Restructuring," *Phi Delta Kappan,* vol. 74, No. 4, December 1992, pp. 308-3 15; Olsen et al., op. cit., footnote 1; and Bernajean Porter, "Aspects: Creative Word Processing in the Classroom,' *The Writing Notebook, vol. 9, No. 4,* April/May 1992, pp. 14-15; and Marlene Scardamalia et al., ''Educational Applications of a Networked Communal Database," *Interactive Learning Environments,* vol. *2, No.* 1, 1992, pp. 45-71.

11 David L. Wilson, ''Computer Programs Without Programmers, " *The Chronicle of Higher Education,* vol. *38, No. 37,* May 20, *1992,* pp. A15-16.



Good software is crucial for effective learning with computers. Material must be engaging and related to learners' ***needs and interests.***

next decade, instruction in basic skills and applications that require higher order thinking skills will become more fully integrated into functional contexts. Flexible applications and learner-designed materials can empower adults and reward them for independent study, while better diagnostic tools, improved tutorials, and automated "checkups" and recordkeeping can help learners manage their own instruction and know when to seek extra assistance.

The expansion of broadcast and cable television programmingg also provides greater resources for adult literacy. Within the next 5 to 10 years, compressed digital video technology will make it possible to carry at least eight broadcast-quality signals on a channel that today carries just one. Given these improvements in technology, cable channel capacity is expected to increase to at least 500 channels; PBS plans to increase its capacity correspondingly. What will people watch on all these channels? One possible future suggests high-quality literacy programming targeted for various groups of adults (e.g., senior citizens, rural farmers, or parents of teenagers), similar to the programming for young children now offered many hours a day.

One area of special concern to the development and use of literacy courseware is clarification of copyright issues (see box 8-C).

Issues of Access and Equity

These technology advances can provide resources that go beyond what is available today. However, unless those who need them most—people like Carla, Dave, Tina, and their families—have convenient, timely, and affordable access to them, the futures projected in the scenarios will not occur. In fact, these learners and millions like them may become further disadvantaged if they do not have access to these resources.

People learn best when they have frequent and regular opportunities to practice new knowledge.[12] As the scenarios illustrate, it is more convenient and easier to practice when technology is available at home. Yet those who most need literacy assistance are those with the most limited incomes, and thus least likely to have access to these empowering technologies.

To analyze the access barriers to future technology, it is useful to look at current patterns of access to the backbones of future learning technologies: the personal computer, telephone, and television. Access is affected by income, race, and ethnicity.[13] Many more adults have access to telephones in their homes than to home computers, but television is currently the most widely distributed technology (see chapter 7, figure 7-l). Despite high purchase prices, the widespread availability of television and, more recently, telephones provide models for greater computer access. Unlike computers, televisions and telephones are sold in a variety of stores, in urban areas and small rural towns. Televisions can be rented, mail-ordered, or purchased new or used. Future learning technologies could become as available as today's television and telephone if they, too, were sold, rented, and leased to learners at reasonable cost, on installment plans or through other financing schemes, through workplaces, community-based organizations, schools, and postsecondary institutions.

LVA-Huntington Valley, Inc.

***Adults** learn best when they can practice new skills repeatedly. It is critical that those most in need of adult literacy services have easy access to technologies for learning,*

In the scenarios, the pocket translator is art example of limited purpose, specialized equipment that could be developed at prices most learners could afford or that businesses could make available to their workers. Similarly, PLDs could be priced at a cost affordable to most workers and families, or provided by the workplace and family literacy programs, According to current projections, equipment with capabilities similar to those described for the PLD will cost about $500 in 1997, if purchased in bulk.[14] Even at that cost, some learners like Tina may be unable to afford these tools unless some subsidy is provided.

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12 See, for example, David Twitchell (cd.), "Robert Gagne and M. David Merrill in Conversation: The Cognitive Psychological Basis for Instructional Design," *Educational Technology,* vol. 30, No. 12, December 1990, pp. 3545; and Robert Gagne et al., *Principles of Instructional Design,* 3rd ed. (New York, NY: Holt Rinehart and Winston, 1988).

13 For example, among African-American and Hispanic households with incomes at minimum wage level, about 20 and 25 percent, respectively, do not have home telephones, compared with an overall rate of *93* percent. Federal Communications Commission, "Tklephone SubscriberShip in the U.S.," unpublished document, February 1992.

14 Gruy Simons, Summer Institute of Linguistics, "Hardware Projections for Project '95 Target Machine, " unpublished paper, 1992; and Marsh and Vanston, op. cit., footnote 1, pp. 63-77.

Box 8-C—Copyright Issues: How They Affect the Development and Use of Literacy Courseware

Copyright law grants authors and other copyright holders the right to control the reproduction, distribution, performance, display, and derivative use of their creations. Copyright law applies to specific types of intellectual property, including literary, dramatic, musical, and artistic works.[1] Emerging technologies are producing new forms of intellectual property, such as electronic databases and multimedia courseware, as well as new means of reproducing them or making derivative works by "downloading" or "sampling." New technologies also create new means of potentially infringing copyright, thus exacerbating tensions between the interests of the producers and users of intellectual property.

Copyright questions have traditionally been resolved through a combination of legislation, negotiation, licensing, and litigation. There is often uncertainty about the scope of copyright in software and multimedia applications, and how permission and licensing will be handled for multimedia works. Litigation to resolve these questions could take years, and legislation even longer. Licenses usually specify what types of users and uses (including any modifications) are permitted. License negotiations can be time-consuming, especially when several sets of copyright holders are involved. These lengthy, often costly, processes could limit access to adult literacy courseware by making startup development too risky for small companies, by increasing product prices and licensing fees, and by limiting creative use of courseware by teachers and learners.

Experiences with multimedia provide examples of how copyright issues can complicate the development of educational courseware. Systematic procedures for granting permission to use copyrighted material for multimedia have yet to be established by most institutions and individuals and there are few established "standard" terms and fees for licensing materials for use in multimedia works.[2] In order to include copyrighted film or music, courseware developers must negotiate fees and the conditions under which the material can be used. Film rights generally must be negotiated with individual copyright holders. Music performance rights are

[1] For further information about copyright and technological change see U.S. Congress, Office of Technology Assessment, *Finding a Balance: Computer Software, Intellectual Property, and the Challenge of Technological Change*, OTA-TCT-527 (Washington DC: U.S. Government Printing Office, May, 1992). See also 17 USC 101 *et seq.* (1988). U.S. copyright law treats computer software as a literary work.

[2] For example, fee structures for music rights are geared to use of the entire song or composition, not use of small pieces of dozens or hundreds of songs. See Office of Technology Assessment, op. cit., footnote 1, pp. 172-73. Early in the development of multimedia, demands for exclusivity or rights in perpetuity strained relations between intellectual property rights holders and software developers. See "Turning Up the Heat on Titles," *Digital Media*, vol. 2, No. 5, Oct. 12, 1992, pp. 5-6.

The rapid pace of development in computer, video, and telecommunications hardware and software typically has been stimulated by profitable markets in business, entertainment, or consumer products. Most hardware is created with these other markets in mind and later adapted for educational applications; eventually, education (K-12 as well as adult literacy) has been able to benefit from these advances in technological power and flexibility. However, some analysts suggest that, to assure that important social goals are not ignored, it is necessary to stimulate the market to assure innovations focused specifically on improving learning.

Although some computer companies that began with education as their primary activity are thriving, as are some educational software companies, serving adult learners in particular requires extra efforts in development and marketing.[15] There is no zip code promoters can target, and developers do not consider those most in need of literacy assistance an appealing market. Yet,

15 Education TURNKEY Systems, Inc. and Wujcik and Associates, "The Educational Software Marketplace and Adult Literacy Niches," OTA contractor report, April 1992.

generally negotiated with organizations such as the American Society of Composers, Authors, and Publishers (ASCAP), Broadcast Music, Inc. (BMI), and other rights holders such as individual record companies. Thus, development of one courseware package can require a large number of separate negotiations. A lower cost alternative is a "stock house" that collects film and music from public-domain sources or independent artists and packages them to sell to users for a flat fee. However, stock houses usually do not have access to identifiable work by well-known stars that have instant popular appeal.

Many small courseware development companies are finding the complex, costly copyright permissions and licensing processes a barrier to entering the multimedia market. Obtaining permission to use copyrighted material is difficult for even the largest developers. For example, for Microsoft's *Encarta*, a multimedia encyclopedia costing several million dollars to develop, five people were hired solely to handle rights acquisitions.[3] Funds spent in copyright acquisition leave less money for developing creative, new approaches to learning. Also, when vendors spend hundreds of thousands of dollars or more to develop a product, they may be tempted to recoup their investment by marketing the courseware aggressively, regardless of its educational effectiveness.

Copyright issues cause difficulties for users as well as developers. Literacy programs and learners are often confused about how "fair use"[4] principles, in particular, and copyright law, in general, apply to emerging technologies. For example, when is it proper to reproduce multimedia material? How much can be reproduced and how long can it be kept? Under what circumstances can teachers share materials with other classes or other centers? Under what conditions can adults borrow materials to take home? How does copyright protection apply to student-created materials that incorporate commercial media clips or electronic database material?

These confusions will only be exacerbated if copyright provisions and informal (negotiated) guidelines change frequently, or, as at present, different provisions continue to apply within and between text, video, and music sources.[5] Adult literacy programs typically do not have access to detailed, timely information about copyright provisions and what practices constitute infringement. Consequently, if vendors believe that adult literacy teachers and volunteers are likely to infringe copyrights, whether intentionally or inadvertently, they may raise their prices to compensate for what they believe to be lost sales. In the worst case, they could discontinue their participation in the adult literacy courseware market together.

[3] "Setting a New Precedent, Microsoft Spends $5 Million to Make New Encyclopedia Designed 'For the Computer,' " *Digital Media*, vol. 2, No. 5, Oct. 12, 1992, p. 10.

[4] "Fair use" refers to a set of statutory and nonstatutory guidelines that govern ways in which copyrighted material can be used for education or in other not-for-profit circumstances. See 17 USC 107 (1988).

[5] See ch. 5 in Office of Technology Assessment, op. cit., footnote 1, for further discussion and ch. 1, pp. 35-36, for potential ways of ameliorating these difficulties.

the number of potential consumers of adult literacy products is large and growing, whether diffused as individual learners or aggregated as members of preexisting groups such as job training or welfare programs.

Similarly, information and telecommunications applications are also driven by the needs of their markets. Where the information is of value to the society as a whole-e.g., access to timely information regarding education, training, health, political participation, and efficient access to government services-user payments alone may not be enough to support information dissemination. Thus, some have suggested that "universal service' should include not just the technology of communication but also a body of information, access to which should be guaranteed for everyone, providing an "information safety net" to all.[16]

The power of networked telecommunications, and the policy of universal access, are significant:

[16] Francis D. Fisher, "What the Coming Telecommunications Infrastructure Could Mean to Our Family," *The Aspen Institute Quarterly*, vol. 5, No. 1, winter 1993, pp. 135, 138.

> For meeting the widely disparate information needs of a large and heterogeneous population, the switching capability of a network is its single most important characteristic. . . . Once we are switched and connected to an information source, interactivity provides the means to further refine our choice of information. . . . Universal access implies overcoming not only the boundaries of poverty but geographical boundaries as well. . . . But offering services to rural users may be worthwhile for society as a whole where alternatives involving travel, ignorance, and economic underdevelopment are expensive.[17]

CONCLUSIONS

Technologies that expand literacy options in the directions suggested in the scenarios will require substantial investment by all segments of society. Businesses will need to commit resources for continuing education and training of personnel as jobs and skills change. Adult learners will be required to contribute the money, time, and effort necessary to learn. The technology industry will have to create hardware, courseware, and networks that serve a wide spectrum of learners. The public sector will need to underwrite the early development of technologies and materials, and test their use in literacy applications.

Motivated adults with appropriate materials learn faster, persevere longer, and retain more of what they learn. Many who are reluctant to enter formal programs could benefit from new models of customized personal instruction, guided by teachers and mentors but facilitated by portable learning technologies. Technologies could imrove motivation by providing immediate feedback and more opportunities to practice learning privately. Technology-based diagnostic aids and instructional management systems could ensure that learning tasks are well matched to learning needs. Finally, adults could learn new skills not even offered when they were in school.

However, access and use of new information technologies are likely to be limited if current trends continue. Although there will be notable exceptions, the quality of most adult literacy courseware is likely to improve slowly. Moreover, many useful learning technologies, such as computers and online databases, are likely to remain too expensive for economically disadvantaged families. This forecast could be altered through Federal policies that encourage the development, access, and use of technologies to expand the quantity and quality of adult literacy options.

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17 ~& pp. 132, 138.