Appendix

Appendix A

Case Studies: Applications of Information Technologies

This appendix presents a series of case studies exploring the applications and uses of technologies in a variety of institutional settings. All were chosen to depict current, state-of-the-art uses within institutions where application has been successful.

The seven studies describing information technology in the public schools were selected to include examples from the Northeast, Midwest, South, West, and Far West regions of the United States—and to include rural, suburban, and urban school settings. In choosing sites to visit, the major criterion was that activities involving technology were already under way and well-established. These cases were also selected to cover a variety of instructional uses of computers; computer literacy, computers as instructional delivery systems (CAI-CMI), and computers as tools for problem-solving.

Three case studies of applications of information technologies in corporate instructional programs are presented to illustrate computer-assisted instruction, computer-managed instruction, computer-based simulation, video disk, and teleconferencing. The studies have been drawn from the airline, high-technology, and tobacco products industries.

Use of information and communication technologies has affected all aspects of library services. With a broad overview of different applications within different types of libraries, there are examples of new and innovative programs that are local, county, statewide, and national in scope.

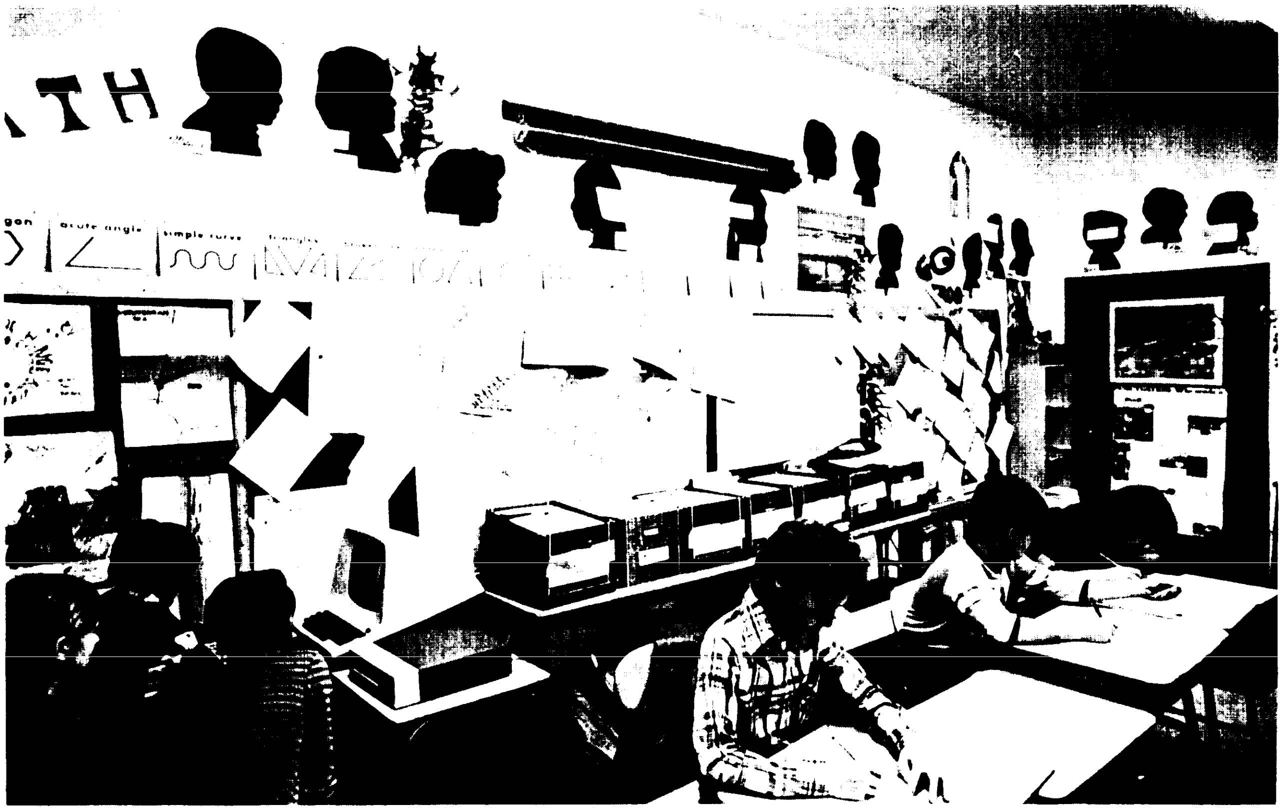
As in libraries, information technology has changed the nature of educational services provided by many museums. Recently, more and more museums have been incorporating information technology, particularly computers, into both their exhibits and their educational programs. A survey of the uses of the technology in museums and a case study on a new childrens' museum in Washington, D. C., are included to demonstrate current programs.

All branches of the military have made substantial investments in research and development (R&D) on applications of information technology to education as well as investments in ongoing programs utilizing these technologies. Descriptions of some of the military's educational programs are included to illustrate the types of programs funded, the range of educational needs found in the military, the uses of information technology to address these needs, and the extent to which these programs may be applicable to the civilian educational sector.

Two other sections–information technology and special education, and information technology in the home—are also included in this appendix. Since special education is a field, not an institution, OTA did not fully explore the uses, impacts, and effects of these technologies in this area. However, because the technologies will considerably affect the schools in general, OTA examined the possible application of these technologies for teaching the gifted and the handicapped. In a similar vein, OTA took a broad overview of educational services that are now available to be delivered directly to and in the home.

Computers in Education: Lexington Public Schools Lexington, Mass.

The Computers in Education program of the Lexington, Mass., public schools was selected for study because the district is considered to be a leader in the application of computer technology, with experience and expertise that spans over 15 years. Located next to Route 128, the home of a thousand high-technology companies, the district typifies a community where parents' technical expertise, leadership, and support have had a significant impact. The Lexington experience illustrates a variety of computing applications, developed by individual teachers with leadership from the district's long-range planner and computer specialist. The program also demonstrates a major planning effort involving teachers, administrators, and parents. This 2-year effort has resulted in a comprehensive blueprint for computers in education that depends on the district's continued ability to handle financial constraints (Proposition 2½) through frugal budgeting, redistributing available funds, and forming new partnerships with the community (town government) and the private sector.



Fifth grade students (at left) at Fiske School, Lexington, Mass., gather about their homeroom's computer console, linked to the Lexington School System's mainframe Digital Equipment Corp. computer, housed at the Lexington High School. The computer is made available to all of the students in the class, much as are books, activity files, maps, records, and educational materials of all nature. Their homeroom teacher assigns students to the keyboard on a rotating basis, giving them assignments which enhance their computer literacy

The Setting

Lexington, one of the suburban towns that surrounds Boston, is located in the heart of the State's booming high-technology area. Many of the Lexington parents and community members are employed by the nearby technology industries in white-collar technical and managerial positions. There has been continual and strong community involvement and support for the schools, with a tradition of community participation in town governance and decisionmaking.

Contrary to trends in other districts, 90 percent of Lexington parents send their school-aged children to the public schools. Assistant Superintendent Geoff Pierson observes that the flight to private schools has not occurred because "there is consensus about what the schools are doing and parents feel that the schools represent their children's interests. "

Lexington is also a relatively homogeneous, affluent, middle-class community. The school-aged population is 95-percent white, 3-percent black, and 2-percent Oriental. Seventy percent of high school graduates go on to a 4-year college. Lexington boasts of having the largest number of merit scholars in the area, in part because there are many "smart kids" in the system, but also because "our program is rigorous and interesting. "

A total of 5,625 students are enrolled in grades K-12 in seven elementary, two junior high, and one high school. Five years ago, the district, accurately projecting serious enrollment declines, planned and prepared for significantly fewer students. Over that period five schools were closed and 150 teaching positions were abolished, while teacher/student ratios were held constant and the number of instructional programs was increased. According to Superintendent John Lawson, declining enrollments, continuing inflation, and the passage of

Proposition 2½, resulted in the allocation of fewer resources to the public sector.

However, Lawson states that the school administration and the school committee have avoided serious problems by planning carefully and spending frugally, "In an era of limited resources we have had to develop better priorities, monitor our successes, and determine where we want to go next. " Not all parents and staff have been happy with the budget decisions and allocation of resources, but they agree that Lexington has fared better than other districts in the State. There is consensus that the over $17 million 1981-82 budget, with a $3,024 per pupil expenditure, supports a comprehensive, high-quality educational program.

Computer Applications in the District

The district's first computer, a Digital Equipment Corp. PDP-8 with 14 terminals, was purchased with Federal funds by the mathematics department in 1965. Math-related computer courses were first offered to high school students, and a year later to junior high school students. As teachers and students became involved, interested parents worked with them to develop software, to expand programing skills, and to train others.

Spearheading all of the computer activities, Walter Koetke, computer coordinator (no longer with the district), encouraged parents and teachers and, according to many, demystified computers. He taught his colleagues BASIC, designed software for the system, and set the foundation for Lexington's computer applications. A math specialist trained by Koetke worked with an advanced group of primary students, transporting these youngsters to a nearby junior high so that they could have once-a-week computer experiences. One of the youngest, a first grader in the group, later became one of the Lexington high school programing stars. By the late 1960's, Lexington led in efforts to bring computer-related experiences to groups of fifth and sixth graders who were transported to junior high schools by their schools' math specialist and by parent volunteers.

In 1975, with leadership from Frank DiGiammarino (director of computer services), Koetke, and others, the district obtained funding from the Massachusetts State Department under title VI, part B to develop a computerized system to deal with the real problems of data management in a local school district. Project LEADS developed software for a wide range of management functions—e.g., budgeting, accounting, scheduling, attendance, and student and personnel data. Project funds also supported the purchase of a DEC PDP 11/40 and peripheral hardware. Shortly, this system was also used to support instructional activities at the secondary schools—primarily in math and science, but also in other areas.

Parents soon began to push for computer use in the elementary schools, locating unused terminals at work, donating personally owned equipment, and helping the schools get the hardware installed. In addition, parents and math specialists trained teachers, Because teacher acceptance and use of computers was minimal, parents took over operation of the terminals and trained additional parent volunteers to enable pupils at all elementary schools to participate, These computer activities continue to build general computer awareness and comfort and to engage students in problem-solving activities, drills, and games. When microcomputers came on the market, the Lexington computer activitists were ready to move.

The first four Commodore PET microcomputers were purchased with discretionary funds in 1978, and a half-time position for a computer specialist was created. A year later, an additional 35 PET's were purchased with Federal Title IVB funds and PTA gifts. At the beginning of the 1978 school year, workshops were offered to reach all teachers to integrate them into instruction. The plan was to diffuse computers among the schools. With a total budget of only $800, a computer specialist (Beth Lewd) was hired to work with each school; community volunteers were enlisted to write software for the PETs or adapt software *from* the PDP 11; and a catalog and materials library was assembled.

In June 1980, it was clear that short-term, unplanned use wasn't working. Rotation of the equipment was modified to concentrate resources in the rooms of interested teachers, and a "models" approach evolved. The wide diffusion of computers was seen to depend on successes in individual classrooms first. Another lesson learned was that the microcomputers had to be available for more than a few weeks (e.g., one semester or all year) to ensure maximum payoff in each classroom.

By 1980, more than 20 models were implemented with a focus on computer literacy and applications in math, spelling, social studies, science, and language arts at all grade levels. In each case, models were developed by individual teachers, a team of teachers, or the entire school staff. In many instances, school principals provided staff support, while central office staff wrote grant proposals to the school board to get additional funds for microcomputers, software, teacher planning time, etc.

To build awareness of computer potential and to obtain support for the ongoing activities, a 2-day leadership conference was held in October 1980. More than 90 district educators attended. Experts from Massachusetts Institute of Technology (MIT), area colleges, regional cooperatives, local school districts, and the private sector made presentations. Teachers from the Lexington district demonstrated hardware and software and structured hands-on experiences. The conference was followed by the formation of computer planning committees.

Workshops and training sessions followed that were intended to provide most of the staff some training, at least at the awareness level. Teacher participation has so far been voluntary. All of the district's library media specialists have had extensive training and, as a result, have initiated several projects: a computerized annotated listing of 16mm films; a materials data base for all nonprint materials in the district; and a computer center/library media pilot. The media specialist's role has expanded in Lexington; in recent budget planning sessions library positions were held constant, partly because of the school committee's commitment to computer activities and because of the plan to focus computer centers around the media center.

Currently, the district's 60 microcomputers, 2 minicomputers, and 33 terminals support the following uses:

Kindergarten - Grade 3
- Reinforcement of number and letter skills
- Computer awareness and independence
- Phonics instruction
- LOGO models
- BASIC for primary grades

Grades 4-6
- Word processing for editing
- BASIC for problem solving
- Using terminals in the classroom
- LOGO
- Skills reinforcement

Grades 7-9
- BASIC and computer literacy
- Word processing for writing
- Simulations in science
- Skills reinforcement

Grades 10-12
- Six math electives ranging from computer awareness to computer science and assembly language programing
- Business applications
- Science applications

Library
- Materials data base
- Computer center/library media center pilot

Management and Systemwide Administrative Services
- Program budgeting
- Program accounting
- Fiscal reporting
- Scheduling
- Grade reports
- Student and personnel data

Parent Involvement and Community Support

Parents have participated in the computer activities and served as a resource by:
- providing technical advice and assistance. Parents serve on advisory and hardware purchasing committees, help install equipment, troubleshoot problems, and support computer plans in school board deliberations;
- writing educational software for the time-share system and the PET microcomputers and by inputing data in the materials data base;
- helping train students, teachers, and other parents on the terminals. Parents help in individual classrooms using microcomputers, and participate in district-level workshops;
- assisting with computer clubs before and after school;
- supervising the use of the time-share terminals in the elementary schools; and
- purchasing and donating equipment. PTAs raised funds to purchase additional microcomputers. Other parents donated personally owned computers and terminals or found excess equipment that was no longer being used by companies.

Gloria Bloom–a parent volunteer, MIT graduate, and former computer programer--estimates that parents currently spend approximately 70 hours a week operating the time-share terminals in the elementary schools. Parents also come to school committee meetings and meet with the superintendent and school principals to help advance the program. Some observers of the Lexington program suspect that parents have led the educators by pressuring and demanding computer programs for their children. Parents point out, however, that educators must play the key role if computer technology is to become integrated into the educational process.

Although the major industries are literally next door to Lexington, corporate-level involvement with the school system is not direct. Rather, collaboration is primarily through the parents of the pupils or through interested individuals in the community who are also connected to the private sector. Through these individuals, hardware is donated, software is developed, company tours are conducted, and information on careers is disseminated.

Impacts

Ironically, increasing success has created problems. DiGiammarino describes the issues in terms of 'the ecstasy and agony of computers. " As educators' experience broadens and expertise develops, the potential uses for computers is recognized —the ecstasy. "This, however, is tempered by the realization that all the conditions necessary to reach the ecstasy do not currently exist—the agony. " For example, more and more teachers are moving ahead with classroom applications, enrolling in workshops and degree programs at nearby universities, and, at the same time, requesting more equipment, software, and in-service training. The present time-share hardware systems are aging fast; the microcomputers break down and are difficult to maintain the demand is greater than the supply; and funds for teacher in-service, professional development, and sabbaticals are limited.

Impacts on Students. Students are motivated and interested in computers, and there is evidence of improved student performance through skills reinforcement drills. But the existing software for the minicomputers and microcomputers, obtained through commercial sources and parent, teacher, and student development, is limited in scope. Although high-quality software is becoming available, it is very expensive. The LEADS system has both management and instructional applications, but its users are primarily central office staff and special education staff. Its potential for diagnosis and tutoring applications and materials retrieval, however, is high. According to school officials, what is needed to make LEADS fully operational is an upgraded minicomputer, a unified distributive network, and training for both administrators and teachers—to be implemented during the second year of the long-range plan.

Finally, there is the issue of program diversity. As programs evolve, different approaches are developed by individual teachers. Each elementary and secondary school uses terminals and microcomputers, but the applications and the penetration into all classrooms varies. Some teachers have greater interest and expertise, hence their students have different experiences. Parents in some schools have become more involved, have access to resources, and are willing to push harder than others. Principals juggle with conflicting needs and set different priorities. The issue of equity in access and quality has concerned Superintendent Lawson and his administrative staff. More than any other factor, it has led to increased leadership responsibility for DiGiammarino, an expansion of Lewd's activities, and the creation of planning committees.

For members of the district computer curriculum committee, as well as for others heavily involved with computers, the benefits to teachers, their students, and the program outweigh the problems or frustrations. Teachers point to their new computer expertise. Many have written their own programs, and others have helped design and implement computer models and curriculum materials. Mainly by trial and error, teachers have made the computer work, and they feel good about what they and their students have learned together. There is a pervasive enthusiasm.

Dave Olney, high school physics teacher, implements one of the district computer models for using the Apple computer in physics. He spends hours writing programs and expanding his own knowledge and previous experience with the DEC system. He is excited about using the microcomputer to speed up and improve Laboratory activities by having students punch-in data, calculate results, and get immediate feedback. He sees a whole range of applications including the feasibility of modeling problem-solving processes in physics. His enthusiasm results from the intellectual stimulation he derives from the logic processes that he uses as he programs these activities.

For other teachers, satisfaction comes from observing the progress of their students in writing, in math and reading, or in simply feeling comfortable with computers in a variety of settings. There is no question that students are enthusiastic users. A group of third and fourth graders working with LOGO and problem-solving strategies, interviewed by their teacher, Florence Bailey, reported that learning is fun, that mistakes can be handled, that solutions can be derived through experience, and that mastering programing skills is challenging:

Eric: It's fun, but it's actually school work. It's better than recess! Brad and I make a good team. He knows things I don't know, and I know what he doesn't.

Tim: If you're bored, you just work on the computer, and you're not bored anymore.

Tanya: I can make my own designs and pictures. You're learning while you're having fun.

Chrissy: The big one upstairs is already programed. This one you can learn to program with your own things.

Shannon: You can learn by yourself. . . if you make mistakes. You can fix a circle that's too big.

Increasing numbers of Lexington students, particularly by the time they reach high school, have expertise in programing that is impressive. Ed Good, director of the high school computer math center, points proudly to students who have written software for the districts' data management system, for elementary classroom instructional activities, and for small businesses in the area. He cites the high school sophomore who designed the interface to transfer (download) programs on the PDP 11/40 to the PET's, thereby saving the district thousands of dollars.

From the models and from other uses, it appears that computers are, and will continue to be powerful tools for both teachers and learners. This notion explains, in part, why an increasing number of staff members are using computers or are interested in having computers in their classroom. Jody Josiassen, a fourth grade teacher, describes his 2-year involvement: "In my teacher training program there was nothing in my education that spoke to this-the hardware-the software. It's a brand new field. I get excited about it from a teacher's point of view because I think it can do things in the classroom for me that I've struggled with in the past. "

Finally, in further justifying the comprehensive plans for future computer applications, Lexington administrators and teachers point to their high-technology community and to the increasingly technology-related world. Two-thirds of Jody Josiassen's students have their own home computers. He views this phenomenon as the "iceberg out there and I'm at the very tip. " He also sees that the schools need to be part of the momentum, "to catch it, structure it and use it . . . and help my students develop their goals to use it. "

The Future

Implementing the Long-Range Plan for Computers in Education. With district implementation of the long-range plan, the following examples will become not only possible, but commonplace. The planning document projections include:

- A third grade student at a computer station ready to LOAD, RUN, and LIST a program from tape or disk.
- A teacher at a computer terminal obtaining a list of all nonbook resources owned by the Lexington School System related to a specific subject heading for students at the seventh grade instructional reading level.
- Elementary school students work at computer stations in the learning center or on teacher prescribed learning activities which have been integrated into the curriculum.
- The coordinator of language arts updating the language arts curriculum data base from staff evaluative information.
- A junior high school student electing to take a followup computer course as a result of positive experiences in the required computer literacy program.
- A student at the senior high school level designing his/her own data base management information system.
- Teachers or students using computer terminals to address computerized information systems anywhere in the Nation.
- A teacher queries a terminal to determine exactly what are the educational plan objectives of two students in the class and what is their progress to date.
- A program director querying a terminal to determine the exact cost to date of his program and precisely what portion of that cost has been used for special needs programs.
- A counselor using the computer to assist scheduling a new student.
- An elementary principal, concerned about the validity of the academic level recommended for his students moving to junior high, using a terminal to examine how previous students have achieved in seventh grade relative to the level recommended by his school.
- The data-processing center adding to the data base the information from the annual battery of basic skills tests given to one-quarter of the school population. Also, printing report cards and searching for those students whose academic achievement is declining.

Acquisition and Placement of Hardware. Key implementation strategies include the acquisition of equipment over a 5-year period, with a mix of microcomputers, terminals, and replacement of the system's PDP 11/40 and 8. Each school will have a cluster of inexpensive portable microcomputers and terminals that tie into the central system. The upgraded central minicomputer system will significantly expand capacity to handle a curriculum materials data base, software collections, and student information and management functions. Each elementary school will have a computer learning center supervised by the library media specialist. A center or cluster will be equipped with the following:

- 11 small microcomputers (several available for loan to individual classrooms),
- three CRT terminals hooked to the central minicomputer,
- one printer directly tied to the central minicomputer, and
- one printer for the microcomputers networking and electronic mail equipment.

Similar centers will be established at the junior high school, with one center servicing the needs of the computer literacy curriculum as well as the academic areas outside of math and science. The second center will support math and science applications. Similar configurations are planned for the high school, as well as an upgraded computer center with a replacement of the PDP 11/40 and a phase-out of the PDP 8.

Funding. Recommended equipment will probably cost almost a half-million dollars. Up until now, computers and terminals were acquired without expenditure of local funds (see previous sections of this report). With reductions in Federal and State funds, the district is searching for other alternatives, such as corporate contributions from the computer hardware manufacturers, to defray part of the equipment costs. The school committee is also being asked to allocate funds from the operating budget to support the computer program. For 1982 to 1983, the plan is to budget $74,566 from local revenues, to use all of the Federal title IVB grants ($16,000) and reimbursements to the district for student teaching from Boston University ($10,000), and to attempt to obtain a 50 percent discount from DEC for the new minicomputer as a corporate contribution.

Although implementation of the plan is based on funding sources such as Federal block grants and other special area funds, the availability of these resources is not guaranteed under present circumstances. Furthermore, funding projections deal solely with hardware acquisition. Costs for software, continued training, and maintenance will have to be absorbed by operating budgets.

A Separate Department for Information Science. The planning committee has recommended the establishment of an information science department to lead program activities–handling staffing, budgeting, maintaining, and evaluating the K-12 computer literacy program. The department would also assume responsibility for the revision, updating, and teaching of higher level courses on programing, systems design, and computer applications. Inservice training and other leadership and professional development activities would be handled as well. Computer literacy and computer science courses would be taken out of the math department, and the scope of the program would be broadened to include all curriculum areas. No new staff positions are contemplated; staff members who have already played leading roles will be reassigned to the new department.

Training and Curriculum Development: Computer Literacy. These efforts will continue with summer workshops and inservice training activities scheduled on release days at the beginning of the school term and periodically during the year. During the summer, teachers from the computer literacy committees will work with Lewd to assemble and prepare materials for elementary and junior high school components. These teachers will be responsible for teaching the course at the junior and senior high schools in the fall. Resources (staff time, equipment, and software purchase and development) will be concentrated over the short term in grades 5, 8, and 10. Remaining portions of the new curriculum will be piloted at other grade levels.

Computers in Education. It is planned to extend the use of computers as tools for instruction. The materials data base will be operational. Because of upgraded central computing facilities, teachers and administrators are expected to increase their use of computerized data. Also expected to increase are the communication and sharing of information and software via electronic mail among all schools, as well as the number of accessing information centers and networks within the community, State, and region.

Parents and the Technology Community. Cooperative efforts with local district cooperatives and user groups, with parents, and with the high-technology industries is essential to Lexington's future. How else, argue the educators, can the district keep abreast of technological advances, encourage or demand useful and appropriate software, make the best use of available resources to advance the long-range plan, and maximize the potential benefits of technology for education?

As a result of district membership in EDCO, a local education collaboration, Lexington teachers will derive benefits from the computer resource and demonstration center that is being established. They will also benefit from the knowledge that they are not alone, that other districts are copying with computer applications, too. The regular exchange of information with such districts is welcomed by the staff. Finally, the technology community and the parents offer valuable resources. Lewis Clapp, president of a local software development company and also a parent, maintains "a school system that does not take advantage of the intellectual power of its parents and community is doing a disservice to its students—particularly in an era of 2½'s and Reaganomics."

The parents of Lexington recognize progress, but they expect more. For example, Clapp believes it is essential that *all* teachers be computer-literate; that public and higher education efforts be coordinated; that computing and computer science curricula be *fully* developed to reflect the current state of the art; that computer tools be used to support the entire curriculum, not just math or science; and that every student has adequate exposure to computers—"knowing what computers are all about and able to run programs-maybe even able to write their own by the time they reach high school. " Clapp argues that the educational community and the public schools have a critical role to play in meeting these goals, but raises serious issues to be faced now and in the future:

> The tragedy is that national support for this is nonexistent-at the time we need it the most. The local district can't do it. Lexington-even Lexington–might not be able to (accomplish these goals) with a budget limited to a 2½ percent increase each year. . . It is a disaster for this nation. If we fail to invest in education nationally, we impact on our future and our ability to be productive . . . (and maintain) the edge we have in computers, in software, and in information retrieval.

Resources

Case study interviews:

John Lawson, Superintendent
Geoff Pierson, Assistant Superintendent*
Frank DiGiammarino, Administrative Assistant* for Planning and Research and Director, Computer Services
Beth Lewd, Computers-in-Education Specialist*
Bob Tucker, Teacher, Estabrook Elementary School*
Martha Angevine, Coordinator, Instructional Material Services, Curriculum Resource Center*
Luree Jaquith, Media Specialist Bowman Elementary School*
Beverly Smith, Teacher, Bowman Elementary School*
Jill O'Reilly, Math Teacher, Clark Junior High School
Bruce Storm, Teacher, Clark Junior High School
Jody Josiassen, Teacher, Barrington School**
Dave Olney, Science Teacher, Lexington High School
Ed Good, Math Teacher, Computer Center, Lexington High School
Louis Clapp, Parent
Gloria Bloom, Parent

● Member, Computer Planning Curriculum Committee
** Member, Elementary Curriculum Committee

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Computer-Using Educators and Computer Literacy Programs In Novato and Cupertino

Introduction

The Silicon Valley and nearby communities were selected for study because the area provides a rich source and critical mass of educators, schools, students, parents and community members, and business representatives directly involved with technology. The area is the center of the Nation's semiconductor industry. It is also the home of a growing number of educational experts and leaders in computing. There are many examples of locally developed projects sprouted by individual teachers or administrators or parents, which have developed into major programs affecting an entire districts' students and staff. These activities involving computers in classrooms also demonstrate how resources–local, State, and Federal funding, as well as parent and local experts and the private sector—are critical to implementation.

COMPUTER-USING EDUCATORS

Computer-Using Educators (CUE) is a support group organized by and for K-12 teachers, teacher trainers, and others interested in the use of computers in education. Started by 12 teachers in the spring of 1978, the organization has mushroomed to a membership of 3,500, primarily in California but also in 48 States and 13 foreign countries. Its growth reflects the phenomenal growth of educational computer applications and mirrors the grassroots development of programs in schools up and down the San Francisco Bay Area. Groups modeled after CUE have also been formed throughout the country.

Through conferences, newsletters, and meetings, CUE is a source of information and a vehicle for sharing experiences with computers, and their use in education. In addition, CUE members originated and now support the Microcomputer Center and SOFTSWAP Library of public-domain microcomputer software housed in the San Mateo County Office of Education. To quote one member:

> Learning is a never-ending process. Formal education is a small portion of this ongoing process. The role of educators is to aid the learning processes. The philosophy of CUE should be to show educators-mostly by example-the role computers can play in the learning process, Computers can be used in many ways to do many functions. The uses, functions, methods, and materials will change and evolve. CUE can help discover and show the way.

Microcomputer Center and SOFTSWAP. The stimulus for the software exchange came from a San Jose State University professor, Vince Contreras, a CUE member. He organized the exchange of public domain and individually contributed software that was deposited in the San Mateo Education Resource Center (SMERC) Library in the spring of 1980. By the time school was out, CUE members had talked several of their microcomputer industry contacts into placing microcomputers in the SMERC Library on long-term loan. Tandy (Radio Shack) and Commodore (PET) provided the first systems. Ann Lathrop, coordinator of the Microcomputer Center reports that the center now has 14 microcomputers and manufacturers help maintain equipment and provide new models as they have become available.

The center has a steady stream of users. The San Mateo County Office of Education provides space, maintenance, and support through Ann Lathrop, library coordinator, and LeRoy Finkel, the county's instructional computing coordinator. Superintendent William Jennings cites the center's benefits to the county's 24 school districts. Teachers and administrators try out equipment and software; both Lathrop and Finkel are nearby to provide help and expertise. CUE members and their district teachers and administrators take advantage of the center for meetings, training sessions, demonstrations, and evaluation of hardware and software. The center is visited by representatives from hardware companies and software houses, educators and government officials from all over the State and even educators from other States and foreign countries.

Ann Lathrop conceived SOFTSWAP, the software dissemination and evaluation project, and garnered the support of colleagues to field-test, evaluate, debug, and clean up the programs in the system. Through SOFTSWAP, teachers can purchase software or swap their original program for that of someone else. Most of the 300+ software programs are short, stand-alone instructional units; many are drill and practice exercises for the elementary school level or for remedial work at the secondary level. All were evaluated by educators and edited for factual and spelling errors, inaccurate or incomplete instructions, programing errors, etc.

When visitors come to the center, they can copy dissemination disks without charge. Single mail order disks are $10 apiece, or free if a disk with at least one original program is contributed. Each disk contains 12 to 30 programs. Since the major thrust of SOFTSWAP is sharing with the widest possible distribution, programs may be freely duplicated, but not sold.

CUE Conferences

CUE's first conference, remembers William (Sandy) Wagner, founder and first president of CUE, evolved from CUE's early meetings. "We'd introduce ourselves, share ideas on curriculum, on software . . . and see more new faces each time. By September 1978 the small group had grown to 50 and it was agreed that "we can't go on meeting like this" . . . a conference would facilitate sharing and in-depth discussions. CUE's first weekend conference in January 1979 attracted 65 educators. A few informal sessions expanded to multiple presentations, wide-ranging exhibits, and hands-on workshops in the fall 1980 conference with 500 in attendance. By fall 1981, conference attendance reached 1,400—with some districts sending all their teachers to view 45 commercial exhibits and 60 different speakers. CUE's officers and executive board members play critical roles in planning, organizing, and running the CUE conferences. They work evenings and weekends—all on volunteered time. The conference coordinators handle some tasks with their own personal computers, as well.

Impacts

The expansion of CUE membership and activities demonstrates not only the growing interest and use of technology in schools, but also the fact that teachers need help. They are coming for more than help, some argue-they're looking for leadership. These computer-using educators "are carrying the message that the time to move is now, " notes Arthur Luehrmann, former director of the Lawrence Hall of Science Computer Project. "The leaders are here in these counties who are responding to the signals coming from society, from the employers, and the parents. "

When asked why CUE and the grassroots phenomenon developed where it did, many point to the "critical mass" of people that emerged—individuals developing separate programs and expertise, but living close enough to meet. Finkel points to the special and unique aspects of CUE. "CUE members are teachers first. We share, we don't have district or school boundaries. We're a network of people . . . and it's a stupendous event each time we meet. " Furthermore, there was a need for support, training, information, and leadership that neither the State education agency, the institutions of higher education, nor the high-technology industries were providing.

Future

There are indications that the latter situation may be changing, albeit slowly. The Fremont and Los Gates High School districts plan to open a joint Silicon Valley High School with support from the Industry Education Council. Equipment and training for teachers are being solicited from high-tech industries. The high school will offer entry-level vocational training and courses for the college-bound information sciences major who wants a head start, and for other college-bound students who want to learn how to use the computer and related tools in their studies and future work. Governor Brown of California, in his address before the State Legislature in January 1982, called for new priorities and action:

> Our schools must augment the three R's with the three C's—computing, calculating, and communicating through technology. We will do so or succeeding generations will inherit a society stagnating in the aftershocks of massive foreign imports and obsolete industry.

In addition to the first priority of an increased commitment to mathematics, science, and computer instruction in California K-12 schools, the State Education Agency is beginning to address technology issues. One issue that concerns many of the local educators is how to meet these commitments, given the growing disparity between districts that have programs, trained teachers, and community resources to draw on and those districts that do not. Furthermore, not every district or county in the State has a major industry to draw on. Even in the Silicon Valley much of the private sector is made up of small, short-term, entrepreneurial businesses that don't have extensive resources.

In reflecting on the grassroots development and the enthusiasm of CUE, Joyce Hakansson, formerly at the Lawrence Hall of Science and now a software designer and developer, cautions: "We need to understand the place of technology and give it a proper role. Don't assign all of our ills to technology . . . recognize that technology is just another tool. " Hakansson notes the new status and positive feelings of self-worth resulting from interaction with microcomputers, but also observes that, "software, the essence and heart of the computer, is less than it could be" and that "what youngsters are doing on computers may not be worth the time or money. " The future applications ought to capture the inherent interest and motivating aspects of the technology and match it with children's learning needs--to integrate computers into the teaching and learning environment.

From the Silicon Valley and surrounding San Francisco Bay Area communities, two school districts were studied. These districts' educational computing programs were locally developed and typify the area's grassroots activities. Key personnel from these districts are heavily involved in CUE: Bobby Godson, from Cupertino, is CUE's President and Helen Joseph, from Novato, is a member of CUE'S executive board. In-depth discussions of school district approaches to implementing computers in classrooms follow: The Novato Unified District, a rural K-12 system at the northern tip of Marin County, and the Cupertino Union K-8 district in Santa Clara in the center of Silicon Valley.

Novato Unified School District, Novato, Calif.

The Setting

Located at the upper tip of Marin County approximately 30 miles north of San Francisco, Novato Unified School District (NUSD) is one of two districts in the county combining elementary and secondary schools. It is the largest of the districts in Marin County. It is also more rural and less affluent than other areas in the county. Agriculture predominates; the major local industry is insurance-the Fireman's Fund. Incorporated in 1961, Novato's community is diverse: blue collar workers, many San Francisco commuters, a growing number of retirees, and personnel and families on the military base. The student body composition is 90-percent white, 5-percent Asian (and increasing), 3-percent Hispanic, and 2-percent black. Three-fifths of Novato graduates goon to college.

In recent years, student enrollments have declined and several schools have been closed. The present enrollment of 8,642 is expected to decrease further and level off to 7,500 by 1985. Presently, there are eight elementary schools, grades K-6; three junior highs, grades 7-9; two high schools, grades 10-12; and one continuation, grades 9-12. One junior high school is targeted for closing at the end of this year. If Novato can find buyers for the surplus school properties it owns outright (three sites are currently for sale), the interest from these revenues can be used for equipment and capital improvements.

Local educators point out that while Marin County boasts the highest per capita income in the Bay Area, Novato is the "poorest part. " The 1981-82 NUSD annual budget is $23,645,286. One-fifth of the budget is federally funded. School finances are and will continue to be a growing area for concern. Superintendent Ronald Franklin explains the district's bind:

> Parents expect that educational programs will reflect excellence . . . the toughest thing we have to deal with in being able to handle our commitment (to the district's computer and other programs) is the uncertainty of the financial posture of both Federal and State governments.

Novato's board and administration are concerned because they see cuts coming on all sides. The district's Federal impact aid has declined from a high of $938,714 in 1977-78 to $602,324 in 1981-82. In 1982-83, impact aid is uncertain. State funds, which provide 70 percent of the district revenue, have been cut, including categorical aid for special education and gifted and talented programs. Educators note that the impact of Proposition 13 passed 4 years ago, is now being felt, since the State's surplus has been depleted.

Computer Applications in the District

Computer education in the district began 8 years ago, when a Novato junior high school acquired a teletype machine and shared with Dominican College the lease of a telephone line hookup with the time-sharing computer at the Lawrence Hall of Science in Berkeley. Novato was one of several school districts linked to the Hall's Computer Education Project (funded by the National Science Foundation). The Hall staff, Lee Berman and Joyce Hakansson, were invaluable resources as computer activities evolved, relates Helen Joseph, computer resource teacher and coordinator. Even after the timesharing project ended, she continued to turn to them for advice and support.

The district's first microcomputers were acquired in 1977, when the time-sharing costs were escalating. Richard Melendy, former math and science coordinator, now school principal, and Joseph met with the district director of instruction and examined how the district might best use the MGM (mentally gifted minor) funds which had supported the time-sharing project. The subsequent decision to purchase Commodore PETs was based on cost and reliability.

Over the next 3 years the computer program grew rapidly, expanding to the two senior highs, an additional junior high, and an elementary school. In this small district, officials made an early decision to standardize hardware because of teacher training, software acquisition, and maintenance requirements. By 1980, there were 28 microcomputers purchased with MGM State funds, magazine sales money, and district minigrants.

The development of the program by Joseph and Melendy had strong support from the district administration. There was consensus that before the district went further, an external assessment and evaluation was needed. Arthur Luehrmann, former director of the Computer Education Project *at* the Lawrence Hall of Science, spent 3 days in Novato in March 1980, meeting with more than 50 people —students, teachers, parents, principals, district administrators, and school board members. In addition to identifying current needs and recommending future directions, the strategy was to involve and educate all those concerned with computer education in the district. Luehrmann's report stated:

> The present state of computer education in Novato is better than the average situation one sees in Bay Area districts today. One finds a solid base of computer equipment, several experienced and creative teachers, a larger number of interested teachers, student demand for increased access to computer classes, strong administrative support at most of the schools, and outstanding work at the district office in planning and managing the development of computer education programs in the district during the past several years. The parents and school board members with whom I spoke were also supportive of the aims and accomplishments of the programs thus far.

Specific findings indicated that primary uses were in the secondary schools, where computer programming courses and that computer literacy activities closely identified with mathematics predominated. Demand for classes exceeded supply, and teachers wanted more inservice training.

Luehrmann recommended a cluster arrangement for each of the five secondary schools, involving approximately 15 computers connected to a central disk unit and printer. Further, he recommended that the two high schools acquire computers that would facilitate instruction in a second programing language. In the elementary schools, uses were to continue to be limited to gifted programs in view of the district's current priorities and available resources. Luehrmann encouraged the development of a de facto computer education department, composed of the teachers of computing to develop curricula, course content, sequencing, and evaluation. He suggested that the district also look at administrative computer uses, drill and practice, and other CAI applications. Finally, he recommended a gradual expansion of the program over a 3-year period, with a projected cost estimate of $110,700 for equipment.

The administration and school board approved the recommendations. In fiscal year 1980-81, $30,000 from local funds and IVB Federal moneys were used to equip the junior highs. A request for funding the second and third phase of the program was submitted to the Buck Foundation, but was turned down. In fiscal year 1981-82, the second phase was funded, again from the operating budget, and one high school is to be equipped with an Apple lab.

Current Programs

Novato's computer education activities focuses on how to use the computer and include programing, problem solving, logical thinking, and debugging (tracking down errors). All seventh graders have a minimum of 3 weeks of a computer literacy unit that includes an overview, a historical perspective, basic terminology, impacts on society, and career awareness. This unit is followed by 2 weeks of hands-on experiences running programs (modeling programming activities, games, applications) and writing programs. Students can also take elective programming and math enrichment courses. One high school offers courses in BASIC and one offers courses in BASIC and Pascal. The few computers in four elementary schools are used for computer awareness activities in upper grades and for enrichment in the gifted and talented programs. A total of 77 computers are used throughout the district.

Staff Training Programs and Workshops

All administrators attended districtwide workshops because the Superintendent felt, "There was a need for every manager to know why we were supporting this program. " The district also supported numerous teacher workshops run by Helen Joseph and encouraged staff to attend area workshops, conferences, and meetings. With the training activities of the Marin County Teachers Learning Cooperative, a 3-year federally funded teacher center, CUE conferences and workshops, and the increasing number of courses taught at nearby colleges, there have been many opportunities for professional development. In the spring of 1982 Joseph offered a course for teachers through Sonoma State College. The district paid Joseph's salary and provided the computer lab facility, while the university provided credit. What was exciting was that this course introduced programing without a mathematics orientation. Thus, its applications will be interdisciplinary and, it is hoped, lead to computer applications in a wide variety of content areas.

Impacts

In establishing the priorities for the computer education activities, the educators and community members in the district have had to ask: how important is computer education? As Luehrmann in his report to the district explained:

> There can be no simple answer to this question. Most people in the world have gotten along fine without knowing what a computer was, and today most educated people have never used a computer. But it was also true in Gutenberg's day (and for four centuries thereafter!) that the majority of people could not read or write. Yet by the end of the last century universal literacy had become an accepted goal of public education, and illiterates were at a distinct vocational and social disadvantage.

Luehrmann argues that those who have computer skills already enjoy several benefits: 1) vocational and professional advancement; 2) intellectual payoffs—new ways to represent or express ideas; 3) facilitation of problem solving, particularly in mathematics; and 4) a desirable skill or proficiency valued by colleges, These arguments reflect the underlying rationale for Novato's programs.

Students in the district are highly motivated in the courses and computer units. Even when visitors come into their classrooms, students ignore them, fully involved with the computer. "We can't keep the kids off the machines, " stated one teacher. Novato also boasts of its computer whiz kids—students now in high schools and in their first year of college who have incredible programing skills. Some students sell programs on the side and find computer-related work in the summer. One student, Casey Kosak, has received national recognition and has been featured in an article in *Datamation*.

Problems remain, however. Keeping up with the advances in technology is one major concern. There is already a need to upgrade several of the PETs that were purchased several years ago. Officials know that new hardware may make their current inventory obsolete in a few years, but they have no easy choices, especially when funds are limited. Another area of concern is the impact that computer electives will have on other areas of the curriculum. Computer courses fill up immediately while industrial arts courses are underenrolled. Moreover, teachers cannot easily be transferred from one course area to another. To complicate matters, the options to take electives may be reduced as the school day is shortened to save money for the district. The high schools have already reduced schedules from a full 6-period day to 5%.

There is still the problem of reaching all of the student population, particularly in the high school classes. Courses are still tied to the math department, but Joseph hopes this will soon change. Finally the relationships among programs and the competition for resources causes concern. So far, "we've been able to maintain a delicate balance, " says Joseph. But she worries what will happen when more schools are closed and staff positions reduced. There is also some concern that implementation of phase 3 (a second Apple lab) maybe delayed, as well.

The Future

Integration of computers into the curriculum is a major objective for the future. There is already some interest among secondary teachers in English, social studies, business, foreign languages, and science. If the computer labs or clusters are used every period for computer literacy and programing courses, this may not be feasible.

There is also an interest in exploring administrative uses of microcomputers in individual schools, particularly to retrieve and handle information. Melendy expressed his concern about the disproportionate amount of time spent in looking up records, in gathering data for reports, and in other clerical tasks: "We're still working at the quill level, when we have the technology to do otherwise. "

Contact and interaction with the State Department of Education and other districts in the county are increasing. The county teachers' center has become an important broker. When the State Commissioner came to Marin County in spring 1982 to focus on computers in education, he met with local district leaders and others at the center and nearby universities.

Novato elementary schools may participate in a LOGO project currently being developed by the Marin Community College, the Marin Computer Center, and the Teacher Learning Cooperative under a grant from the Buck Foundation. The Buck Foundation (administered by the San Francisco Foundation), funds are restricted to use only in Marin County. Currently several proposals for support of computing in county schools—including a mobile computer education van and a series of workshops for teachers are being examined. Joseph would like to see a Marin County symposium of national experts and local educators to measure the impact of programs. She feels it is time to reflect, to examine current programs objectively, and to identify limitations and unanswered questions. According to Joseph, "This is needed not just here, but all across the Nation. "

Cupertino Union School District, Cupertino, Calif.

The Setting

Situated in California's "Silicon Valley, " where apricot groves turn into computer factories overnight, the Cupertino Union School District (K-8) serves a population of 50,000. School population is 86-percent white, 8-percent Asian, 4-percent Hispanic, and 2-percent black. Although the population growth rate is one of the highest in the United States, an acute housing shortage and inflated costs have resulted in a decade of declining enrollment. Fifteen schools have been closed. The 12,150 students, half of peak enrollments in 1969, attend 4 junior high and 20 elementary schools. District boundaries cut across six municipal jurisdictions. Parents support the schools, but officials point out that only 25 percent of the area's suburban population have children in public schools.

Major industries in the area are aerospace- and computer-related. Many of the companies are small and relatively young. This is a high-tech, middle socioeconomic community with high educational expectations. There is interest from the Industry/Education Council and the Chambers of Commerce and service clubs as the schools respond to computer-related, entry-level job needs.

Cupertino has a mature, experienced teaching staff whose average age is 47. Ninety-two percent of the teachers are in the top range of the salary scale. Declining enrollments and reduced staff positions make it difficult to maintain high morale, however. Officials note that the district's staff development and incentive programs and its computer project are "our most powerful weapon" in maintaining enthusiasm and quality education.

With an annual budget of $30 million, 70 percent of funding now comes from the State, reversing almost exactly the ratio that existed before the passage of Proposition 13. Educators feel local control of education has eroded. The one benefit of declining enrollments has been the sale of excess property. Because of high land values, these sales have resulted in significant capital reserves which can be used for equipment and capital improvements only.

District Programs

Cupertino is the home of the Apple Computer Co.: "the boys that designed the Apple grew up here, " relate Cupertino educators, " . . . and when they had put together their first Apple II prototype, they showed it to us. " Associate Superintendent William Zachmeier and computer specialist/teacher Bobby Goodson remember the day clearly. They were amazed and excited with what they saw.

Several months later, when the district's IVC proposal for a math program to the State was turned down, Zachmeier urged Goodson to try again, but this time to try something with computers. With active support from the administration, another proposal was written. Funded by ESEA title IVC for 2 years, the junior high school project provided for a full-time director, but no equipment. In addition, IVB money was allocated to purchase three 16K Apples; old black-and-white TV monitors were located. Goodson learned by talking to people; attending meetings, and worked with students and small groups of teachers—a school at a time.

For the 2 years of the projects, says Goodson, "we felt our way around and 'nickeled and dimed' our way. " Approximately three dozen computers were purchased with IVB funds, MGM State funds, and parent donations. After IVC funding ended, Goodson's position was supported by the local district. The approach was "to learn by trying out various approaches so that when we went to the board for their support of a total district program, we knew what we wanted. "

In spring of 1981, the superintendent made the district proposal to place computer labs in each junior high school, and labs or clusters in half of the elementary schools, at a total expenditure of $299,337. On the night of the presentation, the board room was packed with teachers, administrators, students, and parents. "One by one they got up and told the board why they wanted computers," remembers Zachmeier. "And the board gave us everything we asked for, " says Goodson.

Computer Literacy Curriculum

The computer literacy program was developed by teachers using computers in their classrooms. The program focuses first on computer awareness, and then on computer use.

The goals is that by the end of grade 6, all Cupertino students be fully "aware" of computers. By the end of grade 8, all students should have had the opportunity to use the computer as a tool and to be introduced to the idea of programing.

Inservice Training and Staff Development. The district has a long tradition of inservice. Staff can earn credit toward salary increments, in exchange for released time, for conference registration fees, for instructional supplies, or for university course work. Extensive computer inservice courses were developed and taught at first by Goodson. In time, those she trained taught others; the cadre of resource people continues to grow. The introductory course begins with three short modules of two 2-hour sessions, each followed by optional strands in programing (BASIC, PILOT, LOGO) and software evaluation and design. Courses for parent aides, secretaries, and others have also been developed.

Approximately 80 percent of the teaching staff have participated in at least one course. Moreover, all principals and administrative staff attended a l-day workshop in the summer of 1981, led by Richard Pugh, JHS computer teacher; Judy Chamberlain, teacher of the gifted and talented; and Bobby Goodson.

Installation of the labs is to proceed in stages to provide adequate time for schoolwide planning by each faculty and for support of the program by the computer resource teacher. Three labs were completed by fall 1981. By 1982-83 all junior highs will have labs. Each computer lab will have a total of 15 student stations and a teacher demonstration station which includes a large screen TV and a printer. Two of the labs will be equipped with Apples and two will be equipped with Ataris.

All but two elementary schools have at least one computer as well, and there are at least three different systems in the schools. Diversity of hardware at the elementary school level, where computers are used in a variety of ways in classrooms and in the media centers, presents no problems. In the long run, district officials now think that this diversity will be an advantage.

Sample Programs

The computer lab at Hyde Junior High School is a large room that accommodates the student microcomputer stations comfortably around three sides of its perimeter. Small round tables cluster in the middle, where students come for discussion, instruction, and collaborative work. But most of the time it is the computers that are busy. While they input data and compose print statements, articles and pictures on the classroom walls remind them of the history of computers and where and how computers are used today. Students all seem to be working on their own assignment. While one student writes a program to calculate his grade-point average, another designs a simple game, and still another runs a preset program. Meanwhile, students at Kennedy Junior High School generate graphics on the computer, while elementary school students in the gifted and talented program at the Wilson Exploration Center develop new thinking skills using the computer, and then debug their original programs.

At Muir Elementary School, computers can be checked out to parents and teachers; every weekend they are all checked out. Because the computer in the library is used nonstop, access for many students is a problem. At the parents' insistence, two introductory workshops were offered to parents. The school plans to use parent volunteers to teach computer literacy curriculum activities during alternate library periods. In this school, parents will become a major force as volunteers in the program.

At the West Valley Elementary School one such parent, Cheryl Turner, became a catalyst and prime mover in establishing the school's computer literacy program. The program began with enthusiastic teacher and student response to Turner's demonstration of a computer she had made from a kit. With strong support from the principal, microcomputers were installed in the library media center and Turner was hired as an aide to teach computer literacy. Funding for the microcomputers came from the PTA, a grant from the INTEL Corp., and MGM funds. A parent, an Atari executive, arranged for a loan of an Atari to the school. All but two teachers want their students to participate in the program. Turner, who has "had a fascination with computers for 20 years," enjoys being a role model for the students and demonstrating, especially to the girls, "that it's okay to enjoy electronics and run around with a screwdriver in your purse."

Impacts

The computer literacy program has energized both teachers and their students. Individual parents have been tremendously supportive, although by and large Cupertino does not benefit directly from proximity to the corporate world and Silicon Valley industries.

More than 65 percent of the district's teachers have received literacy training. Goodson sees the benefits especially for those in dead-end jobs. Negative feelings have been turned around, and new life has been put into the educational process. Many are convinced that it is the opportunity to become a learner and "be in control" that is the irresistable appeal of the program.

Many students "turned off" by school have also been motivated by the program. Many are those whose interest and aptitude could not have been predicted. The problem now is getting them to go home from school.

The program has problems, but they do not appear serious. There are teachers who want to be involved in computing but who receive little support, or no access to the computers in their buildings. The inequity between some of the elementary schools continues to grow. There is also recognition that the lab arrangements do not accommodate the needs of the science teacher who wants a computer in class, nor the librarian who wants one in the library, nor the principal who wants one in the office. Additional funds may be allocated or alternate arrangements developed to serve these various needs.

Finally, until recently, there has been no integration of computing programs in the junior high school with programs offered in the high school. Students are frustrated in cases where there are no courses or when courses are outdated and equipment is obsolete.

Implications

The district goal is that all schools will have computer laboratories by 1984. Training opportunities will be expanded, and new uses for the computer in the classroom will be explored. Cupertino educators hope that there will be articulation and coordination between the secondary school systems.

Beyond the new courses and expanded efforts at the secondary level, Associate Superintendent Zachmeier's ultimate goal is to give every youngster a computer some time in elementary school because:

> There will be a need for new skills and new attitudes. It's our job to prepare students for the kind of world that will become *not* the world that was. We will have kids who leave Cupertino . . . who will be fully computer-literate, discriminating buyers and users. And rather than being prisoners of technology, they will be masters of it.

*These first activities provided access to students in the Junior High School GATE program and were supported by State MGM (mentally gifted minor) funds.

*As more equipment is purchased, the district will shift hardware to have uniform equipment in the junior high labs, where programing is taught.

Resources

Persons interviewed:

Novato Unified School District, Novato, Calif.

Helen Joseph, Computer Resource Teacher and Coordinator

Ronald E. Franklin, Superintendent

Richard Melendy, Principal

Jack O. Rothe, Director of Instruction

Arthur Luehrmann Former Director, Computer Project, Lawrence Hall of Science

Joyce Hakansson, Former Education Program Coordinator, Lawrence Hall of Science

Cupertino Union School District, Cupertino, Calif.

William Zachmeier, Associate Superintendent

Jerry Prizant, Coordinator of Media Services

Bobby Goodson, Teacher, Hyde Junior High School, Computer Literacy Lab and Coordinator, Computer Programs

Frank Clark, Principal, Kennedy Junior High School

Richard Pugh, Teacher, Computer Literacy Lab

Ron LaMar, Principal, Hyde Junior High School

Harvey Barnett, Principal, West Valley Elementary School

Cheryl Turner, Aide, West Valley Elementary School

K. A. Fisk, Principal, Muir Elementary School

Judy Chamberlin, Teacher, Gifted and Talented Program Wilson Center

Computer-Using Educators - CUE Monthly Board Meeting, Palo Alto, Calif., Jan. 22, 1982.

Bobby Goodson, President, CUE, and computer resource specialist Cupertino Union School District

Jose Gutierez, Vice President, CUE, and faculty member, San Francisco State University

Ann Lathrop, library coordinator, San Mateo County Board of Education

Helen Joseph resource teacher-math, science, and computers, Novato Unified School District

William Sandy Wagner, computer coordinator, Santa Clara County

Glenn Fisher, computer coordinator, Alameda County

Le Roy Finkel, computer coordinator, San Mateo Office of Education

Karen Kent, director, Teachers Learning Cooperative, Marin County Office of Education

Don McKell, teacher, Independence High School, San Jose

Brian Sakai, computer teacher, San Carlos High School

Russ Bailey, computer district coordinator, San Mateo City Schools

Bob Enenstein, teacher, Carlmont High School, Belmont

Steve King, computer teacher, Crittendon Middle School, Mountain View

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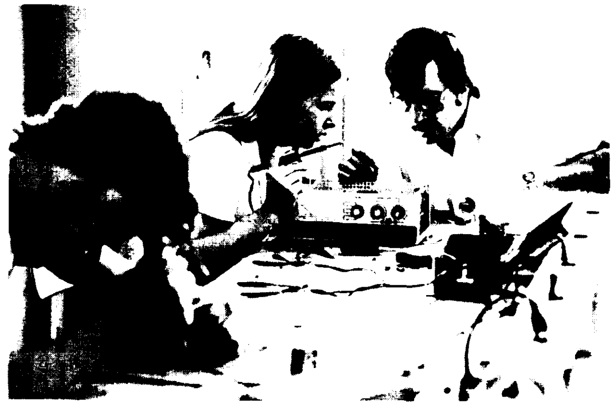
Technology Education and Training, Oxford Public Schools, Oxford, Mass.

Introduction

The technology training and education programs of the Oxford Public Schools were selected for study because they provide an example of how a small, rural school district with limited local funding resources can offer up-to-date education and training opportunities to its students and adults in the community through partnerships with private industry and other rural school districts. This study also provides an example of the impact of Federal and State grants on the implementation of new programs. Although each grant was relatively small, "to Oxford they looked like a Hope Diamond, " according to the Superintendent.

The Setting

Originally a French Huguenot settlement, Oxford was founded more than 300 years ago in central Massachusetts, approximately 20 miles south of Worcester. Once the center of a thriving mill industry, Oxford's economic base seriously declined as the mills closed. At present only one small mill operates; it employs five people. No new industries have been established. Oxford's population of 11,450 is primarily blue-collar. In 1980, Oxford's annual per capita income was $6,582. Of the adult working population living in Oxford and surrounding similar communities, 60 percent are semiskilled or unskilled workers and 11 percent hold professional or managerial positions.



A special program at the Oxford High School District introduces students to the world of computer maintenance and electronics fabrication. This student credits her graduation from Oxford High School to the engaging qualities of the curriculum, which, she said, kept her in school after she had become disenchanted with the regular academic program

The Oxford Public Schools serve 2,460 students in grades K-12 who attend three elementary, one middle, and one high school. Almost all students are white; fewer than 1 percent are black, and fewer than 1 percent Hispanic. Of the high school graduates, 30 percent attend 4-year colleges, while another 30 percent go on to community college and vocational training institutes.

In this rural community, according to its superintendent, there is strong support for education with local taxes, although Proposition 2½ now limits that revenue source. The 1981-82 budget of $4.2 million results in an expenditure of $1,945 per pupil. Many of the teachers are from the local or neighboring areas, and there are common bonds between the educators and the school board. Even with declining resources, administrators and teachers feel that there is support from the board and community and that their efforts in behalf of the students are appreciated.

Building New Partnerships to Link Education and Technology Training

History. Francis Driscoll, superintendent of this small, rural school district with almost no local industrial base, searched for ways to meet his students' diverse needs. Although the district was small, it had students who could not function in regular classrooms because of emotional and learning handicaps, whose abilities were seriously underchallenged, and whose interests weren't being met. The solution he developed, late in the 1970's, was to form a loose federation of similar districts near Oxford, to develop programs that they all needed.

Driscoll reasoned that by regionalizing programs and services through the federation and other similar cooperative efforts, he could create the equivalent of a small-sized city and the critical mass needed. By joining Oxford to Auburn, Leicester, Charlton, Dudley, Webster, and then Southbridge, the combined federation involved 35,000 students, 1,200 teachers, and 62 members of local boards of education.

The Oxford School Board and administration agreed that they would serve as fiscal agents for any cooperative projects. Proposals were developed and funded. One Project-COFFEE (Cooperative Federation for Educational Experiences)—provided occupational training and education for students with special needs, and was funded by the Massachusetts State Department of Education in 1979. A second proposal for a regional teacher training consortium, the French River Teacher Center, was funded by the U.S. Department of Education from 1978 to 1981. Both projects are housed in Oxford, with COFFEE in a portable building next to the high school. The teacher center was built from surplus motel shells, moved to school land, and assembled and finished with professional contractors and students from the vocational training programs.

As district educators looked at the State's burgeoning high-technology industries and the growing relationship between education and training, it was clear to them that high technology was not just for elite students. Informal data gathered from Worcester and Boston area industries revealed that entry-level high-tech jobs were underfilled and that 80 percent of those jobs did not require college training. It was also clear that partnerships with private industry had to be developed.

John Philippe, the program director of Project COFFEE, and Rob Richardson, the director of the French River Teacher Center, became involved with the local industry councils and the State High Technology Commission. Serving on committees and attending meetings, they made direct contacts with individuals from electronics and computer industries located in the Worcester and Boston areas.

Mike Odom, DEC Executive on loan to the Humphrey Occupational Center, notes that the Oxford educators were unusual–"they sought our advice, and they listened. " Similarly, the superintendent proposed to the school board that the district develop a working relationship between education and industry. The school board, remembers Chairman Schur, said, "Go ahead, you have our blessing."

The district efforts focused on computer technology, an area that both the special needs training program and the teachers were interested in. Eventually, several paths led to one of Massachusetts' largest computer corporations, Digital Equipment Co. (DEC). Early contacts were with salespersonnel and then, Mary Ann Burek of the Corporate Contribution Division, who put the district in touch with Del Lippert, Corporate Manager of Educational Services.

Current Programs

Project COFFEE. COFFEE is an alternative occupational education program for the special-needs, disadvantaged, and handicapped students of a six-community cooperative school federation. The program includes life-coping skills education, as well as an occupational educational experience in an adult-like work environment. The high-technology training components provide the student with job entry skills, job placement skills, cooperative job experiences, shadowing experiences (job observation), and a related work study program.

In the electronic assembly component, students read and interpret schematic diagrams and mechanical drawings and gain experiences in layout, manufacturing, and assembly of printed circuits and electronic components. Students test and inspect electronic components, circuits, and assemblies. They are trained for entry-level employment as: electromechanical assemblers, electronic maintenance workers, drafting assistants (electronics), electronics utility workers, electronics inspectors, electronics mechanics, electronic testers, and electronics assemblers. Many of the assembly tools and testing devices and most of the hardware, components, and circuitry used for hands-on instruction was donated to the program as a result of individual, personal contacts with electronics companies.

After a year of operation, the Project COFFEE director, John Phillipo, and Superintendent Driscoll planned a new component that would involve use of state-of-the-art computer hardware. Contacts with DEC were made, and the company contributed $22,800. In the data-processing component, started in September 1980, students use state-of-the-art computer hardware and software techniques in the computer center and an automated office. The instructor assumes the role of data-processing manager, and students learn by hands-on experience in hardware operation and maintenance, computer awareness, and use of BASIC. They are trained for entry-level employment as junior programers, console operators, computer service technicians, data typists, printer operators, control clerks, and computer aides.

Project COFFEE was funded through a statewide competitive grant process utilizing Federal occupational education and special education moneys authorized under Public Laws 94-482 and 94-142, a total of $557,402 for September 1, 1979, through June 30, 1982. In cost breakdowns by program areas, a total of $167,050 was expended for the two technology components for more than 100 students over the 3 years. The students in these high-technology components use facilities in the Oxford district, while students in the distributive education component run and operate The Grand Illusion Printing Co. in Auburn, and students in the buildings and grounds component work in Webster. The program is continuing tenuously on local support, but long-term commitments have not yet been obtained.

Project KING-By Tech. In the fall of 1980, the Governor of Massachusetts created the Bay State Skills Commission to fund projects that would address the needs of the State's computer industries for trained workers. Superintendent Driscoll formed a planning group that involved local educators and representatives from industry, colleges, the French River Teacher Center, the Worcester Chamber of Commerce's Career Education Consortium, and the Central Region Private Industry Council. The key to funding was the stipulation that 50 percent of financial support come from private industry and that the other 50 percent be available from the Skills Commission.

Late in the fall, Driscoll initiated direct contact with Del Lippert, Corporate Manager of Educational Training and Services at DEC's headquarters in Bedford. Recounts Lippert: "Driscoll had an idea and the Governor had a half million in discretionary funds. " It was, according to many in Oxford, "a meeting of kindred spirits-both want to make things better for education. "

Project KING-By Tech (Key Industrial Needs Gapped by Technology) was funded in January 1981 to provide underemployed and unemployed adults training opportunities in word processing, office automation, electronic assembly, programing, and program application. A total of 110 students were served with $46,015 from the Bay State Skill's Commission, $43,015 from DEC, and $3,000 from Quinsigamond Community College for instructors. As a result, the district's inventory of computer center hardware was increased, two teachers received training from DEC, and the working relationship with DEC was well established. DEC's Lippert explained that his company was interested in working with schools "who want to work with us, want to make something happen. " In the case of Oxford, there was a sense that the social and manpower views of the district tied into those of the company. Furthermore, Lippert felt that Driscoll conveyed a commitment and enthusiasm that was unique.

French River Teachers Center. Through the French River Teacher Center, 30 guidance counselors from Central Massachusetts high schools are learning about high-technology career opportunities (Project CHANCE). Sixteen sessions (begun in January 1982) included field trips to computer companies and companies that use high-tech tools, as well as discussion forums with representatives from nearby industries. Audiovisual, self-instructional materials on technology career donated by DEC will also be used. This project grew out of activities with the high-technology industry representatives from Unitrode in Lexington, Prime Computer in Natick, and Micro Networks in Worcester.

The Teacher Center, federally funded through September 1981, has continued to operate with a director arid a part-time secretary. Its continued existence depends on the director's ability to broker new relationships, such as the counselor's project and other activities with the district technology and training-related programs. For example, in February 1981, again through occupational education moneys, the Teacher Center provided training for 30 surplus teachers and other unemployed adults in computer programming (COBOL), word processing, and electronic test technology and assembly. The $54,080 project received $39,742 from the State, $8,640 from DEC, and $5,698 in contributions from the district. Several teachers trained in the program were able to find new jobs in the industry.

A mobile computer bus with $100,000 worth of equipment was loaned to the French River Teacher Center for use by area teachers and students in the spring of 1982. The bus was equipped with a PDP 11-34A computer and two video terminals, one magnetic tape card reader, two hard-copy terminals, and several self-paced instructional stations. Owned by DEC, the bus had previously been operated by the Commonwealth Center in Cambridge.

The Teacher Center will share use of the bus with the Humphrey Occupational Resource Center in Boston. Present plans are to find minimal funding so that a technician can take the bus from school to school, giving youngsters the opportunity to have hands-on experience. The loan of the bus was first discussed during a l-day teacher center seminar on computer technology held December 8, 1980, and attended by representatives of 11 school districts, 3 colleges, and private industry. A loose "consortium of computer teachers" was formed and has met several times.

The center has arranged for teacher workshops and courses on computers and microcomputers, collaborating with the Commonwealth Inservice Institute (funded by an IVC grant through the Massachusetts State Department of Education). Area teachers have learned BASIC programing languages, explored a variety of software applications, and examined computer applications and impacts. The center also organized a technology conference with the New England Teachers' Center Cluster, held this May in Worcester. Director Rob Richardson's contacts with DEC and other high-tech industries will enable him to schedule field trips, speakers, and presentations.

Impacts

Impacts on the School System. As far as principal Roger Bacon is concerned, the benefits outweigh the problems. The district has equipment worth a half million dollars that could not have been obtained any other way (see table A-l). Furthermore this state-of-the-art hardware is supported by DEC training and software. The two Oxford teachers trained at DEC have acquired the most current information and skills, and they immediately draw on these skills in working with their students. The collaborative partnership with industry goes far beyond the benefits received thus far. It is clear to Oxford's superintendent and his technology teachers that this working relationship is critical in enabling the district to keep up with the rapid changes in high technology.

Furthermore, DEC's expertise is recognized and relied on as program additions or revisions are considered. Other nearby companies directly concerned with the high-technology training programs are also continually contacted and utilized as resources. These close ties to industry, argue Oxford educators, make their programs more effective and unique.

Impacts on Teachers. Through the French River Teacher Center, Oxford teachers and those of the surrounding districts have participated in workshops, forums, courses, and visits to high-tech companies. Although no formal assessment of these efforts has been made, teachers indicate that they are better informed, more comfortable with technology, and would like to have more opportunities for training.

Impacts on Students. The Federal and State funded programs have reached numerous students. Project COFFEE students recognize that they now have skills, and they feel good about themselves and their program:

> . . . I'm an electronic assembler, I have a trade. . . . I can build you a stereo; before, I only knew how to push the buttons. . . . There are regular kids (taking the electronics assembly course) . . . and they need our help. They can't do the things we can. . . . If the program wasn't here, I'd be out of school we have teachers who understand us.

In assessments of student progress in entry-level high-technology training skills, based on a series of competency tests developed by the project staff and 16 industry/business representatives, 82 percent passed electronic assembly and 77 percent passed computer technology. The success of these special students is related to many factors. Technology skills, special counseling, and basic educational programs have all played a part. For the high school principal, the important result is that these students are turned around: "When these seniors graduate this spring and I get to shake their hands . . . I feel that this is what education is all about. "

In addition to the COFFEE students, other students from Oxford High School have also made significant gains in computer programing courses and in independent study projects under the direc-

Table A-1 .–Sources of Funds for Computer Hardware and Software, 1980.81

Description	Direct market value	Digital Equipment Corp.	State/Federal grants	Oxford School Department	Total
1 PDP 11/34 central processing unit	$41,500.00				
1 16-line multiplexer	4,100.00				
2 LA 34 decwriters	2,900.00				
1 285 LPM printer	7,800.00	$23,530.00	$39,097.00	-0-	$62,627.00
1 VT 100 video terminal	2,050.00				
3 modem cables	177.00				
1 200 CPM card reader	4,100.00				
Systems management training	2,100.00	2,100.00	-0-	-0-	2,100.00
Data-processing renovation/installation	9,150.00	3,000.00	6,150.00	-0-	9,150.00
3 W3 78 word-processing units	28,500.00	14,250.00	1,250.00	-0-	28,500.00
			13,000.00		
Electronics assembly training	3,200.00	*3,085.00*	115.00	-0-	3,200.00
1 TS-11 tape drive	15,400.00		2,035.00		
3 VT-1OO video terminals	6,150.00	*13,325.00*	7,000.00		*26,650.00*
3 LA 34 decwriters	5,100.00	*4,290.00*			
1 LA 34 decwriter	1,700.00		8,292.00	-0-	16,786.00
4 VT 100 video terminals	8,200.00		-0-		
1 RL02 disk drive	5,911.00	8,494.00			
5 RL02 disk cartridges	975.00				
14 self-paced audiovisual instructional programs	15,320.00	15,320.00	-0-	-0-	15,320.00
94 hours, level I consultants	5,160.00	2,560.00	2,000.00	-0-	5,160.00
Instructional supplies	14,130.00	3,150.00	600.00		
			4,200.00		14,130.00
			4,830.00		
			1,950.00		
Software programs	81,000.00	52,000.00	29,000.00	-0-	81,000.00
Totals	$264.623.00	$145,104.00	$119,519.00	-0-	$264,623.00

SOURCE” Oxford Public Schools, Oxford, Mass

tion of the computer center director, Al Jones. “In this kind of an environment, you don’t have to push them, you just have to keep up with them . . . The interest, the turn-around, the growth, of these youngsters is incredible. ”

As in many other districts, these computer whiz kids are at the center early in the morning and late in the evening until Jones locks the door. Several students—presently three or four—will have the equivalent of 2 years of college-level computing when they graduate high school. Another 30 or 40 will have 2 years of programing experience, not just in BASIC, but also in Pascal and in WATBOL (the University of Waterloo, Canada, educational version of COBOL). Students learn to operate all phases of the system, and their understanding and experiences are intentionally geared to the real world.

Jones talks about one of his students, a junior, who has written a “wonderfully sophisticated program to chart and analyze students’ chronobiological rhythms. ” Jones says this program “is better than the $20,000 software package we bought for principals. ” Another student recently went to help a nearby school district that was having major problems with its DEC system. In 3 hours he had solved many of the problems.

Only a few problems remain. One is that, on occasion, security of school records is a problem because both instruction and management functions are together. Also, there is a growing demand for courses and computer access, and demand may outpace resources. Finally, there are *some who* question the district’s growing emphasis on technology and programs for special students. They worry that other areas will be shortchanged.

Impacts on the Community. According to school board members, parents and students say again and again, “What a difference the technology programs have made. ” Parents describe changes in their children and indicate that they are now interested, know what they want to do with their lives, and have made complete turnarounds. What appears to be most important to the community is that these students have goals and some have employable skills. High school principal, Bacon explains: “They (parents and students) know that computers are the ‘in’ thing in Massachusetts. ”

By extending the technology programs to underemployed and unemployed adults and surplus teachers, the schools have made maximum use of the computer center and have provided benefits to the community. The absence of continuing financial support, however, may limit the long-term.

When the community parents, school board members, teachers, and administrators are asked why it has been possible to bring technology training and education to Oxford, they point to the following:

- an aggressive, energetic superintendent willing to chart unknown waters and take risks in starting programs without the security of long-term funding;
- a willingness by the school board and the administration to serve as the fiscal agents for the projects: to write the proposals; to negotiate with State and Federal funding agencies; and to contact the private sector;
- the commitment and ability to work together —administration, professional staff, school board, other districts, the private sector–to "get what we need for our students;"
- the availability of Federal and State funds, without which none of the programs could have been initiated;
- an ability to find resources when they aren't there: assembling a teacher center from surplus concrete motel shells transported to the site; or scavenging cartons of printout paper used on only one side, which become perfectly appropriate for the student's output; or scrounging obsolete electronic equipment, which became the instructional cadavers in the assembly labs;
- the use of professionally supervised students to reduce building assembly and finishing costs and, at the same time, meet the student need for on-the-job training; and
- a belief that "everything we do can lead to something else. "

Finally, they single out the superintendent's leadership and skill in unifying all of the participants, forging private sector partnerships on a personal one-to-one basis, convincing State officials from various departments to fund programs jointly, and utilizing public schools and community college facilities to expand technical educational opportunities.

Future

How will programs that have been developed continue to be supported? "Will the benefits and the progress made . . . that we are so proud of . . . now be emasculated because of financial constraints?" worries the school board chairman. With increasing costs, a reduced budget from Proposition 2%, and fewer Federal dollars for education, school officials and the community are concerned. There is some hope that the maintenance costs for these programs will be lower than the startup costs. Furthermore, it is hoped that the other districts will be able to find a way to pick up local costs.

Finally, Oxford has submitted Project COFFEE for validation by the Joint Dissemination Review Board of the U.S. Department of Education so that the Project could be eligible for National Diffusion Network Funding. Superintendent Driscoll hasn't given upon the State Department of Education, either.

Then there is further collaboration with the private sector. Educators argue that turning out trained, qualified people is the best selling point they have. The industry needs their graduates. When Project COFFEE students completed the wiring for the computer center, they proved they were capable of technically demanding work, and they saved the district $2,000.

Driscoll's dream for his schools and for his community goes even further. He wants to bring a major high-technology company manufacturing plant to Oxford. He feels this would strengthen the town's economic base and provide the long-term support the educational system needs. Others in the community support this idea and are hopeful that the district's technology training programs will be a strong selling point.

Resources

Case study interviews:

Francis G. Driscoll, Superintendent
Roger Bacon, Principal, Oxford High School
John Phillipo, Director, Project COFFEE
Allen Jones, Director, Computer Center and Teacher
Rob Richardson, Director, French River Teacher Center
Pat Ferreira, former teacher, Oxford High School
Elaine Birchard, student
Gary Bigelow, student
Paul Winiarski, student
Kenny Gatze, student
Walter Schur, Chairman, School Board
Patricia Troy, School Board Member
Del Lippert, Corporate Manager, Educational Services, Digital Equipment Co., Bedford, Mass.
Michael Odom, Digital Equipment Co., Executive-on-Loan, Humphrey Occupational Center, Boston

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Computer Literacy Program: Lyons Township Secondary School District, LaGrange, Ill.

Lyons Township's computer program was selected for study because it exemplifies a systemwide application of computing that involves and affects the district entire student population and more than 90 percent of the district professional staff in all curricular areas. This site provides an example of how a major infusion of computer hardware facilitates its widespread use and within a school system access, Local funds support the purchase of hardware, training of teachers, and development of software. Furthermore, it shows the critical role played by the local superintendent in conceptualizing the program, initiating action, and supporting ongoing activities.

The Setting

Located in the southwest suburbs of Chicago, the two campuses of the Lyons Township High School's (LTHS)–in LaGrange and Western Springs–enroll a total of 4,000 students. The school population is drawn from six suburban areas that are primarily middle-class, bedroom communities of Chicago. Approximately 90 percent of the students are white; 3 to 4 percent are black; 3 to 4 percent are Asian; and 4 percent are Hispanic. The majority, 75 to 80 percent, of LTHS graduates go on to college.

The school district's financial base is stable. Local property tax revenues (which include a strong industrial base) account for 85 percent of the budget; the remaining funds come from the State. The current budget is $19 million; per pupil expenditure is $2,300. School buildings are well-maintained-offices, hallways, and classrooms are pleasant and clean. Facilities appear to be more than adequate. (The boardroom looked more like that of a major corporation than of a school district.)

There is general consensus among the educational and lay communities that the district has been well, but conservatively, managed to support a strong, traditional curriculum. Through prudent management over the past dozen or so years, substantial sums have been placed in reserves—a unique situation, considering the strained economic condition of most of the Nation's schools.

Declining enrollments, the major area of concern for the district, may eventually have a negative affect on the number of facilities used (one or two campuses), the variety of programs offered, and the size of the professional staff. However, the superintendent argues that these problems can be resolved, in part, by the district's effective use of technology,

On the whole, the district's problems appear minor in comparison with other districts' financial woes, population shifts, student unrest, and staff reductions. Administrative and teaching staff and board members acknowledge how fortunate the district is. For example, teachers' salaries are at the top of national pay scales, and a new 3-year contract is in place. The major focus of the students and faculty is education, where learning is viewed as a serious endeavor.

Computer Applications in the District

The district's use of computers goes back to the late 1960's, when its first mainframe computer was purchased for the district management and business operations. As in other districts, instructional opportunities for students were limited to a few highly specialized courses in the business and math departments. Approximately 2 years ago, it became apparent that the district computer was outdated and would need to be replaced. In addition, there was a growing interest in expanding instructional computing activities and a general feeling that computer Literacy was important. The initial approach, according to a member of the school board, was to expand the large computer system to accommodate both needs.

At the same time, the board was interviewing prospective candidates for superintendent. John Bristol was the board's choice, in part because he already had experience with computers and instructional applications and had started one of the earliest computer literacy programs in Minnesota. Bristol convinced the board that student uses of computers ought to be considered separately, and that microcomputers provided a viable option to a mainframe computer with terminals. With strong support from the board, Bristol came to LaGrange ready to revise and expand the district's computer programs.

Planning

The superintendent's first objective was to develop a plan. From the outset, all the curriculum areas were involved. Decisionmaking was not limited to computer experts; building principals, department chairmen, and interested teachers were involved. A basic assumption of the plan was to provide computer experiences for all students: "the use of the computer should not be reserved for the gifted and/or mathematically oriented student. The computer needs to and can be utilized by students of all ability levels, including those with limited learning capabilities. " Three major applications were designated:

Instruction
Literacy
Competency
Speciality
Instructional support
Tutorial work
Drill and practice
Problem solving
Simulation
Instructional games
Instructional management
Success prediction
Monitoring student progress
Vocational guidance
College information

Hardware Selection

Another component of the planning activities was the selection of hardware. Not surprisingly, the most important criterion was "to obtain the maximum number of microcomputers for the dollars available. " Local maintenance and repair capability of the hardware vendor was also important. The planners agreed that highly sophisticated microcomputers with sound and color capabilities were not needed for this initial phase (computer literacy). However, networking capability was considered highly desirable and, networking in the laboratory setting is envisioned.

Hardware for the laboratories use a networked Radio Shack TRS-80, Model III Configuration: one 48K, twin-disk microcomputer, 26 16K, tape microcomputers, two networks, and one printer. Eight laboratories—four in each campus of the high school–are installed, with a total of 208 terminals for student use. The cost breakdown over a 5-year period is shown in table A-2. The superintendent maintains that these costs are reasonable.

In an interview with the *Chicago Tribune*,[1] Superintendent Bristol justified the district's large purchase:

> Some schools are reluctant to buy (microcomputers). They say that tomorrow there will be a faster or cheaper model. But how many tomorrows do you wait for? What is the value to get our students to have computer literacy *now?*

Computer Literacy for All Students

With the installation of over 200 microcomputers in eight laboratory settings, students at Lyons Township High School interact with technology first-hand. During the school day, the laboratories are busy with students and their teachers in a variety of subject areas. *English* students are refining their understanding of paragraphing with a tutorial program; *consumer education* students develop budgets using the number-handling capabilities of the computer; juniors in *social studies* master the facts required by the statewide constitution test in a series of drill and practice exercises; *biology* students solve problems using the computer as a powerful tool for analysis; and *special education* students expand their world history vocabulary in a series of drills, with opportunity for extended practice with an infinitely patient teacher.

[1] *Chicago Tribune*, Sunday, June 7, 1981.

Table A-2.--Five-Year Breakdown of Computer Hardware Costs

	Each	Total
Hardware (Networked Radio-Shack TRS-80, Model III)		
1 48K, twin disk	$1,946.10	$1,946.10
26 16K, tape	779.22	20,259.72
2 networks.	389.22	778.44
1 printer	904.80	904.80
Total per classroom		$23,689.06
Total for 8 classrooms	x 8 =	$191,112.48
Cost extension		
5-year life		
400 students per year		
Cost per student for literacy per year		
(Total cost ÷ 5 years ÷ (4,000 students + 4,000)		
$191,112.48 ÷ 5 ÷ 8,000 = $4.78/student/year		

SOURCE: Lyons Township Secondary School District, These computer-related activities are part of the program aimed at schoolwide computer literacy. In increasing numbers, students use the terminals before and after school. According to Bristol:

> My computers are used all the time. It's the best-used activity I have. To think that we were nowhere last spring and (look at) where we are today, I would have to say we've made a significant step forward.

A further step was taken in the spring of 1982, when all students completed a 5-hour "literacy package" that included lectures, films, group discussions, and hands-on activities. The package: 1) provided information about how computers work; 2) promoted keyboard familiarity; 3) promoted knowledge of BASIC language components; 4) facilitated programing activities; and 5) focused on future technology developments and their impacts on society. Current plans are to implement this package during second-period classes –1 day a week for 5 weeks, on a staggered schedule—thereby reaching all students with minimal disruption of ongoing classes.

The subject area applications and the special 5-hour computer literacy package were based on curriculum objectives originally developed by the Minnesota Educational Computing Consortium and adapted by the Lyons Township teachers to fit local needs.

Other Computer Applications

Six different computer specialty courses are now offered through business education and mathematics. These courses include data processing, programing languages (BASIC, COBOL, RPG), and systems analysis. Approximately 10 students complete the entire range of courses. However, within the last year, an extra section of the introductory BASIC course was added to the north campus schedule, and two additional sections were added to the south campus schedule. According to one of the computer course teachers in business education, there is a "growing interest from one semester to the next . . . that is a result of the literacy program. "

Teacher Training and Staff Development

The goal of computer literacy for all students and the objective of providing hands-on experience with computers in all subject areas made systemwide teacher training not only desirable but absolutely essential. Since the district could not count on hiring new staff, particularly as enrollments continued to decline, the superintendent's strategy was to reach out to all faculty members to build their awareness of the potential for *computers* in education, to cultivate their support for the program by involving them in the planning of workshops and computer software curricula, and to develop their computer literacy through training workshops and other staff development activities.

Costs for most inservice training activities (e.g., substitutes, consultants, payment for additional working hours) were absorbed by the district operating budget. A separate allocation for the summer software development activities was approved by the school board. By relying primarily on local district resources and scheduling activities during school hours, the district reduced training costs. At the same time, this approach widened the base of support and ensured districtwide commitment to implementation of the computer applications.

According to Esther Gahala, director of curriculum, there appeared to be a strong sense of learning by doing; the staff response was largely positive. Participation in the 8-hour fall workshops was voluntary, although some staff felt pressure from the administration. Gahala felt: "the value of these (staff development activities) was in finding out what not to do with teachers and students as well as what to do. Each experience refined our judgment and helped us in planning the next phase. Even more important to Gahala--who points out that she was unprepared to and, at first, totally overwhelmed by the thought of implementing computers in education—was the emergence of a cadre of 45 to 50 teachers who could advise, evaluate, and be a strong support system for the rest of the faculty.

Software Development

It is not clear whether software development was part of the superintendent's original plan. However, once the curriculum committee and advisory groups examined available software, there was a growing consensus that the district would need to develop its own. Proposals for computer applications were solicited and 47 proposals from 16 departments were accepted. Among the proposals were:

- Reinforce the spelling of words English teachers believe all students should know.
- Test the effects of alcohol on parts of the body, using statistical information, for a health course unit on alcohol abuse.
- Determine the gross national product of a country after being given certain characteristics.

- Drill basic chord fingering for learning how to play the guitar.
- Recognize grammatical errors in sentences for an English course.
- Determine appropriate calorie intake based on individual physical characteristics, physical activity, and weight goals for a unit on nutrition in a home economics course.

The superintendent wanted to involve teachers in the ongoing development process and, at the same time, use computer programers to write the software. To bridge the gap between the teacher-authors and the programers, the superintendent selected teacher-consultants from the staff who had both curriculum and programing expertise to function as supervisors. These supervisors played a pivotal role in software development by helping teachers understand how their teaching ideas could be translated into interactive computer formats and by helping programers design routines that were educationally sound.

Over the summer three software development teams (fig. A-1) produced more than 108 different program packets at a cost of $87,000. Originally, Bristol projected that 60 packages would be completed at a maximum total cost of $90,000. By hiring three local college student computer science majors as programers, the district used local resources and paid them at a rate of $10 per hour. However, without the expertise of the three teacher-supervisors (one of the three was described as a computer genius, able to solve problems and make the programs run for even the most novice user), the efficiency of the programers might have been reduced.

Impacts

It may be too early to assess the impact of the recent computer-related activities in the Lyons Township Secondary School District. However, there is evidence to suggest that both students and teachers have benefited.

Access to Computers

Students in this district do have opportunities to use computers during their regularly scheduled class time and before and after school. Some students interviewed carry their own floppy disks with their books from class to class. Some of the disks contain games; others hold student programs and ongoing projects. The district does not yet have data on the number of computer-related activities completed by students. However, it can be reasonably assumed that these students are interacting with the technology far more than students in other high schools where the number of terminals is far less.

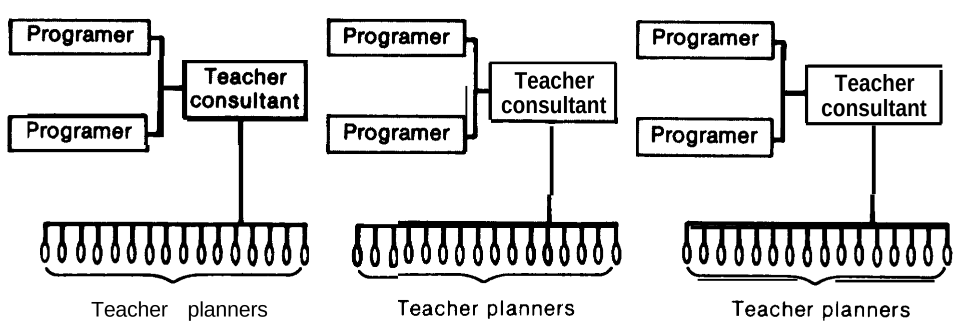
Teachers in the district also appear to have significantly more access to computers. Several teachers indicated that they regularly work with the computers on their own time. Some even take microcomputers home over the weekend.

Interest and Motivation

There is ample evidence to conclude that teachers and students alike have been stimulated by the programs. A student reflected: "I was here this summer . . . and teachers were asking—are the computers here today? Each day (the teachers) were learning new things. It really got me geared up—excited about the computer course this fall. " An unanticipated benefit has been the opportunity for both students and their teachers to share learning experiences.

Teachers comment repeatedly about the intrinsic motivation of the computer. Some applications are more interesting and effective than others. The

Figure A-1.—Software Development Model



SOURCE Lyons Township Secondary School District, La Grange, Ill degree of meaningful interaction is a key factor, according to Julie McGee, an English teacher. To maintain student interest, programs must be cleverly and creatively designed, "we can't just put our lecture notes on the computer. " All indications suggest that interest and enthusiasm will continue. However, cautions a student, not all students react the same way: "too much review and testing, large amounts of text (sic too much writing, not enough graphics), mandatory classes may turn the kids off. " For the teachers, "time, money, experience, vision" and a willingness on the part of the administration to revise plans to fit needs will be critical.

Curriculum and Instruction. So far, impacts on the curriculum have been limited to computer literacy activities. The strategy of building applications into existing courses appears to be working. One problem, however, is the uneven development of software. Some subjects have many applications (English, home economics) while others have only a few. Drill and practice formats predominate. Only a few simulations and tutorials exist,

Instructional effectiveness of the computer packages and related activities has not been formally assessed. As students and their teachers use the materials, they indicate that most are working. According to the director of curriculum, "we have the overwhelming feeling that what we are doing is worthwhile. " However, there is a need to analyze the appropriateness and effectiveness of the materials, not only to improve them, but also to move ahead.

Some questions remain: Are the students learning skills and content more effectively? Will all second-period teachers adequately cover the computer literacy activities? Do the activities result in student comfort and skill with computers? Is the computer's potential being realized? How well do computer programing courses mesh with postsecondary academic programs and vocational training? There is some frustration over not being able to tackle all of these questions at once.

Professional Growth and Development

Estimates vary on the extent to which Lyons Township High School teachers have become computer-literate. For many, the workshops introduced a welcomed new skill. For others, the groups were too large, the keyboard and computers were too alien, and the fear of failure was a barrier. Continued meetings and support activities have gotten and kept many teachers involved, but a few holdouts remain,

On the whole there is ample evidence to suggest that the majority of the high school faculty has strongly supported the program. Direct involvement of teachers in planning, training, and software development resulted in strong feelings of pride and ownership. The district strong support of professional development appears to be paying off: 108 software packages are in use; new ideas are continually being developed; and many teachers are expanding computer knowledge and expertise on their own time—taking courses, learning from more knowledgeable colleagues, and teaching themselves. Opportunities for new role as teacher-programers are invigorating and rejuvenating this mature, highly experienced faculty.

The Future

In the immediate future, the superintendent and his staff expect to implement the computer literacy program fully. At summer's end, all students will have taken the 5-hour course, and the remaining software packages will have been completed.

The next steps will focus on developing a comprehensive plan for computer competency and specialization. Full integration of the computer for computer-assisted and computer-managed instruction is expected within the next 5 years. The latter will depend on continued local software development and the availability of commercial courseware, In addition, with the major infusion of hardware, a corps of teacher experts, and an on-going program, the superintendent believes the district is ready for research and development. The opportunities for working collaboratively with hardware vendors, software publishers, university researchers, and other districts are beginning to be explored. There are tentative plans to hold a software development conference involving educators and developers statewide, perhaps nationwide. Plans already exist to field test new hardware components for the Radio Shack computers.

At the heart of future plans are the teachers and staff in the district. Bristol is convinced that the full potential for retraining, for new roles, and for continued purposeful activity has barely been tapped. It is likely that funds for continued staff development and for computer activities will be available as long as the school board, community, and educators support the various computer activities.

Resources

Case study interviews:
John Bristol, Superintendent
Esther Gahala, Director of Curriculum and Instruction
Julie McGee, English Teacher
John Gentry, Business Education Teacher
Bill Mchalski, student
Janet Kaski, student
Mark Nelly, student
Kim Firestone, student
Tric Coates, student
Doug Hammer, student
Jean Donnelly, President of the School Board

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Minnesota Schools and the Minnesota Educational Computing Consortium

The decision to visit selected Minnesota schools and focus on the activities and impact of the Minnesota Educational Computing Consortium (MECC) was based on evidence that Minnesota leads the Nation in computing activities in its educational system. This case study deals with a State education agency that provides a centralized system for computing and support services. With a computer inventory of approximately $44 million[1] and estimates that 1 to 1½ percent of annual school budgets will be used for hardware purchases, Minnesota classrooms are expected to have 10,000 instructional computing stations by 1984.

[1]Data Newsletter, Minnesota Educational Computing Consortium, January/February 1981.

The Setting

Minnesota is the "Land of 10,000 lakes, " and almost as many computers. Most of the State is rural. Fifty percent of the its population of 3,804,971 is concentrated in the Twin Cities of Minneapolis and St. Paul. There are 437 school districts and a median district size of 722 students. Major industries are agriculture, mining, and computer-related technologies.

Minnesota has provided strong support for public elementary, secondary, vocational, and higher education. Its education budget has one of the highest per capita education expenditures in the Midwest. This support has been matched with a commitment to innovation and educational improvement. Over the last decade, the State has provided funding through the Council on Quality Education (CQE) and title IVC Federal moneys for research and development of instructional computing applications. Projects have focused on instruction in all subjects, as well as piloted new ways to deliver instruction. Projects such as the Hopkins computer-assisted management system, the computer learning center in Littlefork, and the Robbinsdale computer software development, provided working models of technology applications and a foundation for statewide activity.

Many Minnesota school districts are sought out for their computer expertise. The plans of the Minneapolis public schools demonstrate the extent of this expertise. Within the last year, the State's financial picture has changed, significantly. In struggling with an $850 million deficit, the legislature has begun cutting the $2 billion (2-year) education budget. The cuts, an estimated $l20 million, are expected to take effect in 1982-83. Educators across the State are concerned that these reductions will affect teaching positions and programs.

MECC: A State Computing Agency

Presently in its ninth year of operation, MECC operates the world's largest general-purpose, educational, time-sharing system. An estimated 96 percent of Minnesota's students have access to this time-share system, which is available to its users from 7 a.m. to 11 p.m. daily. While timesharing access has remained fairly constant, with a slight increase in off-hour use, the acquisition of microcomputers in the State has accelerated, resulting in a significant increase in computing activities available to students.

History

In 1972, concern about computing and education led to discussions among the Governor, the chancellor of the community college system, the State commissioner of education, key State legislators, and private citizens. As a result, remembers John Haugo, former executive director of MECC, a task force was established by then Governor Wendell Anderson. Haugo was hired to head the planning effort, which resulted in a report that was essentially the plan for MECC. In retrospect, several factors were critical in initiating a major statewide educational computing effort that involved elementary, secondary, and higher public education.

First, the computer industries based in Minnesota (3M, Univac, Honeywell, and Control Data Corp.), created interest in, and awareness of, computing. These corporations also provided many computer resource personnel. Second, instructional computing was beginning to catch on, and educators were concerned that if they failed to take an active role, it would develop without their input and direction; there was concern that noneducational agencies would take charge. Third, there were examples of successful, cooperative, instructional computing ventures principally among the Suburban Minneapolis schools, the Total Instructional Education Service (TIES) consortium, and evidence that technology could deliver instructional services. With this was also a growing interest in cooperation and sharing of resources. Fourth, there was concern about the increased demand for computing services and the proliferation of hardware systems in various educational institutions. Fifth, there was recognition that educational funding constraints would limit operations, while a consortium would not be so limited. However, the most important factor, as far as the legislators were concerned, was equality of educational opportunity. The legislature was sold on the notion that computing opportunities ought to be available in all parts of the State.

The plan, therefore, was to provide access to the central computer through a telecommunications network. The State would subsidize the telecommunications cost to provide equal opportunity to all systems, even those most distant from the central system. Funding for the system and specific services to users would be contracted annually. Each school district or agency determined what they needed. The budget requests were developed and sent to the legislature.

Getting the time-share system to work was no easy task. In fact, there were many problems with hardware, telecommunications lines, and software systems. It took at least a year before the system was operating.

MECC Organization and Functions

MECC was established in July 1973 to provide computer services to students, teachers, and educational administrators. Organized under the Minnesota Joint Powers Law, its member systems include:

- State Department of Education (433 school districts);
- Minnesota State University System (7 campuses);
- University of Minnesota (5 campuses);
- Minnesota Community College System (18 campuses); and
- State Department of Administration (statutory authority for State University and Community College Systems).

MECC is responsible for coordination and planning—maintaining a long-range master plan for educational computing and developing biennial plans, providing technical reviews of proposals for facilities and services, and reporting on what is being done with computers by all of public education. MECC is also responsible for services to members, and it is this role that is being expanded (by the revised Joint Powers Agreement, August 1981), while the organization's policymaking role and its role in approving major computer acquisitions is being reduced. The latter activities will be determined by the State Board of Education with the Commissioner of Education.

Instructional Services Division

Operating the Time-Sharing System. The Instructional Services Division (ISD) runs the world's largest educational time-share system. It works reliably, and is "up" 99 percent of the time. Its Control Data Cyber 73 System, with 448 user ports, is currently accessed by more than 2,000 terminals located across the State in most public schools, all community colleges and public universities, and many of Minnesota's private schools. A multiplexing communications network with 23 hubs provides access to the computer.[2] ISD is also responsible for the communications network—its installation, maintenance, and coordination with local telephone companies.

'*Instructional Microcomputing and Timesharing: A Minnesota Perspective*, MECC Instructional Services Long Range Planning Project, 1981, p. 39.

An extensive library of programs supports a range of activities from drill and practice to mathematics problem generators, office management, and career guidance information. Thirteen different computing languages and programs are available to users. Software is continually maintained and improved.

Technical Assistance and Training. Through ISD, instructional computing coordinators are located throughout the State in each of the regions. These regional coordinators work with teachers who in turn serve as local coordinators for the school district or education agency. According to Will Jokela, MECC Instructional Coordinator for Central Minnesota, these local coordinates are crucial to the program. "They make things happen and are part of the whole planning and implementation process. "

For example, when Jokela conducts workshops across his region, he often uses local coordinators as resources. Jokela also holds sessions to demonstrate new programs for local coordinators, and these are often times when they share programs developed locally and duplicate MECC microcomputer programs. He keeps up with computing activities through the electronic mail system (also part of time share) and through visits to local schools and colleges. The regional coordinators help in disseminating information in the newsletters, through conferences, and through the electronic mail system.

At the same time, Jokela and others in his role became the link in continuing advances and changes. Soon after the MECC inexpensive computer contract was awarded, Jokela was "trying out the Atari" and getting ready to demonstrate its use to interested educators. He also delivered and installed the Apples purchased through MECC, and literally carted Apples across central Minnesota. Of his 73 public school districts in Region III, all have Apples and 62 used the time-share system in 1981-82.

Since the first purchase of Apple microcomputers in 1977, increasing amounts of the coordinators' time have gone into supporting microcomputers. Marcia Horn, an instructional coordinator in the Twin Cities area, points out that as soon as a workshop is announced, it is filled. Horn is impressed with the eagerness to learn and the excitement of those who attend her MECC introductory courses. In the sessions, technology is manipulated, not just talked about. That participants recognize the need for hands-on experiences is indicated, in part, by their willingness to bring all the equipment to class. Microcomputers and diskettes replace books, paper, and pencils, as learning tools. Principals, teachers, and librarians learn about and learn with the technology, in much the same way as do their students.

Developing Instructional Computing Software and Support Materials; Dissemination and Distribution. Software that has been designed and developed includes operating system manuals, computer literacy courses, and a range of supplementary instructional materials and management aids. Development is directly linked to the users (through the creation of software at the local level), to field testing and revision, and to implementation. Networking, originally begun through the time-sharing system, has been extended through the State instructional computing conference, regional meetings, the newsletters, and the other user activities.

What is clear is the value of sharing ideas, of providing a vehicle for development, and of disseminating this new information to users. Individual teachers, school districts, and regional organizations contribute software. MECC staff work with the developers to obtain rights to the material, then they document and standardize it so that other schools can use it. All software and support materials are available to Minnesota users (for copying) free or at nominal cost.

In October 1980, institutional memberships were offered to nonprofit educational institutions outside of Minnesota. Presently, there are 51 members in 23 States, Canada, Australia, England, Kenya, Saudi Arabia, Scotland, and Switzerland. In addition, software reproduction and distribution rights are arranged with commercial vendors under a royalty agreement. The income from these agreements and sales goes directly back into software development.

Management Information Services Division

Management Information Services supports a range of administrative management functions. Every school district in the State is required to use the finance reporting system developed by MECC. This division has also developed a student support system that handles student data, attendance, scheduling, reporting, and history. The personnel/payroll system is used by half of the districts in the State.

Special Projects Division

The Special Projects Division carries out research projects, developments of new applications, and evaluation. With funding from the National Science Foundation (NSF), computer literacy curriculum modules and support materials are being developed. An interactive video disk/microcomputer course in economics is under way with support from private foundations.

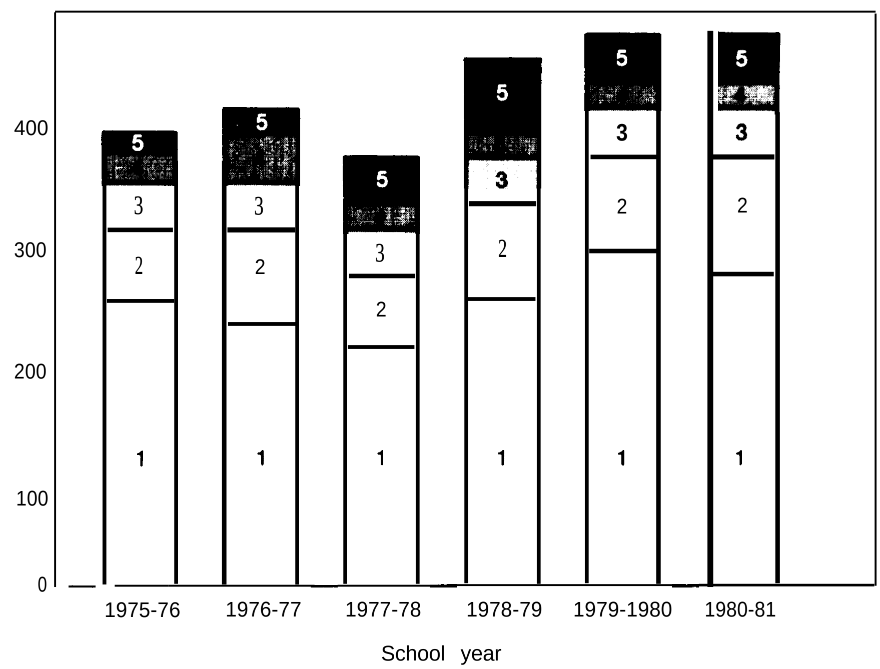
Impacts

Providing Access to Computing: Instructional Time Sharing and Microcomputing. Not only access but *equal access* has been Minnesota's goal for all students. From the very start, it was recognized that there was a need to achieve economy of scale in computer hardware acquisition, to create a cost-effective communications network to minimize the systems design and development costs, to share expertise and applications, to have uniformity and compatibility of data (administration), and to train educators.

The use of the timesharing system has been fairly consistent in time of the number of ports purchased by users and the increase of log-ins and connect time, which increased by approximately one-third during 1978-81 (see fig. A-2). Of the elementary, secondary, and vocational school districts, 75 percent used the time-sharing system, a slight reduction in use. At the same time, however, microcomputer use rose from 57 percent the year before to 85 percent of all districts.

The major use of the time-share system is for programing-up to 45 percent–with students from all over the State having access to almost a dozen different programing languages. The impact of these opportunities is not readily assessed through numbers, but clearly many of these student users have become outstanding programers. Winners of the MECC annual student software

Figure A-2.—MECC Timesharing System Port Distribution by User System, 1975-81



Key:
1 = Elementary/secondary/vocational
2 = State universities
3 = Community colleges
4 = University of Minnesota
5 = Nonmember institutions

SOURCE /m tructional Microcomputing and Timesharing A Minnesota Perspective, Report of the Instructional Services Long Range Planning Project, Minnesota Educational Computing Consortium, June 1, 1981 competition develop creative and impressive products. "Many of the future technology leaders will come from Minnesota, " notes Brumbaugh, "having had 8 to 10 years of computing opportunities in the public schools as well as training at the University of Minnesota's world-renowned computer sciences programs. " Minnesota benefits directly, since many of these high school and college students are hired as part-time programers at MECC and many enter Minnesota-based industries.

The impact on increased access by MECC's early entry into microcomputing with the award of the State contract to the Apple Computer Co. is clear. The decision to standardize hardware to one system was based on the belief that standardization was necessary in order to be able to support that system with software and training, thereby indirectly affecting access. (By early 1982, total Apple sales reached 2,863.) Most of the purchasers of these microcomputers are elementary, secondary, and vocational schools.

In 1981, MECC developed a second set of specifications for a low-cost microcomputer. The State contract was awarded to Atari, which agreed to pay MECC to convert at least 75 of existing MECC/Apple programs. In the first 3 months of the Atari contract, 230 microcomputers had been purchased.

A major reason that districts are purchasing microcomputers is to provide greater access. The high school in Maple Lake, a small rural district, has three Apples, one TRS-80, and one time-sharing port. Before the microcomputers, the 500 students had limited computing experience through time sharing. Even though four microcomputers aren't enough, they make a big difference to Mary James, a teacher and the district's computer coordinator. James is adamant about reaching every Maple Lake youngster:

> By the time they are 35 they all will have computers—many for their farm businesses—others in technical work (if they leave Maple Lake)--and for recreation . . . if most families have three snowmobiles sitting in their driveways now, they'll soon have computers, too.

It's not just the hardware that makes a difference, it's the support James gets from the range of MECC services. In this rural district, with an operating budget of $2.5 million for 1,320 students, the opportunity to use computers for instruction and to provide computer literacy courses and independent study, is due in large measure to MECC and to local administrative and school board support. James says:

> If MECC drops the time share we'd feel it . . . the larger city districts will continue. If I lose the port, I can stand it. If I lose the support of MECC, the whole program goes.

Developing Software and Making It Available to Users. Software and support materials have been steadily developed and revised to support the time-share system, the Apple microcomputer, and the Atari microcomputer. On the time-share system there is a library of more than 950 programs used at all levels. More than 200 microcomputer programs have been developed, and the number of new programs continues to expand at a rate of 8 to 10 new programs each month.

Although software development has been focused on Minnesota users, in the case of materials for the Apple (and now the Atari), two-thirds of the software distribution (primarily for the microcomputer) is outside the State. Single-item sales, institutional licensing agreements, and distribution arrangements with commercial vendors have increased significantly over the last 2 years. MECC officials point out that all of the income from software sales goes back into development. The current budget for development has tripled, with only 5 percent of the funding for software development coming from Minnesota. According to Brumbaugh:

> The amount of resources invested in instructional computing material development continues to grow, without any reduction in sight . . . It's estimated that 250,000 copies of MECC diskettes have been distributed or sold to computer users throughout the world. Software sales this year are expected to reach one million dollars.

Software development has been effective because it has been tied to what teachers want. Actually begun by teachers sharing ideas through the time-share system, it has continued to build on teacher ideas. Much of the software has primarily been cleaned-up, field-tested, documented, and made available to users by MECC. Another reason for success, many argue, was the decision to develop software for one microcomputer system. This decision provided an opportunity to refine authoring procedures, understand the capabilities of the machine, and develop more programs (e.g., instead of three programs for three machines, nine programs for one machine). After the award of the second computer contract, it was not difficult to convert many Apple programs for the Atari. The need and demand for microcomputer courseware in Minnesota continues, however. In MECC's 1981 Computing Opinion Survey, "Schools want materials in all subject areas-with the highest priorities given to computer science, business education, mathematics, science, and special education, " with less need for drill and practice and games and more need for problem solving, tutorial, and simulations.[3]

Local districts will continue to develop their own software and will also continue to purchase commercial software. For the latter, it may be desirable to provide help to schools by developing statewide purchase contracts for software, as has been done for hardware. Finally, as the market for software enlarges, there will be an increase in development in the private sector, argues Haugo, now president of a software development company.

Impacts of Information Technology

Professional Development and Training. Professional development and training is cited frequently as a major area of need that must be addressed if education is to take advantage of computer technology. Over a 6-year period (1974-80), MECC has provided significant development and training activities: 3,572 visitations by MECC staff to districts and campuses; 1,639 informal presentations; 1,756 workshops with a total attendance of 26,340; and 623 meetings for local computer coordinators. As impressive as these figures are, MECC officials point out that the demand for training exceeds capacity. Brumbaugh notes: "For every request for service that we fill, we turn one down. " Although many local districts provide additional training activities—the educational service unit or area vocational technical institutes and colleges and universities are offering an increasing number of courses—the needs for training are not fully met.

Furthermore, as State funding resources diminish, continuing to provide the current level of services will become a problem. According to Brumbaugh, there has to be a way to deal with teacher turn-over (trends show that the more highly technologically trained teachers leave), with new teachers as they enter the system, and with maintaining training for those who want to stay abreast of technological advances. When asked who should do inservice training for instructional computing, teachers and administrators ranked MECC staff as the most desirable-followed by local staff, then regional service centers, and finally colleges and universities. Data suggests that local staff will be able to assume most introductory demonstrations, but more advanced topics and courseware authorizing and design will require MECC staff.

Close Ties With Local Districts, Using Local Expertise. The superintendent of the Alexandria Public Schools, Clayton Hovda, attributes his district's early involvement with computers to the opportunity to be part of the statewide time-share system, as well as to the fact that MECC from the very start had key people "who came through the educational process, who knew how schools worked because they were school-based. " There was and continues to be a symbiotic relationship between the schools and MECC.

For example, the Alexandria schools shared computing and time-sharing facilities with the Area Vocational Technical Institute (AVTI). That experience, along with other examples (TIES), provided a model for extending the time-share concept across the State. A further example of this symbiotic relationship can be seen in the role of the local computer coordinators. According to Bill French of Alexandria, this role is strongly supported by MECC; the fact that most districts have a computer coordinator can be credited to MECC's efforts.

Providing Leadership. There is no question about MECC's leadership in providing hardware standardization, software development, and training. However, several school districts and regional agencies are leaders as well; and districts such as Hopkins and Robbinsdale have received national recognition for their computing activities. It is apparent that MECC walks a fine line: local autonomy of programs is highly valued, yet service and assistance are welcomed. The revised Joint Powers Agreement puts MECC squarely in a service role. It is also agreed that there is a need for leadership and coordination to maintain and advance computing applications; in this regard MECC, as the State's computer agency, plays a key role.

School districts outside the State, and even other nations concerned with educational computing, have turned to MECC for advice, technical assistance, and resources. For example, the first computer contract specifications developed by MECC became the model for the bids developed by the Region IV Education Services Center in Texas and for those prepared by school districts and several States including Florida, North Carolina, and British Columbia. A recent article which surveyed all statewide computing activities ranked Minnesota as the clear leader.[4] "No other State education agency comes close to achieving

[3]1981 MECC Computer Opinion Survey, User Opinion on Training,

[4]"Survey of State Governments and the New Technologies, " *Electronic Learning*, November/December 1981.

the level of commitment and organization achieved by MECC. But many State officials are now realizing that it may be their responsibility to move in that direction. ”

The Future

With reductions of the State subsidy for telecommunications, increased local costs pose a real barrier to time sharing, especially to the smaller, rural districts further away from the Twin Cities. Although much of the instructional activities can and will be shifted to the microcomputers, a real loss may well be the availability of advanced programing languages and the communications activities and the electronic mail system which tied so many of the districts to one another. Richard Pollack, Director of Special Projects, describes the time-share system as “the glue that brought it all together. ”

A spate of news stories have highlighted Minnesota’s financial difficulties. “What the rest of the Nation’s schools have been facing has finally caught up with us, ” one of the educators remarked. Many districts have begun to tighten their belts by laying off teachers and increasing pupil-teacher ratios. However, many districts, like Alexandria, plan to go ahead with plans for their computer programs. Bill French, teacher and computing coordinator comments: “I can see us buying 4 to 6 Atari’s for each elementary school . . . What’s $500 when we pay $2,000 for a typewriter or an Apple?” The additional costs for training and software are, in a sense, covered through the services provided by MECC. Although MECC has already had budget cuts and expects more in the future, increasing revenues from software sales will lessen the impact.

Superintendent Arthur Bruning, of the Hopkins School District, a Twin Cities suburb, also expects to expand his program using the low-cost computers. He sees technology bridging home and school, with the computers going home for extended activities. In this district, with an $18 million annual budget, he argues, “We will need to set aside resources for technology-for there is going to be a change (in the way we educate youngsters) and the pupil/teacher ratio will increase because of economics.”

Brumbaugh is optimistic. He sees opportunities for expansion of software and new technological advances that will make a difference in instructional computing. One example of these advances is an interface that allows microcomputers to be networked or clustered together. Once clustered, software maintenance is reduced, recordkeeping and management functions are simplified, and centralized printing is feasible. MECC is designing its own interfaces and networks. By fall of 1982, these networks will be field-tested in selected Minnesota schools. In addition, MECC’s long-range planners estimate that the number of instructional computing stations in classrooms in Minnesota’s schools, colleges, and universities will reach 10,000 by 1984.

Minnesota computer educators also confidently predict continuing developments in instructional computing, pointing to present programs—the result of more than 8 years of experience. The MECC software and materials, training activities, and the range of successful applications in computing, were possible because funding was sustained over a long enough period of time and over a critical mass of educational institutions and users. MECC’s accomplishments, the computing activity in Minnesota schools, and the significant number of students with access to these programs is the result of the State’s vision and its long-term commitment.

Resources

Case study interviews:

Minnesota Educational Computing Consortium, St. Paul, Minn.

Dale L. Schneiderhan, Acting Executive Director

Kenneth E. Brumbaugh, Director, Instructional Services, and Deputy Executive Director

Douglas P. LaChance, Acting Director, Management Information Services

Richard Pollak, Director, Special Projects

Marge Kosel, Manager, Instructional Systems Development

Marcia Horn, Instructional Coordinator

Kasey Mork, Instructional Coordinator

Willis Jokela, Instructional Coordinator

Minneapolis Public Schools, Minneapolis, Minn.

Paul Dillenberger, Math Resource Teacher

Hopkins Public Schools, Hopkins, Minn.

Arthur Bruning, Superintendent

Ken Corens, Computing Coordinator

Don Sension, Computer Center

Maple Lake Public Schools, Maple Lake, Minn.

Mary James, Teacher, Maple Lake High School, and Computing Coordinator

Eagle Bend Public Schools, Eagle Bend, Minn.

Wilbur James, Superintendent

Richard Lundgren, Communicasting Project Director

Alexandria Public Schools, Alexandria, Minn.

Bill French, High School Teacher and Computing Coordinator

Clayton Hovda, Superintendent

John Haugo, former Executive Director, MECC 1973-1981, presently President, Edu Systems, Inc., St. Paul, Minn.

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Instructional Computing Houston Independent School District, Houston, Tex.

The Houston Independent School District (HI SD) was selected for study because it is a recognized leader in urban education, in developing innovative programs such as magnet schools and in implementing cooperative efforts with industry and the business community. It has successfully halted declining pupil achievement, a major problem for urban school districts. The district also provides examples of how technology can be used to support and deliver basic skill instruction, to communicate with parents, to assist teachers, and to become the basis for technological understanding and computer literacy.

Moreover, it provides an example of districtwide leadership and coordination through a newly created department of technology and the Nation's first associate superintendent for technology. With a growing minority student population, the district has engaged in a planning effort to address equity and access to ensure that all students acquire basic skills and technological competence. As one of the largest school districts in the Nation, Houston also shows how economies of scale, critical mass, and volume purchasing power can be used to implement new programs and produce software/curriculum materials.

The Setting

The Houston metropolitan area population in 1981 was 2.4 million. It is a highly mobile population with a high growth rate for Hispanics and Asians. A total of 193,702 pupils attend 169 elementary and 70 secondary schools. Over the last 10 years the ethnic makeup of the student body population has shifted from an almost all-white population to one that is 23 percent white, 44 percent black, 30 percent Hispanic, and 3 percent Asian. Approximately 62 percent of the high school graduates attend college.

Houston is at the center of a booming industrial area. Its major industries are oil and gas, banking, construction, and chemicals. There are strong ties between HISD and area industries, the chamber of commerce, and the other business organizations. This relationship has been cultivated by Houston's superintendent, Billy Reagan, over a 7-year period. Through cooperative business/school arrangements, the district's pupils and programs have benefited. For example, magnet schools receive hundreds of thousands of dollars for equipment and scholarships from companies such as Exxon, IBM, DuPont, and others. There is evidence that the district focus on technology utilization, academic achievement, and career training programs has been positively received by the business community.

The annual budget of $507 million supports a wide array of educational programs for this district's diverse population. The district currently receives $13 million in Federal title I moneys. Houston administrators expect to feel only a slight impact from cutbacks in Federal funds, since most of their revenues are locally generated. Unlike many urban districts, Houston's financial base is thriving and its financial future appears secure.

The following issues facing the district affect educational programs and educational quality:

- The shift from an emphasis on desegregation, to an emphasis on quality integrated education (mid-1970's), to the current emphasis on the prevention of resegregation.

- Changes in family needs (dual wage earners) and an increasing number of single-parent families.
- An increase in the Hispanic population and enrollment, with a critical shortage of Spanish bilingual teachers.
- The shortage of math, science, and computer science teachers; a high teacher turnover rate in critical areas; and difficulty in retaining top-quality teachers.
- The increased computer use in all aspects of society and in the district.
- The increase in community support from parents, patrons, religious organizations, and businesses and professional organizations.
- The increase in student achievement since an all-time low in 1975, and the desire to maintain these achievement gains at all levels.

The major challenges, feels Superintendent Regan, are "continuing to offer quality education in an integrated environment to all children, and attracting and holding nonminority children, both from within and outside the District."

Instructional Computing

In the early 1970's, the district's first instructional computing programs were offered through the Region IV Education Service Center's computer. By 1972,20 terminals were used for problem solving, drill and practice, and BASIC programming instruction. Math and data-processing classes at the secondary level were primary users. Computing activities were limited, points out Patricia Sturdivant, Associate Superintendent, and there were problems with inadequately documented courseware programs and manuals and with high costs of hardware and associated maintenance costs. The links through telephone lines were unreliable, and when the mainframe was down no instruction was available. Despite these frustrations a small cadre of teachers persevered. These educators, more often than not, were self-taught. Few had computer-science college training.

By 1977-78, Houston's instructional computing efforts were well established. While computer applications varied, the major emphasis was on increasing pupil achievement in reading and mathematics. Not only was this a major priority for the district, but Federal title I funds were used to support these high-cost programs. Student gains were "dramatic," according to high school principal Franklin Wesley.

In 1979, the Region IV ESC established a microcomputer task force, to evaluate what was happening in the region's districts and to prepare recommendations for action. Task force members included Superintendent Reagan, superintendents of the Byran and Orange Cove School Districts, the director of data processing from Spring Branch ISD, and Sturdivant, then Region IV ESC Instructional Computing Coordinator. The task force found that use of time sharing had leveled off (after 5 years of steady growth), that interest in microcomputers was high, and that microcomputers were being purchased with "insufficient planning, and little understanding of their potentials or limitations." After purchase, districts were faced with inadequately trained teachers, a shortage of software, and a lack of technical support for hardware operation and maintenance.

The report recommended that hardware be standardized to facilitate training, maintenance and software exchange and development, and that high-volume purchase arrangements be made to reduce costs. Bid specifications were developed, and in June 1980, Bell and Howell's Apple 11 Microcomputer System was selected.

The Region IV Instructional Computing Services Division served as the fiscal agent for school districts purchasing microcomputers. High-volume purchases resulted in savings close to a million dollars over a 2-year period. In addition, the center provided computer literacy training to area school administrators and teachers, with more than 3,000 teachers receiving training. The center also offers a low-cost maintenance service for computer hardware; publishes a monthly newsletter; coordinates courseware purchase and selection; loans video tapes, films, and other training materials; and offers special workshops to meet the needs of individual school districts in the region. The working relationship between HISD and the service center is evidenced by Reagan's choice of Sturdivant as his new associate superintendent for technology.

Current Programs

By October 1981, the district survey of microcomputers reported 200 microcomputers located in 47 percent of HISD campuses. The most frequently used system is the Apple II, 48K. Local funds were used to purchase 45 percent of the microcomputers in the school buildings, while Federal funds paid for 31 percent. Parent-teacher organizations bought or helped to buy about 4 percent of the systems. Of those reported uses, 44 percent focused on classroom instruction; 29 percent were used for classroom management, and only 4 percent were used in school administration.

A year and a half later (March 1982), the estimated number reached 323. While use of the terminals linked to a minicomputer has decreased, several elementary and secondary campuses continue to operate drill and practice laboratories for compensatory (title I and SCE) and handicapped students.

Managing Competency-Based Education. The Booker T. Washington High School's competency-based education program for students uses the school's PDP-11 to score student tests, monitor student performance on specific learning objectives, and report progress to teachers. The school's principal, Wesley, argues that this approach is working for this school's depressed economic community and its predominantly black population of students who are at the bottom of the academic scale.

Computer Science/Programing Languages. Housed on the same campus (Booker T. Washington) is one of the district magnet programs—the High School for the Engineering Profession. These students take computer science courses in BASIC, Fortran, applications, and problem-solving, using terminals connected to the school's PDP-11. The school's computer science teacher works jointly with an engineer on loan from IBM. Other secondary schools offer computer science courses of instruction in several programing languages on both time-share terminals and microcomputers. In some elementary schools, students learn programing in mathematics.

Project BASIC. All secondary schools have implemented Project BASIC, a commercially developed program for HISD's Apple microcomputers which monitors reading lab students' progress and tracks their mastery of reading skills. Before implementing the program, extensive training took place: first of principals, then reading teachers, and finally technical aids who input data and retrieve information on the microcomputer.

Implemented in the 1981-82 school year, the project required a reorganization of the secondary reading labs, more than $600,000 (primarily SCE funds) to purchase hardware, software, and materials to operate the labs, and reallocation of existing operating funds to hire 67 basic skills computer operators, one media equipment maintenance technician, one supervisor, six area reading specialists, and one systems analyst.

Computer Literacy. A computer literacy curriculum, developed by Region IV ESC, is being piloted in five elementary schools with language programs for gifted and talented students. At Askew Elementary, students learn about computers and their impact on society. Their parents are also involved, Together, they find microprocessors that they use at home, and they collect and read newspaper and magazine articles. In class, students have experiences with the computer in drill and practice, simulation and tutorial activities. Finally, they learn simple programing routines. These students seem to enjoy all the activities, notes one of their teachers–particularly hands-on experiences. "They love it so long as they have a computer on the end of it. "

Operation Fail Safe. The district's computing power has also been used since 1977 in a unique parent involvement program, Operation Fail-Safe. Although not a teaching application, the program affects the instructional program. It is designed to reach parents, communicate information about their children's achievement, and help parents help their children (see fig. A-3).

This system-wide program is an example of how computer technology has been used to provide important data on a timely basis and on a massive scale, impacting 200,000 pupils, notes Sara Cordray, program director, Using the Region IV twin CDC Cyber 170 mainframe, HISD profiles each student's performance on the Iowa Test of Basic Skills; generates progress reports listing specific skill strengths in reading and math; develops individualized reading lists (sent home as a letter to each parent) based on each students' interest and independent reading level from a data base of 12,000 library books; and prepares vocational profiles based on a standardized assessment of each student. (Accompanying each profile is a printout of occupational opportunities and education and training requirements.)

Other current uses (documented in the HISD Microcomputer User Survey) of the microcomputers vary from school to school. Microcomputers are used in mathematics, reading, science, language arts, accounting and business education, special education, computer literacy, and programing activities. Some schools have computer clubs and some offer classes after school for students and parents. Some teachers are creating their own software, and others use commercially prepared materials.

Impacts

When Houston educators assess the impacts of technology on education, they point to improved

Figure A-3.—Sample "Fail Safe" Parent Letter

RODERICK GRADE 3

BERRY ELEM TEACHER : LACO

DEAR PARENT,

YOUR SUPPORT AND INVOLVEMENT IN OPERATION FAIL-SAFE IS MAKING A BIG DIFFERENCE IN HELPING RODERICK'S READING SKILLS. ATTACHED ARE SOME MORE ACTIVITIES THAT YOU CAN USE AT HOME.

GOOD LUCK IN HELPING YOUR CHILD BECOME A BETTER READER.

READING PRESCRIPTION FOR RODERICK

* MATERIALS: NEWSPAPER, COLORED PENCIL.
ASK YOUR CHILD TO HUNT HEADLINES FOR BLEND WORDS. ASK HIM TO CIRCLE THE ONES HE FINDS. HELP HIM READ WORDS HE DOESN'T KNOW. LET HIM READ THE WORDS HE DOES KNOW.

* PAIR PICK
CAN YOUR CHILD HEAR THE TWO WORDS THAT BEGIN ALIKE? READ THE THREE WORDS TO HIM. TWO OF THEM BEGIN WITH THE SAME SOUND. SEE IF YOUR CHILD CAN PICK THE PAIR THAT BEGINS ALIKE.
EXAMPLE:

SKIP SKILL STAND — WHICH TWO BEGIN THE SAME? (SKIP, SKILL) WHAT TWO LETTERS MAKE THAT SOUND? (SK)

DO THE SAME FOR THESE WORDS:

1.	SMUG	SPILL	SMELL
2.	STOP	SNOW	STAIRS
3.	SPUN	SWIM	SPOT
4.	SWING	SWEATER	SKIRT
5.	SNUG	STONE	SNACK
6.	SMART	SMELL	SNOW
7.	SPEAK	SPUNK	SMILE

* GOOFY SENTENCES
ASK YOUR CHILD TO MAKE SOME "GOOFY SENTENCES" WITH THE BLENDS. THE OBJECT IS TO INCLUDE AS MANY BLEND WORDS AS YOU CAN. THE SENTENCES CAN BE SILLY FOR MORE FUN.
EXAMPLES:

SMALL SNAKES SKATE SPEEDILY.

FLIMSY BLUE FROGS DRIVE SMALL PLAY CARS.

TO GET THINGS STARTED, SUGGEST BUILDING A LIST OF BLEND WORDS FOR "ST," "SK," "SM," "SP," "SW," "SN," "CL," "FL," "PL," "SL," "BR," "CR," "DR," "FR," "GR," "PR," "TR," AND "BL." BRAINSTORM WITH YOUR CHILD TO THINK OF MANY WORDS AS YOU CAN FOR EACH BLEND. THEN WORK TOGETHER ON CREATING THE GOOFY SENTENCES.

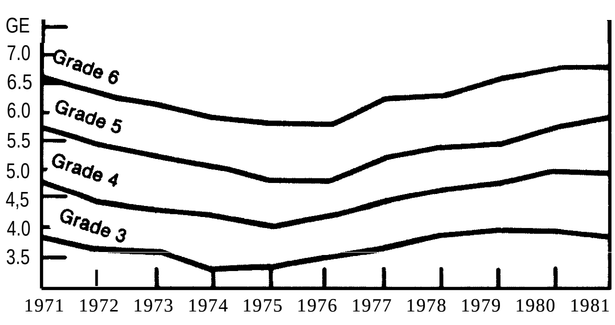
SOURCE: Houston Independent School District.

student achievement. The profile of HISD elementary students' mean composite scores from 1971 to 1981 documents the increased basic school performance of a student population who typically are low achievers (see fig. A-4). In 1980-81, the district completed its sequential testing program through grade 12. Although the results at the elementary level are more impressive, scores in grades 5, 7, 8, 9, 10, and 11 also show a significant improvement in achievement. Although not the sole factor, technology plays a critical role.

When the title I computer-assisted instruction (CAI) program was evaluated, students in grades 2-6 averaged gains of 1.1 months in reading and 1.2 months in mathematics in 1978-79. Students in grades 3-7 made similar gains of 1.1 months in reading, 1.4 months in mathematics, and 1.5 months in language in 1980-81, Of teachers whose students participated in the CAI labs, 93 percent felt that student performance improved as a result of CAI and 63 percent reported that students' achievement was greater than would be expected in a traditional instructional program. While students looked forward to CAI classes, teachers complained about the disruption to their classes when students were pulled out. Scheduling was fixed and inflexible. Moreover, when computers were down or telephone lines malfunctioned students missed instruction.

Operation Fail Safe was evaluated in 1977-78 to determine the relationship between parent involvement and student achievement. The level of parent involvement, determined by the school principal, was compared with students' achievement test scores. At every level—elementary, junior high, and senior high-a significant positive relationship was documented. A second study of a pilot parent-assist program involved 200 parents of third grade

Figure A-4.– Iowa Tests of Basic Skills, Mean Composite Scores, HISD, 1971-81



SOURCE Houston Independent School District

students in four schools. After students' reading skill areas were identified, materials were prepackaged and distributed weekly for parent-child use at home.

A comparison of these students and a control group (students not participating in the program) revealed higher significant gains for pilot students. Beyond these statistical gains, Operation Fail Safe has the strong support of the business community. Local businesses and corporations have paid for a $1 million advertising campaign that highlights parent involvement activities with the message, "Don't Fail Me–Help Me. " Seventy-four percent of elementary school parents and 39 percent of secondary school parents attend the program's parent-teacher conferences.

HISD and the Region IV ESC have provided leadership for the 101 local area school districts and for the State education agency. The Apple microcomputer bid process and contract had national recognition and was used as a basis for other district and regional education agency efforts. Region IV was one of the first to join the Minnesota Educational Computing Consortium (MECC) as an institutional member, providing area schools access to MECC-produced software.

HISD organized a technology conference for the National Institute of Education's Urban Superintendents Study Group in December 1981. The conference brought together educational leaders, hardware manufactures, and educational publishers to discuss common needs and to work towards collaborative efforts.

Finally, the district is bombarded with requests for information and for help–"everything you know about computers. " There is a steady stream of visitors who come to observe programs and see teachers and students in action.

As HISD moves its technology programs forward, Sturdivant sees the need to help schools to effectively use the technology that they have. She believes that, before schools acquire hardware or add to their inventory, they must plan for their use. That involves an understanding of the technology's potential and its limitations, the learning objectives to be met, and the trained teachers needed to implement the program. Sturdivant is also in favor by focusing on a few applications at a time, so as to give the district leverage for purchasing hardware and software. The major publishers will provide what the district needs "if they know we will buy, " The full impact of technology on HISD will come when "technology is fused to education . . . to what teachers are doing . . . and (is) not another add-on to the curriculum. If teachers can't be convinced that technology will make their job easier, they're not going to buy it. "

In addition, here will be a concerted effort in HISD to continue to identify those programs that are working and to replicate them. The key, states Associate Superintendent Michael Say, "is to channel the use of technology and coordinate it . . . Houston is on the verge of moving ahead in a significant way. " The district will fund the emerging programs out of State and local funds because "we want to determine our own emphasis and maintain our own programs. " Federal funds, he argues, should be used for innovation and state-of-the-art development.

Future

For HISD, the future is now. Although technology is already a part of the Houston educational scene, with diverse activities well under way, there is a pervasive feeling among educational leaders that hard decisions must be made, innovative actions initiated, and major resources reallocated as quickly as possible. At the same time, cautions Say, "We can't just throw technology out there and expect it to be used. " Houston's efforts will focus heavily on teacher and administrator computer-literacy training, and on acquisition of hardware and software that is coordinated with planned program development. Superintendent Reagan believes technology holds "untold promises . . . not to replace teachers but to become the full partner of the teacher. " The district's future plans are diverse; several are close to implementation or are already under way. Other plans are 2 to 5 years away from completion.

New Roles for Teachers. The position of teacher technologist with pay incentives (increased salary supplements) has been approved. Teacher technologists will teach teachers, parents, and youngsters and serve as catalysts, planners, and implementers of computer literacy and other programs on individual school campuses. These teachers will draw on the small cadre of staff members already implementing programs, as well as on others who are ready to move into this role. It is hoped that these new opportunities and increased pay will hold the district's trained teachers and attract new recruits, many of whom are choosing industry for their careers.

Extensive Staff Development. Through existing programs offered at the microcomputer center and through the establishment of additional centers and demonstration projects in schools involving teacher technologists, training activities will be significantly expanded. First priority for awareness and training activities will be school principals. School officials note that the principal is the key figure in program implementation.

Expanding the Use of Microcomputers as Instructional Delivery Systems in the School and Home. School officials expect the number of microcomputers in HISD to increase from the present 250 to 300 to approximately 1,000 in a year and to 5,000 to 7,000 in 5 years. A major use of these machines will be to increase student time-on-task in basic skill areas, especially in title I schools. Moreover, microcomputers will be made available to parents who have participated in training sessions and who are willing to help their children increase academic skills at home. Pilot programs will begin in September with schools that have implemented parent-school training and the Operation Fail-Safe partnership activities.

Although there is a lack of available, appropriate software, district leaders believe that there is enough to begin the programs and that more will follow as the microcomputers are purchased, and the district envisions software lending libraries available to parents who will purchase hardware on their own. Eventually, Houston's cable system will become part of home-school activities, with individual student prescriptions, homework assignments, and a range of learning packages geared to terminals in the home.

Computer Literacy for Diverse Student Populations. Over the next 4 years, the district plans to expand and develop magnet elementary and secondary schools located near major government, business, industry, higher education, and cultural centers of the city. This in-town consortium of magnet schools will be linked together by common program components and a common HISD transportation system. The plan is to integrate diverse cultural, racial, and socioeconomic student populations by offering a strong academic program that integrates the use of the computer as an instructional tool in skill development and enrichment activities.

Educational programs will take advantage of nearby resources, expanding HISD's Business School Partnership Program, which brings volunteers into the schools to tutor, teach minicourses, and organize field trips. These magnet programs will also use the resources of libraries, museums, universities, colleges, and community centers. With the increased focus on technology, the practical technical expertise of resource people from industry and the business community will play an even more important role.

Developing Technology-Based Courses. One way to deal with the district critical shortage of math, science, and bilingual teachers is to develop courses that do not require a full-time teacher. Although not on the district's immediate horizon, there is a growing idea that such courses, mini-courses, and the like can be developed because of advances in computer and video disk technologies. There is also a plan to make better use of the district's in-house television arid cable capabilities by designing remote-learning stations with instruction coming from a teacher in one location.

While some educators see these plans as visionary, others point to HISD's innovations in other areas and argue that, under Superintendent Reagan's leadership, these ideas will become reality. The superintendent is a powerful persuader: "Unless technology -i.e., the microcomputer, the video disk, and television—is fully developed and exploited to the maximum degree, we will fall further and further behind in Houston in providing the manpower for industry, for our defense, and for our future. "

Resources

Case study interviews:

Houston Independent School District, Houston, Tex.
Billy Reagan, Superintendent
Michael Say, Associate Superintendent for Instruction
Patricia Sturdivant, Associate Superintendent for Technology
Ronald Veselka, Assistant Superintendent for Research and Evaluation
Sara Cordray, Program Administrator, Parent Support Programs
Frank Wesley, Principal, Booker T. Washington High School
Richard Frazier, Teacher, Booker T. Washington High School
John Roustenstraugh, Test Engineer on Loan from IBM and Teacher
Helen Heard, Principal, Askew Elementary School
Two classrooms of gifted and talented students using microcomputers
Joy Louisa, Principal, River Oaks Elementary School
Susan Otto, Teacher of K-5 computer literacy classes
Madeline Reed, Director of Mathematics
Carol Kukendahl, Director of Reading and Language Arts
Patsy Rogers, Computer Resources Director, Microcomputer Center for Teachers

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Information Technology and Education in the State of Alaska

The State of Alaska is providing extensive and varied applications of computer and communications technology to education. Special geographic, demographic, sociological, and financial factors have made the State a forerunner in educational information technology. Alaska has a population unusually receptive to change and technology; a compelling need to apply communications and information technology to education; and the financial capability to invest in capital-intensive innovations.

Although many of the technical, political, legal, organizational, and educational issues and problems being addressed in Alaska are common to other parts of the United States, the special circumstances of Alaska require that any attempt to generalize from Alaskan experience be done carefully. Given this provision, it seems reasonable to look to Alaskan experience for useful lessons in the application of technology to education.

The Setting

Alaska is the largest State in the United States, covering a land area equal to about 20 percent of the remaining 49 States. Physically separated from the contiguous 48 States, it is characterized by rugged terrain, extremes of climate, low population density, limited land transportation, and many small isolated communities accessible only by sea or *air*. The total population of 400,000 includes 50,000 native Americans who belong to seven major and distinct culture and language groups. Over 50 different native languages and dialects are spoken in the homes. Alaska's population overall is relatively young. The frontier character of the region attracts pioneering young adults, while the rigors of life discourage retirees from remaining for their later years.

Alaska has about 90,000 school-age children distributed over an area twice the size of Texas. Alaska's 450 public schools vary in size from 2,500 students in an Anchorage high school to 8 or 10 students in one-room schools in remote areas. Although some of the 52 school districts in Alaska are geographically larger than those in most other States, they may have only about 1,000 students. The State is required by court decision to provide education to students aged 7 through 16 in their home communities, rather than by sending them to boarding schools in other communities.

In rural communities, most students are native Americans who have only brief history of schooling. The educational level of many parents is low, and the benefits of standard American schooling are not necessarily valued. Many of the students have a history of poor academic performance and a negative view of schools.[1]

The recent discovery and exploitation of oil in Alaska has provided the financial capability to invest large sums of capital in education. In addition to the average per pupil expenditure of nearly $7,000, there are special projects–such as $200 million for construction of schools and about $125,000 for the installation of a satellite receiver in **a rural** village. Rural schools are financed totally by State funds.

It is far beyond the scope of this case study to trace the general history of communications in Alaska. But it is important to recognize that the developments in educational technology in Alaska have occurred in the context of a generally atypical communications situation.

Communications technology that most Americans take for granted-telephones, radio, and television-have had a very complex and problematic history in Alaska. Alaska's long-distance telephone facilities were operated until 1971 by an arm of the U.S. Air Force. The system, served by high-frequency land radio stations, was unreliable because of ionospheric disturbances common to the region. In 1971, 142 villages had no telephone service at all. RCA Alaska Communications bought the system and was certified by the Alaska Public Utilities Commission to provide telephone service.

RCA encountered a variety of difficulties including hindrances by weather, unreliable electric power, employee problems in coping with village conditions, and villagers' lack of sophistication in dealing with the new system.[2] Because of the difficulties of providing communications on a private industry basis, the Alaska State government has taken a more active role in providing communications.

By the early 1970's, it became apparent that satellite technology offered a more promising means of providing telecommunications services to villages than had any previous technology. Several projects involving satellites were initiated by the State government, including an experiment funded jointly by the U.S. Department of Health, Education, and Welfare (HEW) and the National Aeronautics and Space Administration. (Later transferred to the National Institutes for Education (NIE)).[3] HEW and NIE support for this "ATS-6 experiment" was about $2.5 million.

The ATS-6 experiment involved educational and biomedical applications of satellite-transmitted color television and interactive audio to 19 sites in Alaska. Actual operations lasted only 9 months, during 1974-75, but planning had begun in 1972. The experiment was extensively evaluated and reported on.[4 5 6]

While some of these evaluations concluded that the experiment was not cost-effective, the project did build a base of technical expertise in the State with regard to satellite communications technology.[7] For example, a great deal was learned about

[1]William J. Bramble and Ernest E. Polley, "Microcomputer Instruction in Remote Vllages in Alaska, " Alaska Department of Education, 1981.

[2]A. Hills and M. G. Morgan, "Telecommunications in Alaskan Villages," *Science*, vol. 211, January 1981, pp. 241-248.

[3]L. Grayson, "Educational Satellites: The **ATS-6** Experiments, " *J. Ed. Tech Sys.*, **vol.** *3(2),* **fall** *1974.*

[4]B. Cowlan and D. Foote, "A Case Study of the **ATS-6** Health, Education and Telecommunications Projects, " ARC No. 308.3 **-C875, EHR-19**, Office of Education and Human Resources, Bureau of Technical Assistance, Agency for International Development, Washington, D. C., August 1975.

[5]Office of Telecommunications, "Alaska **ATS-6** Health/Education Telecommunications Experiment: Alaska Education Experiment Final Report, **vols**. I, II, III and Executive Summary" (Juneau: Office of Telecommunications, Office of the Governor of the State of Alaska, September 1975).

[6]**Practical** Concepts, Inc., *Implications of the* ***Alaska*** *Education* ***Satellite*** *Communications Demonstration for Telecommunications* ***Policymakers*** (Washington, D. C.: Practical Concepts, Inc., January 1976).

[7]T. S. Pittman and J. Orvik, **ATS-6** and State Telecommunications Policy for Rural Alaska: An Analysis of Recommendations, Center for Northern Educational Research, University of Alaska, Fairbanks, Alaska, December 1976.

the use of low-power ground stations.[8] Effectively structured audio conferences for adult interaction were found to be effective for educational purposes.' Institutional issues regarding media began to be addressed, such as ways of providing for local (as opposed to State or national) control over media and methods of providing appropriate programing for rural Alaska.

In 1975, the Alaska State Legislature provided an appropriation of about $10 million to initiate construction of more than 100 small Earth stations throughout Alaska that would extend satellite-based long-distance telephone service to many communities. The following year, the legislature expanded this satellite network to include television broadcasts for some communities. Since 1977, daytime instructional television (ITV) programs have been broadcast by satellite, and sites receiving these broadcasts have increased in number.

In 1978, the Alaska State Department of Education, with joint funding from NIE and the State, initiated the Educational Telecommunications for Alaska Project. This project, funded at $6 million, has developed several of the major educational technology systems and applications described in this report, including an electronic mail network, an information retrieval system, and multimedia individualized courses.

To help determine the instructional potential of satellite television, the legislature in 1979 requested that a study be made of the feasibility of using television for instruction on a statewide basis. "A Report on the Feasibility of Telecommunications for Instruction in the State of Alaska" was submitted to the legislative council in February 1980, In response to the recommendations of this report, the legislature approved an appropriation of $8.6 million to implement the instructional television and audio conferencing systems now known as the LEARN/ALASKA Network. LEARN/ALASKA is managed by the University of Alaska Instructional Telecommunications Consortium (UAITC), a joint organization of the University and the State Department of Education.

Use of Information Technology

Six major kinds of computer and communications applications are in varying stages of implementation and use in Alaska. These include the following:

- instructional television;
- audio conferencing;
- electronic mail;
- information retrieval;
- individualized study by technology; and
- computer literacy.

Instructional Television. By December 1981,85 Alaskan communities were receiving instructional television via satellite dish antennas. Additional communities continue to be added to the LEARN/ALASKA television network. The statewide instructional television channel broadcasts nearly 18 hours of progr aming every day for audience levels ranging from preschool through adult. The programs may be used directly in class or taped for later use.

Most of the programs are purchased from educational program producers in the contiguous 48 States. However, the State of Alaska is now providing funds for Alaskans to produce programing tailored to the special needs of its regional and cultural groups. The Northwest Arctic School District has received a grant from the State to develop programing appropriate for the Inupiaq Eskimos who live in 11 villages scattered throughout the 35,000 -square-mile district (about the size of Indiana). Students in Kotzebue are producing ITV programing which can be broadcast live from Kotzebue's transmitter.

Despite the large commitment to State instructional television, many problems remain. First, scheduling of broadcasts to meet user needs is a problem in a State that spans five time zones. Local taping of broadcasts for later use can resolve this problem, but there are copyright issues involved and not all programs can legally be copied. Second, the high cost of developing the needed programs can not be amortized over a large audience due to the sparse populations. Moreover, programing aimed at adults in the home is often ineffective when the home environment is crowded and not a suitable learning environment. Finally, political problems arise when the State-run network is perceived by local cable TV operators to be in competition with private industry.

The cultural impact of television has been an issue of considerable interest since the State first took initiatives in this area. Mechanisms for providing native consumer control over programing, scheduling, and operations have been of major concern since the earliest experiments. For example, James Orvik of the Center for Northern Educational Research observed, "Depending on how the

personal communication with William Bramble, Alaska State Department of Education, December 1981.

[9]T. S. Pittman, op. cit., p. 15.

development of a system is managed, early reliance on satellites as the principal means of delivery could be an open invitation to begin centralizing and homogenizing the entire process of media delivery and media use. To the extent such a trend would erode the emergence of local and regional systems, there is cause for concern."[10]

One of the strategies that has been adopted to ensure local and regional control for the LEARN/ALASKA network is the provision for regional programing facilities and the establishment of local capability to develop programs.

Audio Conferencing. In addition to instructional television, the LEARN/ALASKA network provides the hardware and the communications capability for audio conferences, which cost about $64 per line per hour to operate. In December 1981, the network had 59 audio conferencing sites; 104 are planned by September 1982. At each community audio conference center a coordinator helps users with the technical and administrative aspects of setting up and conducting a conference. A guide assists users in conducting effective teleconferences.

The University of Alaska has been an early user of this system for education. Students at many of the remote university campuses can join together in class discussions through the audio conferencing system. Some faculty members are beginning to develop expertise in the use of this technology, which, although powerful, requires a considerable amount of administrative time to implement. According to one professor, a faculty member must spend about four times more time administering a course that operates via audio or computer conference than he spends for a similar conventional course. These pioneering faculty are developing expertise in the appropriate structuring, management, and coordination of audio conferences.

Another major application of audio conferencing is for teacher inservice training. This method is highly cost effective in this State, where travel costs are very high.

Electronic Mail. Certain characteristics of an electronic mail system (EMS) make it an ideal technology for overcoming cultural, geographic, and scheduling barriers to education. Through EMS, students with different cultural backgrounds, located in distant places in different time zones, engage in seminar-type discussions with one other and with their professors. Even when all the students in a particular class are physically located at the main campus, they have more interaction with each other and with their professor through the system than they would be able to have in a typical classroom. This is particularly true for native Americans whose minority culture background often results in little class participation. The asking and answering of direct questions in a face-to-face setting is often in opposition to culturally accepted modes of interacting.[11] In Alaska two EMSs serve educational users: the University of Alaska computer network and an EMS operated by the State Department of Education.

The University network is by far the largest, serving 7,000 users at campuses and agencies throughout the State. In the month of November 1981, 104,000 messages were transmitted on this system. Used in innovative ways for learning and teaching, the University's system made it possible throughout the winter for high school students in Nome, Anchorage, Juneau, Kenai, Fairbanks, and Petersburg to participate in an honors program managed by a professor in the mathematics department of the University of Fairbanks. The students received assignments, collaborated with each other, and transmitted their work to the professor through the system.[12] Problems encountered in using the University network for classroom interaction have included: lack of visual material; lack of cross referencing of messages; too many simultaneous threads of conversation; too high a reading level in messages; inability to control negative messages; and student inability to digest unrelated topics.

EMS operated by the State Department of Education was developed by the Educational Telecommunications for Alaska (ETA) project. This network links administrators of the 52 school districts with each other and with the State Department of Education at Juneau. The system is directly accessible only to district administrators, not to school personnel, since the district offices are distant from rural schools. In November 1981, the system transmitted about 3,500 messages. The primary benefit of this system is for State and district administration.

There is no physical interface between the university network and the State EMS. The most commonly cited reason for this is security.

Information Retrieval. The Alaska Knowledge Base, developed as a part of the ETA project, is

[10] J. Orvik, "ESCD/Alaska: An Educational Demonstration," *J. Communication*, vol. 27:4, autumn 1977.

[11] Personal communication with Ronald Scollen at the Center for Cross Cultural Studies, University of Alaska, December 1981.

[12] Personal communication with Dr. van Veldhausen, Department of Mathematics, University of Alaska, December 1981.

a computerized guide to help Alaskan educators find current information about curriculum materials, successful classroom programs, and resource people willing to serve in the schools. Users access the knowledge base through the computer terminals located in the administrative offices of the 52 school districts and the department of education. During a 3-month period in 1981, about half the school districts used the system, retrieving about 3,500 items of information from this knowledge base.

Individualized Study by Technology (1ST). A major product of the ETA project is a series of 1ST courses for high school students in remote schools. These courses are designed to provide instruction that would allow the small, isolated schools to offer a variety of high-quality courses at the secondary level without increasing the staff size and without transporting students to schools in large population centers. When a school adopts 1ST courses, it acquires an Apple computer. The computer is also used for a variety of other applications such as high school accounting courses, computer science and data processing training, and drills in basic skills.

Six 1ST courses have been developed: Alaska history, English, developmental reading, general mathematics, general science, and U.S. history. The course packages include student reading materials, lab guides, audio cassettes, teacher guides, text and reference materials, and computer-based exercises and tests. The computer materials operate on stand-alone microcomputers (Apple II). An important component of the course design, computer-based activities provide a high degree of interaction with the student. In pilot tests of the courses the computer exercises were the mode of instruction most preferred by 74 percent of the students. Audio tapes were liked the least.

As typical of technology-based instructional systems, the pilot test evaluations indicate that revisions are needed.[13] "The lack of an overall model for what and how to teach in 1ST courses has contributed to some of the problems with course design, such as the lack of higher cognitive level tasks, high levels of reading difficulty, and problems with use of audio tapes."[14] Nevertheless, the adoption rate in 1981 far exceeded expectations. As of December 1981,95 schools had adopted one or more of the courses. Apparent benefits of the 1ST courses include the following:

- the courses work well for students whose attendance at school is irregular or seasonal, which is the case in many rural Alaskan schools;
- the courses provide more educational options within a small school;
- the computer component is motivating, and the equipment has other applications in the school;
- the courses are complete and self-contained, and are not dependent on local material resources or teacher knowledge of content;
- the courses provide continuity of curriculum in schools where teacher turnover is high.

Availability of the initial 1ST courses has provided Alaskan educators with an example of what is possible through technology. Demand for additional courses is building, particularly for high school mathematics and science courses. However, it is not clear at this point how development of such courses will be funded, or even how revision and maintenance of the initial courses will be supported.

The cost per student of 1ST courses will depend on the overall number of students using the courses, the number of students per course per school, and the lifespan of the materials and programs. It appears that the cost per student per course of about $900 will be less than the average Alaskan rural conventional course cost per student (about $7,000). One major cost component for 1ST is teacher training. In fiscal year 1981, the cost per teacher for training was about $1,500. Travel and per diem expenses accounted for a large proportion of these teacher training costs.

Computer Literacy. In Alaska, as in other States, the availability of low-cost microcomputers has generated considerable interest by educators in computer-related skills that should become part of the curriculum. Several hundred microcomputers are now available for student use in schools, and the number is growing rapidly. The Alaska Association of Computer Using Educators has been formed with the help of the State Department of Education. The department also publishes a newsletter for the association.

By providing teacher inservice workshops in computer literacy and by providing information to educators on available software, the State Department of Education assumes a leadership role in promoting computer literacy. In an arrangement with the Minnesota Educational Computing Consortium (MECC) the department provides cop-

[13] M. Howe, et al., " Individualized Study by Telecommunications Pilot Test Final Evaluation Report, " Alaska Department of Education, June 1980.

[14] Educational Skills Development, Inc., "Final Report Evaluation of 1ST Courses FY 81 Pilot Study, " Alaska Department of Education, November 1981.

ies of MECC educational software free of charge to the schools. It is now establishing a process for evaluating commercially available courseware and will seek to make arrangements with publishers to license distribution of courseware in the State.

Computers and Culture. In 1971, the Computer Center Director of the University of Alaska began a series of educational experiments in Alaskan high schools. He hypothesized that the use of computer technology could assist Alaskan natives in overcoming cultural barriers to learning in the classroom. He found that Eskimo children in Nome broke through cultural isolation through the use of Fortran programing; that a teacher could interact with Indian children through computer terminals when they would not interact with him face-to-face; and that Eskimo children gained an understanding of arithmetic through the use of handheld calculators.[15]

Impact on the Use of Information Technology

The LEARN/ALASKA network and the ETA projects have been implemented in the past 2 years and are just now beginning to be used operationally. The impact of these systems on education will not be observable for some time. There appear to be no plans by the agencies involved to monitor or evaluate the impact of these systems.

Knowledgeable persons in Alaska make the following kinds of predictions of the impacts of computer and communications technologies on education:

- curricula of small schools will become more standardized through use of the 1ST courses;
- nonschool-based education, such as correspondence courses, will become more important;
- individual schools, as opposed to school districts, will assume greater decisionmaking control;
- previously isolated cultures will become more socially sophisticated;
- native languages will disappear; and
- cultural barriers to educational progress will be overcome.

The increasing use of audio conferencing is rendering obsolete some institutional mechanisms and jurisdictional boundaries. Communications networks cut across school district and State lines, raising issues about institutional jurisdictions over accreditation of courses, tuition payments, school schedules, and the like.

Through their varied experiences in the implementation of computer and communications technology in education, Alaskans have addressed issues of design, implementation, and public policy that very likely all Americans will eventually have to address. By no means have all these issues been resolved in Alaska, but there is a more mature understanding of them now than 10 years ago.

- What are the risks involved in technological innovation, and how might they be minimized? According to a model being developed at the Center for Cross-Cultural Studies at the University of Alaska, the risks of wasted capital investment and undesirable cultural side effects can only be minimized if systems evolve with a high degree of user control over growth rate and direction.
- Should the cultural and other impacts of innovation be monitored and, if so, how? There is no formal mechanism for monitoring impacts and outcomes in Alaska. Some believe there is no point in it; others are concerned over our lack of understanding of impacts.
- What is the appropriate role of State government in delivering instruction-e. g., via television or computer-assisted instruction?
- By what mechanisms can educational needs be taken into account in the processes of establishing policies and regulations regarding telecommunications?
- How can educators and users drive the design of innovations?
- How can development of high-quality, user-relevant programing be financed?

The Future

Increasing use of computer-assisted instruction is highly likely in Alaska. The Report of the Governor's Task Force on Effective Schooling recommends "computer-assisted instruction as a viable means of enhancing schooling with respect to the development of skills and acquisition of content."[16]

Application of video disk technology, combined with microcomputers, is planned. The Office of Planning and Research in the State Department of Education has established a design team to analyze authoring systems, assess feasibility of group

[15] E. J. Gauss, "Computer Enhancement of Cultural Transition, " proceedings of the 1979 National Educational Computing Consortium, Iowa City, June 1979.

[16] Governor's Task Force on Effective Schooling, "Effective Schooling Practices, " State of Alaska, December 1981.

interactive video disk systems, and prepare recommendations for applications to instruction.

Audio conferencing will be combined with instructional television to provide interactive courses. Students watching an instructional television program will be electronically linked together and to the instructor, thus providing a technologically advanced kind of correspondence course.

University students in Alaska will have increasing access to courses at out-of-state institutions via computer and audio conferencing systems.

EDUCOM

EDUCOM was founded in 1964 as a nonprofit organization for colleges, universities, and other nonprofit institutions of higher education. Its current membership includes over 360 university and college campuses in the United States and abroad. The goal is to help its members make better use of computing and information technology. Areas of application are academic instruction and research, college and university administration, and library and information dissemination. EDUCOM provides the following types of services and activities:

- sharing and exchange of specialized computer and information resources;
- consulting on the management and use of computer technology;
- maintenance and dissemination of a financial modeling system;
- conferences, seminars, workshops, and publications; and
- research and specialized software.

Services and Membership Activities

1. *EDUCOM Bulletin.* The *EDUCOM Bulletin* is published quarterly, with a circulation of about 10,000. The bulletin reports on presentations, research projects, applications of information technology to higher education, and systems of interest to the education community.
2. *Annual Conference.* Annual conferences address resource sharing, computer networking, the development of information systems, and other topics of current interest to member institutions.
3. *Seminars.* Seminars in 1981 included, “Managing Microcomputers on Campus, ” and “EFPM: The EDUCOM Financial Planning Model. ”
4. *Research Reports and Monographs.* For example, the report of a 2-year, NSF-funded study of factors affecting the sharing of computer-based resources.
5. *Informal Communications.* These include letters to presidents, memoranda, and other mailings relating to the sharing of resources and the use of computing and other technologies in higher education.
6. *Discounts.* EDUCOM provides for discounts on the purchase or lease of computing equipment and related materials and services from selected vendors.
7. *Task Forces.* Task forces are designated to study special issues of interest to members.

Special Activities

EDUCOM provides specialized services through the activities of EDUNET, the EDUCOM Consulting Group, the EDUCOM Financial Planning Model (EFPM), and research and development.

EDUNET. This is an international computing network for higher education and research. EDUNET itself neither owns nor operates any computing facilities. Rather, it acts as a broker, linking using institutions who have unusual computing requirements with 1 of 16 institutional suppliers. Connecting links are established through commercial communications networks, provided by networks such as Telenet and TYMNET. Typical communications charges are $4 to $6 per hour. All arrangements, including billing, are handled centrally by EDUNET.

Planning for EDUNET was initiated in 1966 under partial sponsorship of NSF. Several studies and experiments followed, and a full network was established in 1979. On July 1, 1979, EDUNET became a permanent and self-sustaining activity of EDUCOM.

Membership in EDUNET in June 1981 included 168 institutions. Local access is provided in 250 U.S. cities, 50 Canadian cities, and 30 foreign countries. Resources available from EDUNET supplier institutions include:

- electronic mail and conferencing systems,
- tutorial programs,
- CAI authoring languages,
- statistical packages,
- subroutine libraries,
- planning and analysis models,
- simulation languages and games,
- data bases,
- data-base management systems,

- information storage and retrieval systems,
- programs for textual analysis,
- graphics software, and
- text editors.

EDUNET services also include a hotline, the quarterly *EDUNET News*, the informal EDUNOTE, a Member's Guide, electronic mail and conferencing, training workshops and introductory seminars, an on-line catalog of resources available from suppliers, and searches tailored to special requirements. EDUNET has developed special software so that microcomputers such as the Apple II can access the large computers used by EDUNET suppliers.

EDUCOM Consulting Group. EDUCOM Consulting Group was formed in 1972 as a source of impartial advice on the use of computing and information technology in higher education. Consulting is available in four areas:

1. System Performance Evaluation.
2. Strategic Resource Planning.
3. Organization Planning.
4. Management Systems Implementation.

In 1978, with a grant from Eli Lilly, & Co., EDUCOM built the EDUCOM Financial PIarming Model (EFPM). Users can build and operate budget models through a question-and-answer routine that requires no computer sophistication; access is via the EDUNET dial-in network.

EFPM now resides on a Cornell University computer. It is used by over 120 institutions. As of August 1981, it cost $2,000 per year ($1,750 for EDUNET members), plus $2,250 startup consulting ($2,000 for EDUCOM members), and from $8 to $20 per terminal hour. It is supported by user fees and grants. EDUCOM supports an EFPM Users' Group through a monthly newsletter and periodic meetings. Recent applications have been made in foreign higher education, in noneducational settings (the New York Public Library), and in the development of linkages for access by microcomputer.

Research and Development. Previous studies have addressed EFPM (described above), computing in small colleges, and the role of technology in library resource sharing. Of special interest is a 2-year study, completed in April 1981 for NSF, to identify factors affecting individual and institutional sharing of computer-based resources.

Budgets and Financing

The financing of EDUCOM is like that of other typical regional service organizations (RSOs).

> The typical RSO functions on a very tight budget with virtually no discretionary funds, and some proportion of continuing income derived from external funding agencies. With a tight budget, a small staff, and high reliance on volunteer efforts, the typical RSO is in a precarious financial situation. In order to offset financial instability, most RSOs rely on a mixture of revenue that includes membership fees and fees-for-service, as well as external funding.[1]

EDUCOM was incorporated with $1,000 privately donated by five faculty from five different medical schools. No public moneys were involved. It operated entirely on the basis of membership dues, fees for service, and volunteerism until 1972. Then, in the early 1970's, NSF sponsored three seminars and the development of a network simulation model. This led to the establishment of the Planning Council on Computing Education and Research. The council's activities were funded by grants from 20 EDUCOM institutions, with matching grants from the Ford, Carnegie, and Exxon Foundations. This funding was restricted to special activities and did not support day-to-day computing. In 1979, the council disbanded with the launching of EDUNET.

Additional funds have been granted by the Lilly Foundation to develop and maintain EFPM and by the Exxon Foundation to support computing relating to the law. Over the last 10 years, EDUCOM's total budget has changed, however, from over 50 percent reliance on outside grants to less than 10 percent. Membership dues and fees for service provide the large majority of its income. A tiny fraction is generated by TELENET discounts. Residual requirements are met by the current Lilly grant.

Future requirements for external support are expected to run between $50,000 and $100,000 per year. Thus, although EDUCOM has made significant progress toward self-sufficiency, its financial future is not yet secure. For example, EDUNET can balance its books only by drawing on a reserve fund established at its inception.

EDUCOM expects to receive progressively less support from the Federal Government, in part because of current Federal attitudes and in part because EDUCOM's own goals rarely match precisely the program interests of specific agencies. One successful strategy has been the solicitation of matching funds, preferably from private foundations. This approach assures consensus and

[1]D. D. Mebane, "Computer-Based Resources Sharing in Higher Education," *EDUCOM Bulletin*, vol. 16, No. 3, fall 1981, pp. 27-32.

commitment on the part of EDUCOM users, a sharing of the financial load, and isomorphism between EDUCOM goals and resources.

Industry-Based Training and Education Programs

The following discussions describe applications of educational technology in the corporate instructional programs of three companies. Examples have been drawn from the airline, high technology and tobacco products industries. Forms of information technology utilized by these companies include computer-assisted instruction (CAI), computer-managed instruction, computer-based simulation, video disk and teleconferencing.

High Technology

CAI is put to extensive use by a high-technology firm with corporate headquarters in the Northeast. The company has a large internal education group and an executive team that views training and education as an integral part of the product development and manufacturing process. Management instruction, technical training, and customer education curricula are developed centrally by the staff within this unit, but instruction is highly decentralized. Field training centers located in areas of good market potential, are the sites of most training for staff and clients. Computer-based instructional packages developed for use at these centers, are often distributed directly to corporate field offices for initial and refresher staff training.

Over the past few years, the company has experienced a severe shortage of college-educated generalists, a type of individual it had previously recruited to fill field-service engineering positions. Formerly, these individuals were given instruction in total systems design and, with access to engineering specifications, were expected to be fairly self-sufficient on field service calls. However, as the company's product line became more and more diversified, this approach to training and maintenance became unworkable.

At about the same time, the problems presented by classroom training on a fixed schedule, plus the ever-increasing travel and salary costs incurred while staff were receiving instruction, began to have impacts. Responding to these conditions, the company decided to revamp its recruiting program and training system for field-service engineers. A job analysis led to the development of three separate types of task-related instruction for three distinct types of hardware:

- terminals,
- small computer systems, and
- larger computer systems.

Having made the divisions, it was possible to lower educational recruitment criteria far below the bachelor's degree level for those to be trained to service terminals and small computer systems. (This was a major breakthrough, since the company employs some 16,000 field-service engineers worldwide.) CA I packages were developed in-house to reduce travel and salary expenditures of classroom training at the field-education centers. Field-diagnostic centers were established as backups to the new field-service structure, so that customers could contact experts knowledgeable in hardware and software design to diagnose the specific equipment malfunctions they were experiencing and to recommend their remediation.

This new training and maintenance system is paying off in a number of ways. The CAI system has proven to be very cost effective. It has enabled managers to weave training into existing work schedules, and has been more responsive to individual learning requirements. The new field-service organization has enabled the firm to overcome what was a severe personnel shortage and to keep customer service charges to a minimum. However, a technical education representative stated that the firm must continue to be aware of the limitations of CAI in that" . . . people can only use a linear system for so long before the learning curve is affected; they need contact with other individuals. " He urges managers of individual installations to use the system with groups of trainees in a classroom setting for maximum effectiveness.

At present, no other forms of information technology are used in the staff education program. In the near future, there are plans to use video disk integrated with a microcomputer. Cable television and satellite communications may also be used in the technical education programs.

Tobacco Products Co.

As an outgrowth of technological change, a major tobacco products firm has established a unit within its information systems group charged with analyzing the potential uses of newly available technologies in production and support activities of the corporation, including training. As a result of this program, a project on applications of synthetic speech and voice recognition is under way;

Hughes Aircraft Co. 's Training and Maintenance Information System (TMIS) is being used for the first time on a corporate production line; CAI is being extensively employed; and, within the next few months, a teleconferencing network will be established.

At one time, TMIS was being used as a training and maintenance aid for the U.S. Army's tank maintenance technicians. Under contract to the Army, Hughes Aircraft had developed the device, which consists of a video disk unit integrated with a microcomputer. Its cathrode ray tube (CRT) is used to present text and digital graphics-often simultaneously. After seeing a demonstration of the system in the company's corporate training center and conducting a formal evaluation of its potential in the factory environment, the tobacco firm decided to contract with Hughes to develop two prototype units to train employees to maintain and repair cigarette packaging equipment (both mechanical and electronic maintenance). The two devices—approximately 4½ ft high, 2 ft wide, and 2 ft deep—were installed in 1978.

Initially, the company saw two distinct applications for TMIS. They planned to develop a training software package for classroom use together with one designed to run in the plant on the production line, where several units would be installed, to assist maintenance/repair personnel on an ongoing basis. They soon discovered that one maintenance/repair software package with "imbedded training" would work in both settings, but in practice still-motion mode (single frames) would be used in the factory.

An evaluation of the prototype units in the training center was conducted in 1979. The results were dramatic in terms of the time and money saved as compared with traditional classroom instruction. As a result, three devices that had been specifically constructed for placement in the industrial environment were ordered from Hughes. Installation of the prototype in the plant is now in progress and will be followed by an evaluation of actual production-line use.

Because of the successful use of TM IS, the company is now considering the use of video disk to archive office records and to create an electronic parts catalog containing simulations of equipment. Users would be able to walk around a particular item, focus on its component parts, and then—using the same system— ascertain the number and availability of the part. Recommendations have also been made to use video disks for management training.

Many uses of CAI may be observed throughout the company. For the past 3 years the company has used PLATO basic engineering and computer science skills to train factory and office personnel. It uses Apple computers to teach task-specific skills, such as those entailed in learning machine operations, where simulation can be a particularly useful learning device. Approximately 35 percent of all training is devoted to the retraining of existing personnel, a process necessitated by continual modernization and modification of factory equipment.

A considerable amount of new construction and expansion of existing plants is now under way, and a teleconferencing system designed to link these facilities with corporate headquarters is about to be installed. The company is already examining how this technology, although originally designed to monitor construction progress, can be applied to training.

Airline Industry

A major commercial airline has an elaborate training development system that consists of:

- a corporate headquarters-based program for sales, instructor, and management training;
- a corporate headquarters-based computer division training activity;
- a centralized flight training center, located at a major airport away from corporate headquarters; and
- a centralized maintenance training center, located at another major airport some distance from corporate headquarters.

Once the design phase is complete, sales, instructor, and management training may be delivered centrally (corporate headquarters) or at individual airports or ticket offices. A CAI group develops courses that are then used by airline staff via existing terminals to book reservations and related activities. Wherever possible, CAI is used for "straight knowledge transfer. " For example, CAI development staff have devised courses on how to book reservations, compute fares, and carry out other tasks that are necessary in occupations such as that of a reservations agent, a passenger service agent, a storekeeper (airline supplies), a flight attendant, and airport operations personnel. Each time the airline's computer division develops anew application, lessons are developed centrally, and notices of their availability are distributed to all airports, ticket offices, and other locations, where management uses them to the extent that they apply to entry-level training and/or instruction of existing staff.

The airline would like to use the PLATO system in its management training program, but found it too expensive. Uses of satellite technology and telecommunications systems have been investigated, but costs have also precluded their use even though it is recognized that they are cost effective in the long run. Video disk technology has not been employed, nor are there any plans to use it in the future. Video cassettes are frequently used in management training to enhance traditional methods carrying out role-playing exercises.

Computer Division Training

The Deltac self-instructional video-cassette system is used by the computer division to provide technical training to programers, not for initial instruction but for professional development and upgrading. No other forms of information technology are currently being used.

Flight Training

Many applications of the PLATO system may be seen at the airline's Flight Training Center. A program for Initial First Officer training has been designed and tested, but little or no use has been made of it as yet due to current economic conditions within the industry. The company has also used PLATO in pilot training, and is now moving ahead with a Boeing 767 pilot training program to be developed entirely on PLATO. For the first time, this system will be used in lieu of flight simulators. Simulating various types of cockpit equipment, PLATO will give 767 pilot trainees a way to master these individual systems that is less expensive than using them in combination. Up to now, PLATO has only been used to substitute for the cockpit procedures trainer, a device that allows participants to practice certain processes after classroom instruction, but before flight simulator training.

The airline has also been investigating the use of video disks in conjunction with PLATO for flight training of visual effects and it may incorporate their use into the instructional package by the end of this year. Teleconferencing is being used to keep 767 course developers in daily contact with Boeing Aircraft engineers so that training designs may proceed in advance of actual aircraft delivery. (The airline also used teleconferencing for Boeing 747 design conferences.) While there are no plans to use satellite technology, a complete video tape production facility has just been installed at the Flight Training Center, which the manager of flight training hopes to use to develop instructional tapes for distribution to field operations at airports across the country.

Maintenance Training Center

All airline personnel engaged in maintaining airplanes and ground equipment either receive instruction at the Maintenance Training Center or are trained by means of video tapes that are produced there and then shipped to 56 maintenance stations (located at major airports). This is the third year that the airline has utilized video tape in developing maintenance training packages, at a rate of about 40 packages per year.

The manager of Training Support Services stated that the bulk of maintenance training is still carried out in the classroom by an instructor, Overhead projectors are used, as are slide-tape presentations that are developed by in-house curriculum specialists. Over the years, the airline has developed a number of computerized simulators for use in training airplane maintenance personnel, but high cost of simulators cannot be justified by the amount of use they get prior to delivery of a new line of equipment. After the planes are received, there is always sufficient "ground time" available for training.

Computer graphics are being investigated, since engineering drawings produced in the design phase are made available by airplane manufacturers on magnetic tape and their volume makes the use of manuals very difficult. However, cost may turn out to be the key obstacle here. The use of video disk technology has also been explored, but the manager of Training Support Services found it to be " . . . too costly to make that first disk . . . ," since his distribution network consists of only 56 maintenance stations. The cost of converting video tape to video disk is also a major prohibiting factor.

Information Technology and Libraries

The library-an institution that acquires, manages, and disseminates information—both provides educational services and serves as an educational resource. Information technologies offer libraries unique opportunities and capabilities for enhancing their current services and for extending them to new areas-particularly if, "The task of the library is to consider itself an institution for allowing people to utilize information."[1] Consequently, the advent of the information revolution could alter both the way libraries operate and their role in society.

Findings

- Information technology has changed the operation and user information programs of public, special, and academic libraries.
- Utilizing information technologies for operational programs can make libraries more productive and efficient and allow them to devote more resources to other programs-e. g., user services.
- Information technologies permit a library (sometimes called an information center) to greatly expand its resources. Networks, on-line information services, and cable services permit the sharing of materials and provide access to information in a way that was not previously possible.
- Libraries may be the only way that certain members of society can gain access to information technologies and to the information that these technologies provide.
- Libraries that fail to adopt these new technologies for information services many risk becoming irrelevant.

Libraries and Information Technologies

Use of information and communication technologies has affected all aspects of library services. Software is now commercially available for practically all aspects of *library operations:* circulation, inventory, acquisitions, periodicals, cataloging, and reserves. The use of the technologies for *information user services* has resulted in the formation of library networks and in the ability to access national data bases, thus allowing faster and more efficient access to information.

Programs oriented both to operation of the library and to user needs are critical for fulfilling a library's mission. For instance, an on-line acquisition system can reduce the ordering and receiving time for a new library purchase, thus providing patrons with the desired material in a shorter time. Circulation, cataloging, and other automated library systems offer similar benefits. One example of a commercially available system for library operations is the Automated Library Information System. This system can support many of the operational procedures in a library and is fully integrated.* Its many uses range from charge and discharge functions to cataloging and the maintenance of master holdings.

Networks

Two or more libraries may form communication networks utilizing information technologies to enhance the exchange of materials, information, or similar services. The formation of local, regional, and national networks has already significantly altered the operation of libraries.

The IRVING Network. When fully operational, the IRVING network in the Denver-Boulder, Colo., area will use communications technologies to link the library systems of Aurora, Boulder, Littleton, Denver, and Jefferson County in order to enhance their current capabilities. Each of the library systems employs different automated systems and in some cases different library operations procedures. Connecting these heterogeneous data bases, this new communication link will allow shared cataloging, more efficient interlibrary loans, shared acquisition, enhanced development of special collections, circulation within the entire system, an electronic message service, a reference information service, access to administrative data, and increased access to special collections (e.g., Denver's Western collection and Jefferson County's Asian collection.)

To date, no such system exists anywhere in the United States. This network, designed to expand beyond the current five systems to accommodate up to 30 other libraries, could serve as the foundation for the larger, automated, statewide network now under consideration.

The planning for IRVING was made possible through a Library Services Construction Act (LSCA) grant, and its implementation was funded by the Colorado Board of Education. Studies identified a distributive configuration as the most effective system for transmitting electronic data among the libraries in an interactive, on-line mode. Conventional analog service from Mountain Bell was chosen as the transmission media. The distributive option will require a smaller investment initially than would other alternatives (e.g., the use of public packet switching using public networks accessed via telephone links). Moreover, software

[1] M. Turoff and M. Spector, "Libraries and the Implications of Computer Technology," proceedings of the AFIPS National Computer Conference, vol. 45, 1976.

*A system which is fully integrated is one in which the individual procedures operate in support of the other system procedures.

for such a system will be easier to develop and maintain. This approach also permits the separation of the operation and the control of the network by allowing each participating library to be responsible for the operation of its own system.[2]

The CARL Network. Through the Colorado Alliance of Research Libraries (CARL) network, seven research libraries will share an on-line public access catalog reflecting the holdings of all institutions. Six of the CARL members are academic libraries; the seventh is the Denver Public Library, which, as members of both IRVING and CARL, expands the network. The holdings of these libraries represent 47 percent of the total collections and over 90 percent of the unique items in the State. Once these holdings are on-line, a user will have to search only a single public catalog rather than seven. Creating a single on-line catalog for these institutions will require modifying many operating procedures to comply with common formats, common records, and a common data base.

The University of Colorado at Boulder, the Colorado State University, the University of Northern Colorado, the Colorado School of Mines, the Auraria Complex, the University of Denver, and the Denver public Library have established a nonprofit organization to create this new research resource within the State.

As in the IRVING Project, LSCA funds were used for the initial planning efforts. Currently, moneys from the seven institutions; DataPhase Systems, Inc.; and Tandem are being used to complete the project. Two-thirds of CARL is now complete. Testing will begin by the summer of 1982; implementation is scheduled for the following fall. Once the public-access on-line catalog is in operation, member libraries intend to investigate electronic delivery of materials between their institutions.[3]

The OCLC Network. On-line College Library Center (OCLC) network is an example of a major computer-based cooperative network that is employed by all types of libraries nationally and internationally. The OCLC network allows libraries to acquire and catalog materials, order custom-printed catalog cards, initiate interlibrary loans, and locate materials in member libraries (2,500) and more. Through dedicated, leased telephone lines, members access OCLC services on specially designed terminals, through dial- access terminals utilizing the TYMNET telecommunications network, or by direct dial. The OCLC On-line Union Catalog contains over 7.4 million bibliographic records in MARC (Machine Readable Cataloging Format). If a library identifies an item of interest, OCLC produces presorted catalog cards. Also available are accession lists of newly cataloged materials for microform catalogs, circulation records, and selected dissemination of information (SDI).*

On-line Information Services. The increasing inventory of literature and information is making it almost impossible for a user to keep up, let alone to catch up. An example of the explosive rate of information growth can be seen in the areas of chemistry and chemical engineering, where the rate of literature growth can be tracked by the number of papers abstracted in the publication, *Chemical Abstracts.* For the 10-year period from 1961 through 1970, the rate of increase was 8.4 percent; during the 5-year period from 1971 through 1975 it more than doubled, to 16.9 percent. The recent increase has been even more dramatic—4.6 percent annually from 1976 through 1980.[4] This rapid expansion of information has also taken place in many other fields, such as medicine, law, and computer science.

On-line services such as national bibliographic data bases (e.g., DIALOG and BRS)–which are computerized retrieval systems covering a wide array of continually expanded subject areas-will make it possible for libraries to offer their patrons rapid access to a variety of information sources at relatively low cost. For example, PATSEARCH/ Video PATSEARCH, contains information on 800,000 patents heretofore available only in the U.S. Patent and Trademark Office files in Washington, D. C., on microfilm, or piecemeal through other data bases. The advantages of on-line services are listed in table A-3.

Maggie's Place: Pikes Peak Regional Library District. On-line community information and referral programs are being explored and instituted by some libraries as a concomitant of their access to national information sources and the resources of other libraries and information services. The Pikes Peak Regional Library District in Colorado, for example, has developed *Maggie Place,* a community information resource, which consists of computerized local and regional information of interest to its patrons. Users can access on-line all of the career and recreational adult educational courses

[2] S. Hartman, IRVING Coordinator, Boulder Public Library, Boulder, Colo., February 1982.

[3] W. Shaw, Executive Director, CARL, January 1982.

*SDI is the selection and dissemination of information of specific interest to a library patron.

[4] D. B. Baker, "Recent Trends in Chemical Literature Growth, " C&E News 59(22):29, June 1, 1981,

Table A-3.—Advantages of On-Line Services

Advantages of on-line services:
- Produce results very quickly
- Are cost effective
- Can be used for most types of searchers
- Can search fields (or data categories) for which there is no printed index
- Have the capability for searching very complex and elaborate strategies
- Offer the opportunity for increasing completeness of coverage through searching of multiple sources
- May contain information more current than available in the corresponding printed index
- Can be easily updated on demand or at regular intervals
- Permit any amount of strategy broadening, narrowing, or changing
- Causes less fatigue per search and reduces searcher's errors
- Require very little space for operation
- Save staff time
- Some kinds of data are retrievable only on a computer system
- Many more types of information can be searched on-line than in a manual system
- Material can be ordered with a simple command and charged to an account—a copy on demand service

SOURCE: Office of Technology Assessment.

available in the region through this program. Similarly, information is available about day-care centers, clubs and other community organizations, social services, and a matching carpool data base. The files are available both in the library and to approximately 500 members of the community and businesses with access to terminals.

Programs developed and in use at Maggie's Place include those for library resources, networking, and community resources. The library resource files are automated programs that relate to the operational needs of the library such as circulation, reserves, and acquisitions. Networking files give the user access to State and national information resources, such as DIALOG, BRS, ORBIT, RLIN, GIS, COCIS, and The Source.[5] The community resource files contain on-line information of interest to members of the Colorado Springs community. Currently, they include five files: calendar, day care, clubs, courses, and carpool. All of these are available for use in the library or in homes or businesses via telephone lines.[6]

Maggie's Place, compared with other public libraries, has a number of unique features. First, the amount of automation is unusual. A substantial investment has been made by the library district for this effort (almost $400,000 since 1976). Yet, despite the initial large investment, savings have been high-over $500,000. Second, the community resource files are the only such files in the Nation. Beneficial to librarian and user alike, they are a central and easily accessible source of the kind of information frequently requested. They demonstrate that information technology can assist both the operational needs of the library and the resource needs of the patrons.

Third, by making the library's programs accessible to outside users (over 500 presently), the library has expanded its capabilities for community use and utilized the information technology to its best advantage. And last, through the use of the technology, Maggie's Place offers all users access to information resources.

Microcomputers in the Library. Many libraries are considering installing a microcomputer on a coin-operated basis. Recently, several firms have begun to actively market such services to public libraries across the country. For example, in a contractual arrangement with Copy Systems, Inc., and CompuVend, a TRS-80 was installed in the Tredyffrin Public Library near Philadelphia. The computer is available for patron use at a cost of $0.50 per 15 minutes. The company is responsible for the operation and the maintenance of the equipment and has provided 24 Radio Shack program tapes, manuals, and workbooks on BASIC language and programing.

Library patrons may use the terminal for homework, statistical manipulation, learning how to program, playing games, and work. Children and teenagers appear to be the predominant users (65 percent), although this is expected to change in the near future. Average use of the microcomputer has been 2 to 4 hours per day, 7 days a week. Based on such community response, a computer with a larger capacity will be installed shortly. The new system will provide access to The Source and will attempt to satisfy the computing capacity require ments of the local business community. New program tapes such as Visicalc will be supplied.

With this arrangement the library uses the technology as an informational and educational resource. In addition, the library makes it possible for all those who do not have access to this technology in their homes or in their businesses to become familiar with computers and to have access to the valuable information resources they provide. The library also benefits in a number of ways: limited staff time is involved; the library is not responsible for operation and maintenance of the

[5] DIALOG: Lockheed Missiles and Space Co., Inc.; BRS: Bibliographic Retrieval Service, Inc.; ORBIT: System Development Corp.; COCIS: Colorado Career and Occupational Information System; RLIN: Research Libraries Information Network; GIS: Time Share Corp.

[6] K. Dowlin, Director, Pikes Peak Regional Library District, February 1982.

equipment; no financial burden is placed on the library (e.g., purchase of the equipment); the equipment will be updated to reflect changes in the technology and to reflect market needs in the community; step-by-step instructions allow the user to use the microcomputer with little, if any, assistance from a professional; and, thus, no extra staff training is necessary.

Other examples of microcomputer use include the following:

- The Clinton-Essex-Franklin Library System in upstate New York has installed a microcomputer for use by patrons. The decision was prompted by concern on the part of the librarian that patrons, particularly children, were neither familiar with computers nor had access to the technology. Although the microcomputer was installed in the Children's Room, it is available to adults as well. Volunteers have been teaching computer programing, and librarians believe that, based on its usage, the overall program is an overwhelming success.
- A cooperative effort has been initiated between the San Bernardino City School District, Calif., and the public library to assist students in preparing for proficiency tests. Microcomputers in three of the city's library branches provide CAI in mathematics and in the language arts. A queuing system allows high school students to be first-priority users through June 30, 1982. Other library patrons have access to the terminals that are not being used by students.
- The public library in Providence, R. I., has installed INFORM, a system whose uses range from bibliographic instruction to the use of audiovisual equipment. INFORM is regarded as an on-line library guide or handbook that also includes updated information on community events and agencies. Its touch-sensitive terminals are available with graphic and textual capabilities.
- Groups of school librarians in the St. Louis, Me., area have developed a series of self-instructional programs for the Apple 11 that are user guides for periodical indexes and almanacs, *Bartlett's Familiar Quotations, Current Biography,* and poetry indexes. The programs are aimed at the secondary school to adult levels.
- The St. Luke's Hospital Health Sciences Library in Missouri has instituted a wide range of programs on an Apple 11 Plus computer. Current programs include, among others: recordkeeping and reporting for nurses, continuing education classes, an "intelligent' terminal for on-line searching, nutritional assessment of intensive-care newborns, audiovisual inventory listing, and the logging and analysis of on-line searching records.

The provision of such services raises new questions for participating libraries. Where should the terminals be located. Should provisions be made for privacy? What type, if any, of collection development should the library engage in? Should the library sell disks for patron use'! Should there be a scheduling or reservation system or should patrons use the computer on a first-come first-served basis?

Cable Services and Video Facilities. With the expansion of cable franchises nationwide, an increasing number of libraries are exploring the potential of cable for delivering library services. Many libraries have employed video capabilities for years, but the addition of cable services in a community has expanded the library's resource base. The most extensive users of cable and video are junior and community colleges and public libraries. The former rely on cable services as a means of delivery, production, and housing of course materials; and the latter, for expanding the library's role as a community information resource center.

Generally, junior and community colleges, because they are relative newcomers to the academic scene, are most actively involved in video programing and cable services. Many colleges constructed during the 1960's and early 1970's incorporated video capabilities in their library facility or plan. Older research institutions and libraries, on the other hand, generally cannot afford to invest in video facilities nor to adopt their current structures to include such facilities.

The Division of Learning Resources at the Greenfield Community College in Massachusetts is an example of a community college library that has integrated video capabilities with local cable services. The library houses both commercially available video tapes and faculty/student-produced products. Students in conjunction with the Learning Resources Center and the local cable franchise produce weekly cablecasts for the community.

The Monroe County Public Library in Bloomington, Ind., is an example of a local public library actively involved in all aspects of cable and video services. The library has cablecast 3,000 to 4,000 programs a year (or 60 to 64 hours of programing per week) to the community on Community Access Channel Three. Half of the local subscribers (90,000) watch programs on Channel Three. Also 38 percent of the subscribers noted that local programing was a primary reason for initiating cable services.

A wide range of programs are offered and produced by the library. Some programs, such as "Kids Alive," are produced by children with assistance from the library staff. Local teachers, trained by library staff, allow the equipment to be used for many school activities. City council meetings are regularly cablecast; and special-issue programs, about housing and the elderly, for example, are presented.

Because of its active involvement in cablecasting, the library and Channel Three have been asked to participate in the refranchisement process. Library involvement in this process is common and occurs frequently. In fact, in franchise proposals library needs and desires are solicited by the bidders. Some of the programs developed at Maggie's Place will be used at other libraries as a result of cable awards.

Implications of Library Technology. Approximately 10 percent of the libraries of the United States have some form of automated capabilities, and an increasing number of libraries are exploring the possibilities of these technologies. On-line information retrieval services and provision of information technologies enhance the traditional services provided by libraries but also raise important questions of cost. For example, can a library afford to run searches for patrons on DIALOG free of charge? Can it afford to use these national bibliographic data bases, which require trained searchers, and entail cost ranging from $10 to $150 per hour? Such costs place an added financial burden on public as well as on academic and special libraries. For some libraries faced with reduced funding from State, Federal, and local sources, the price of the technology may be particularly burdensome. However, by not providing these services, libraries may prevent people from finding and utilizing the information, a situation contrary to the traditional role of libraries in society. (Furthermore, it has been suggested that when libraries provide these services and develop community resource files they become competitive with private information vendors.)

Such concerns are particularly relevant to a reconsideration of the role of public libraries in an information society. At present, libraries provide access to information and knowledge to all users free of charge, but it is questionable whether they will be able to continue to do so. One role proposed for libraries incorporates and reflects societal change. This role would entail:

- providing access to complicated or seldom used data bases;
- providing community conferencing and message center programs;
- providing on-line access to information or library resources;
- providing access to community data and community information locations for referrals;
- providing access to resources in other libraries via networking;
- providing access to high-demand information and materials via computer or video disks; and
- providing access to electronic resources for those who cannot afford home computers or terminals.[7]

Museums

Findings

- More and more museums are incorporating information technology, particularly computers, into both their exhibits and their educational programs. The technology is used for operational purposes and to provide computer literacy and related courses.
- The introduction of the technology to museums is altering the role of these institutions. This change is especially evident in the recent establishment and success of childrens' museums across the country.

Museums, like libraries, provide important educational services. Since the establishment of the first public museum in 1743, museums have exerted a strong influence on U.S. culture. They function as repositories for conserving the world's culture and for relaying it to present and future generations.

Beyond the overall educational nature of their exhibits, most museums conduct and provide additional educational services. Recently, more and more have incorporated information technology, particularly computers, into both their exhibits and their educational programs. They are used generally for operational purposes and to provide computer literacy and related courses. The delay in acquiring information technology until only re-

[7]Ibid.

cently, has been primarily due to the fiscal constraints common to most museums, which operate on a limited budget and depend on donations that can fluctuate from year to year.[1]

The Use of Computers

Computers are generally used for four purposes: for interactive exhibit devices, for exhibit control, for administration, and for education programs. All have educational applications.

Interactive Exhibit Devices. Museums use computers and related technologies to increase the attention span and alter the traditional experience of the typical patron. It is possible, for example, to increase a viewer's attention span from 10 seconds to 3 to 10 minutes, a significant improvement that has enormous implications for how a museum can present information. Examples of exhibits range from instruction on how to use a computer to using a computer to calculate quickly the nutritional value of a meal. Simulation programs are widely utilized, although these are also the most difficult to create.

Incorporating computers into an exhibit presents some special problems not generally encountered with other media. The exhibits must be appealing in order to attract users, but the programs must be relatively simple, since most users are unfamiliar with the technology. Furthermore, such programs must be able to contend with repeated mistakes, constant use, and even abandonment by the patron. ' Thus, developing programs suitable for a museum environment involves considerable skill.

Exhibit Control. The control of exhibits by computers has a number of advantages: 1) cost and maintenance are reduced because of fewer components; 2) additional features can be added at minimum cost; 3) control devices can be standardized from exhibit to exhibit; 4) the potential exists to customize a patron's experience; and 5) computers permit greater flexibility in altering an exhibit at relatively low cost.[3]

Administrative Uses. Computers are largely used for such standard purposes as word processing, accounting, updating mailing lists, recordkeeping, collection management, and inventory.

Education Uses. During the past 10 years several museums have introduced computer literacy programs and computer labs. Offering these courses is a natural extension of previous and ongoing educational activities within museums. And, as with libraries, the availability of such programs makes it possible for users to become acquainted with this technology in a nonthreatening environment in which there is no pressure to succeed or fail.[4]

The Hands-On Approach

The Lawrence Hall of Science. In general, museums that provide programs in computer literacy have adopted a hands-on philosophy. This principle was first initiated at the Lawrence Hall of Science in Berkeley, Calif., in 1972, when an exhibit entitled "Creative Play With Computers" was introduced. The exhibit used the university's timesharing system and teletypes. Since then, this program has been expanded to include a computer laboratory, and computer technology is used extensively throughout the exhibits. The computer laboratory has 30 microcomputers that can be used for computer literacy programs or individual programing by anyone 8 years or older. The Hall of Science also operates the Science Shuttle, which transports microcomputers to local schools for computer literacy and related classes. The Science Shuttle has greatly increased the access to computer technology by local school-age children.

The Capitol Children's Museum. Newly established in Washington, D. C., the Capitol Children's Museum is a learning center with a strong emphasis on communication. The most recent addition to the facility, the communications wing, traces the growth and development of communication throughout human history. Like the Lawrence Hall of Science the museum uses the hands-on approach in all of its exhibits. Similarly, the museum has a computer classroom, the Future Center, with 20 microcomputers.

A visitor to the museum's communications wing is introduced to communication through a sound and light show held in a model of a 30,000-year-old cave. The cave depicts the earliest type of communication: drawings of man's experience with hunting and tools. Further developments in the forms and means of communication are shown through a wide range of exhibits: torches used by the Greeks to relay messages, drums used by African

[1] R. King, Director of Exhibits, Boston Museum of Science, February 1982.

[2] D. Taylor and D. Rhees (eds.), Survey *of Computer Use in Science-Technology Museums* (Washington, D. C.: Association of Science-Technology Centers, 1981).

[3] Ibid.

[4] P. Hirschberg, Coordinator, Communication, Capital Children's Museum, April 1982.

tribes to relay messages via different sound patterns, and a variety of written forms—alphabets and hieroglyphics. In addition, other ways to communicate such as Braille, Morse code, pig latin, and sign language are shown. Many of the more recent types are demonstrated by means of video tape players or microcomputers.

The wing also contains telecommunication devices. For instance, there is a fully equipped radio studio available for use where children can produce and tape messages for their own use. There are future plans for a comparably equipped television studio. Also, there is a scale model of a satellite dish inside the museum that replicates the museum's communication satellite dish which can receive up to 40 cable channels.[5]

The Future Center is a classroom equipped with 20 Atari 800 microcomputers complete with printers, disk drives, and color monitors. Its purpose is to introduce new users to microcomputers and to allow previous users access to the technology. The center thus makes available to everyone both the technology and the skills and information it provides. The courses offered range from those designed to assist teachers who are unfamiliar with the technology to become computer-literate to those to introduce children to the technology. Schools that do not have microcomputers can schedule class visits on a regular basis.

The courseware are combinations of programs developed by the museum staff and software donated by Atari. For example, PAINT, a software and book package, allows the user to create paintings on the Atari, while using a variety of learning skills as well as learning about and exploring the microcomputer. For more experienced users there are courses in programing BASIC. Because obtaining quality software is a major problem, the staff of the museum is actively engaged in design-

'Ibid.

In the Capitol Children's Museum, Washington, D. C., a visiting primary school teacher works with her students as they become computer-literate. Schools from throughout the Washington area utilize this facility to introduce their students to the world of computers. Many schools enroll their students in a special series of classes designed to enhance their primary and secondary education ing and developing software for the Future Center's constantly growing and enthusiastic clientele.

As a nonprofit institution, the Capitol Children's Museum *relies* on corporate donations and grants to continue its operations and to develop new exhibits and educational services. The majority of the museum's equipment has been donated by private companies; e.g., the satellite dish by Scientific Atlanta, the microcomputers from Atari, and a PDP 11/70 and supporting hardware (printer, video terminal, and disk pack) from the Digital Equipment Corp. (DEC), to name just a few.

The recent gift of a minicomputer by DEC represents a significant contribution to current museum services, but more importantly to future potential. Once operational, the PDP 11/70 will be able to interconnect all of the museum's exhibits, thereby increasing the control over their use. It will also provide an internal tracking and information system of exhibit users—how many visitors utilize what exhibit for how long, and so forth.

In the long term, the computer will be the basis for Kid Net, a time-sharing system that will be both an internal and external network. Internally, the system will facilitate such activities as electronic mail, games, and demonstrations. Externally, the network will be connected with other Washington-based institutions such as local schools and Congress and will possibly tie in with other children's museums such as the one in Boston. Other long-term possibilities include a national electronic newsletter. [G]

The Use of Video Disks

Several museums are experimenting with video disks for storing and preserving collections. Because they are both very new and very costly, few museums, have employed this technology. However, the video disk's features make it uniquely suited for collection management: large amounts of material can be sorted; materials don't deteriorate; researchers are not dependent on original materials; and the content of a museum's collection of photos, slides, or art can be sent for viewing to other institutions around the world.

The Smithsonian Museum of American History is placing some of its collection of (30,000 to 38,000) slides and photographs on a video disk. This measure will ensure the life of this combination of materials since most of it is fragile and subject to damage from repeated use.' In a similar project, the National Air and Space Museum is placing some of its photograph collection on video disks and interfacing the disks with the museum's computer. The museum also has an interactive video disk which allows patrons to design an aircraft. [8]

The National Park Service (NPS) of the Department of the Interior also uses video disk technology. NPS originally used video tape players at many of its visitor centers. However, the initial high cost of purchasing the equipment, plus the high rate of failure, maintenance costs, and tape breakage, led to initiating trials of video disk technology. Several video tape players have since been replaced by video disks. NPS is also considering video disks for use in collection management for reasons similar to those of the Smithsonian American History Museum. If collection management of selected projects at NPS is implemented, the disk would provide access to a variety of educational materials.

'Ibid.

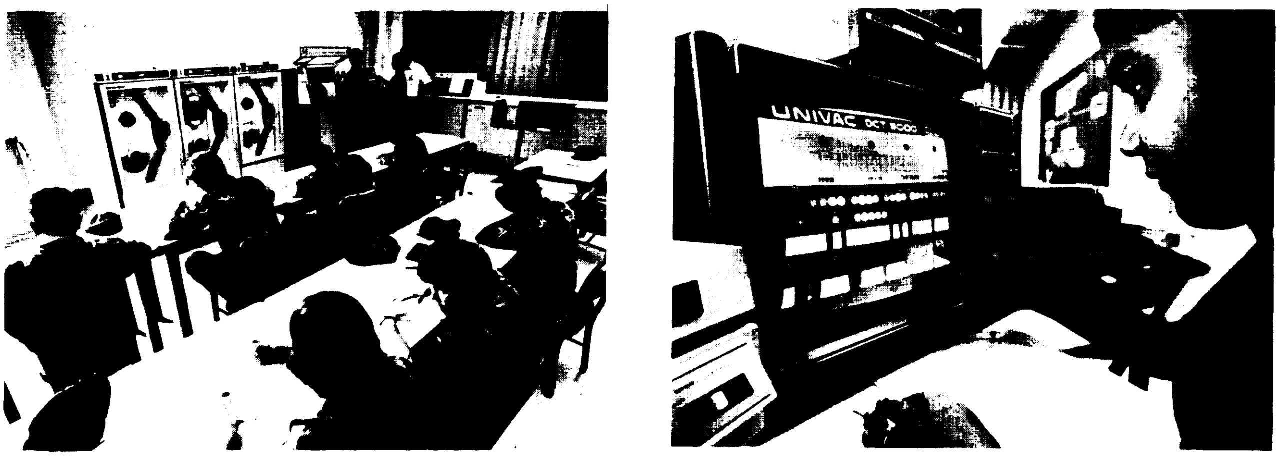
'J. Wallace, National Museum of American History, Smithsonian, May 1982.

[8]H. Otano, Chief, Audio-Visual Systems, National Air and Space Museum, Smithsonian Institution, May 26, 1982.

Military Uses of Information Technology

Findings

- All branches of the military have made substantial investments in research and development (R&D) on applications of information technology to education.
- The Department of Defense will likely be the only Federal agency likely to make major investments in R&D projects with educational applications.
- Educational uses of information technology have focused on two areas: training and basic skills.
- The need for a very large investment in basic skills training by the military, $56 million in 1979, is an indication to some that the public schools are not providing an adequate education.
- Many of the projects initiated by the armed services could be transferable to the civilian sector, although there may be barriers to transfer. Considering the large investment made by the armed forces in information technology R&D, it would be useful to establish a mechanism whereby potentially transferable projects could be identified and barriers to transfer removed.



Fort Gordon Signal Corps Training Center, Fort Gordon, Ga.—in former days, Ft. Gordon students would get 12 minutes of "hands on" instruction at this $7 million satellite down-station. The rest of the classroom time was spent in costly waiting. But with the new information technologies, instructional time has increased fivefold

The military has been a leader in the development and use of instructional delivery systems having used high technology for many years. Its great need for technical skill training, together with the critical nature of its national security mission and its nonprofit orientation, has led to a training technology revolution and a good market for state-of-the-art technology in military education and training.

Interested in new methods of training that improve efficiency, reduce training costs, and increase the effectiveness of training, the military has turned to information technology for solutions to some of its educational and training problems. The armed services need people in operational assignments. By advancing and applying state-of-the-art technology in training, they hope to turn out quality individuals sooner for operational job assignments.

In addition to supporting improved general and specific military skill training, the armed services also support basic skills training. Military jobs demand basic skills equal to or greater than those of civilian jobs.[1] Many current recruits lack competency in basic skills, a situation that has important implications for the operation of sophisticated technology and that has led to plans to increase, improve, and automate technology training programs. Anticipated manpower shortages undoubtedly will necessitate the enlistment and subsequent training of individuals of less aptitude, thus placing even greater emphasis on programs for instruction in basic skills.

As the largest education and training institution in the Nation, the military constitutes a large and viable market for training equipment, programs, and services. In fiscal year 1982, for example, approximately $10.5 billion will be spent on individual training. The training of individual officers and enlistees is differentiated from the training of operational combat units, and individual training can be broken down into a number of categories. Indoctrination and basic training for approximately 338,000 students will cost $822 million, while approximately 709,000 students will receive specialized skill training for military jobs at a cost of $2.4 billion.[2] (See table A-4.) In fiscal year 1982, approximately 236,500 student man-years will be spent at training schools.

The Department of Defense (DOD) now spends about $267 million for R&D on training and personnel systems technology, with $181 million or 68 percent of this for R&D on simulation and training devices and education and training.[3] (See table A-5.) The three service laboratories primarily responsible for military education and training research are: The Army Research Institute for the Behavioral and Social Sciences (ARI); the Navy Personnel Research and Development Center (NPRDC); and the Air Force Human Resources Laboratory (AFHRL). The number of instructional technology R&D work units by major categories in operation as of April 1981 is estimated in table A-6. While all of the categories listed receive ongo-

[1] G. Sticht, *Basic Skills in Defense* (Alexandria, Va.: Human Resources Research Organization, Final Draft Report, November 1981).

[2] J. Orlansky, "Techniques for the Marketing of R&D Products in Training," paper presented at the Society for Applied Learning Technology, Warrenton, Va., February 1981.

[3] Ibid.

Table A-4.—Number of Students and Cost of Various Types of Individual Training, Fiscal Year 1982

Type of training	Number of students in thousands	Cost in millions	Approximate in thousands per study
Recruit	338	$822	$2.4K
One-station unit training (Army)	104	322	3.1
Officer acquisition	16	313	19.4
Specialized skill	709	2,382	3.4
Flight training (basic flying skills)	6	1,458	229.7
Professional development education (e.g., military science, engineering, management)	32	330	10.2
Medical training	—	276	—
Support, management, travel, pay	—	4,618	—
		$10,521 M	

SOURCE Military Manpower Training Report for Fiscal Year 1982

Table A-5.—Cost of R&D in Training and Personnel Systems Technology, in Thousands of Dollars, Fiscal Year 1982

	Army	Navy	Air Force	Total
Human factors	$17.6	$ 14.1	$14,4	$ 46,1
Simulation and training devices	24.2	107.1	17,5	148,9
Education and training	13.4	11.8	6.6	31.8
Manpower and personnel	9.0	19.0	12.0	40,0
Totals ...	$64.2	$152.0	$50.6	$266.8

SOURCE" J Orlansky, "Techniques for the Marketing of R&D Products in Training, " paper presented at the Society for Applied Learning Technology Warrenton, Va , February 1981

Table A-6.—Number of Ongoing Instructional Technology R&D Work Units By Service and Department of Defense Total, April 1981

Technology	Service: Army	Navy	Air Force	Total
Simulation/games	26	49	68	143
Instructional system development	51	59	25	135
Training management	26	14	10	50
Learning theory	13	18	11	42
Computer-based education	13	16	9	38
Basic skills	2	4	—	6
Voice technology	—	3	—	3
Video disk	—	2	—	2
Artificial intelligence	—	1	1	2

NOTE' Inclusion of work units into the categories in the table are fairly arbitrary and are based on work unit titles The absolute numbers of work units listed are approximations of service R&D efforts as of the date of directory publication It should be noted that this enumeration does not consider size of the work units, only number of work units cited

SOURCE: *Directory of Researchers for Human* Research and *Development Projects* (Washington, D C Office of the Under Secretary of Defense, Research and Engineering), pp. 7-43.

ing support, high-technology simulation and the development of instructional systems and capabilities for more efficient and effective training appear to receive the most emphasis.

Interservice coordination shows potential for minimizing duplication of research efforts and funds. The Office of the Under Secretary of Defense for Research and Engineering is currently building a management information system that will document all of DOD's training research to include funding levels. This system, Manpower and Training Research Information System (MATRIS), will be fed into the Defense Technical Information Center (DTIC).

Comparison of Military and Civilian Education

In considering educational needs, distinctions can be made between the civilian and military education sectors, differences which influence the nature of education programs introduced. Some of the similarities and differences between military and civilian education and training are:

- The military educates and trains personnel within a more restricted age, sex, and range of ability; typically, military enlisted trainees are 18- to 21-year-old males with a high school education.
- Military personnel are paid their salaries while in training. Thus, instructional procedures that reduce training time and increase opera-

tional assignment time can assist in reducing training costs.

- Within the civilian sector, vocational education, job training for business or industry, and nonmilitary Government training are generally more similar to the military's educational goals and priorities than is education in elementary and secondary school systems.
- Measures of effectiveness may vary between the military and civilian institutions. Military research on computer-based instruction, for example, has emphasized saving student training time while maintaining constant achievement. Nonmilitary research generally emphasizes increasing the amount of achievement while keeping the length of courses constant.

Computer-Managed Instruction

In computer-managed instruction (CM I), learning takes place away from the computer. The computer scores tests, interprets results, advises the student what to do next, and manages student records and administrative information.

Advanced Instructional System. The Air Force's Advanced Instructional System (AIS) is an example of a military CMI system. It is a large-scale, prototypical computer-based education system installed at the Air Force Technical Training Center, Lowry AFB, Denver, Colo. The present version consists of 50 student terminals, 11 management terminals, and a CDC CYBER 73-16 computer that can support up to 3,000 students a day in four courses: inventory management, material facilities, precision measuring equipment, and weapons mechanics. These courses were selected to represent a cross-section of the technical training courses at Lowry, and they serve about 25 percent of the base's student body. Management terminals provide computer-assisted instruction (CAI) services for use by instructors (for developing or revising lessons and for retrieving data collected by the system). The system could be expanded to provided CAI services to students.

The AIS was designed with two objectives in mind: 1) to develop and implement an individualized, computer-based training system in an operational military training environment; and 2) to provide a testbed for computer-based educational R&D. It includes over 700 student carrels and 500 media devices that permit the instructional delivery device (sound-slide, filmstrip, programed text, etc.) to be adapted to the individual student. For example, a slow reader might learn more efficiently via audiovisual presentation rather than via printed text. With instructional content duplicated across delivery media, the computer assigns material and devices according to student aptitudes and preferences, as well as by resource availability. The actual allocation of media in the AIS is 55 percent printed materials, 35 percent audiovisual presentation, and 10 percent CAI.

The AIS computer provides three main support functions: 1) administration and management (resource allocation, materials development, recordkeeping, and report/roster generation); 2) instruction (student predictions, individual and team lesson assignment, test scoring, and delivery of instruction); and 3) data analysis/research (automatic data accumulation, sampling capability for statistical analysis, and standard statistical analysis programs). The computer thus takes over the majority of the managerial functions of the instructors, permitting them to concentrate on individual student instruction.

Many measures were used to evaluate the A IS, including costs, student and instructor attitudes, attrition rates, and the ratings of AIS students in their post-school jobs. In most cases, comparisons were made between AIS students and pre-AIS students in the same courses. Cost savings estimates were made by the Air Training Command manpower accounting personnel.

AIS results have been documented in several technical reports issued by the Air Force Human Resources Laboratory. In general, AIS students' achievement have been equal to or greater than non-AIS students-with net time savings of 15 to 40 percent, depending on the course evaluated. Maximum savings have been achieved in the lower-level, routine courses. Overall cost analysis shows that the system was totally amortized by January 1979, in a period of only 2½ years. This complete recovery of costs through savings in student instructional time is particularly noteworthy considering the extensive R&D costs included for research purposes. The AIS suggests that large-scale implementations of CMI would be cost effective.

Student attitudes were clearly very positive. The students felt that they had more opportunity to talk individually with their instructors than in conventional courses (61 percent), that the self-paced instruction was a good use of their time (77 percent), that they preferred AIS instructions to lectures (55 percent), and that the instructors were available whenever they needed them (73 percent).

Instructor attitudes, on the other hand, tended to be negative in general. They felt threatened and missed the ego-bolstering lecture method. Course attrition rates overall tended to rise slightly through the first 5 years of A IS implementation from a pre-AIS baseline of about 4 percent in 1974 to slightly over 5 percent through 1978. Attrition rates, it should be noted, are very sensitive to policy changes. The supervisors of A IS graduates reported satisfaction with their performance. The ratings of AID graduates were significantly higher than comparable ratings of pre-AIS students. A sample of 199 supervisors rated the performance of their AIS graduates as follows:

Excellent	25 percent
Very Satisfactory	34 percent
Satisfactory	37 percent
Marginal	4 percent
Unsatisfactory	0 percent

Overall, the AIS appears to be a successful, large-scale implementation of CMI. McDonnell Douglas Corp. is currently modifying the system to be transportable, to operate on smaller computers, and to be marketable to the Canadian armed services and to U.S. civilians.

Job-Oriented Basic Skills Training

Schools traditionally have 12 years to equip students with the level of skills necessary for them to function as adults in jobs or in further education. For the most part, schools are successful in their approach to imparting necessary basic skills for adult life. Fewer than 10 percent of those who have completed 12 or more years of schooling are severely deficient in their application of skills to practical tasks, as estimated by a 1975 adult performance level study.[4]

However, a substantial number of people either do not complete 12 years of school, or do so without gaining the requisite mastery of necessary basic skills for adult life or career performance. The services have had to cope with the critical problems presented when large influxes of poor readers entered the armed services, for instance, during Project 100,000. The traditional approach to remediate the problems of adults with insufficient basic skills for career success has been a continuation of the school general-literacy program.

However, traditional literacy training by the military has not been demonstrably successful. The most direct way to ensure that an individual can cope with specific military skill applications (to cope with a military career or environment) is to teach these applications or ones as similar to them as possible. For these reasons, the military has sponsored R&D leading to a technology for job-oriented basic skills or remedial literacy training.

A considerable investment in basic skills programs has also been made. As indicated in a Department of Defense (DOD) study, during fiscal year 1979 approximately $56 million and an enrollment of 160,000 were allotted to basic-skills education.[5] The military has a high demand for listening, reading, writing, and arithmetic skills. Reading levels of material, for example, average in the 10-13 grade level range. This far exceeds the reading skill levels of many military enlistees as well as much of the civilian youth population.

Thus, there are a variety of basic skills programs in DOD and the four services. Pre-enlistment programs, such as referral to civilian adult basic education and English as a second language (ESOL) programs, are sponsored by DOD for applicants who do not meet service enlistment requirements. All of the services have some form of basic-skills education available from the time the new recruit enters the service. One such program is the Air Force PLATO SIP (Skills Improvement Program), which uses CAI to improve the reading skills of medical personnel and the math skills of maintenance technicians.

Project FLIT. Project FLIT, a job-oriented, or functional literacy program, is being developed under Army support. Work on this program was started in 1967 and is ongoing. Military job literacy tasks are really quite different from reading skills applications practiced in traditional schools. For example, schools emphasize "reading to learn" while military job tasks involve "reading to do" (e.g., finding specific information or following directions). While schools test memory for what is read with closed book tests, military job tasks are generally performed in the presence of the written material, which is consulted frequently.

Researchers attempted to estimate the actual literacy demands of military jobs. One product of this research was the FORECAST readability formula, which was developed using Army job reading material and an adult Army recruit population. Another product was a "Guidebook for the Devel-

[4]Adult Performance Level Project Staff, *Adult Functional Competency: A Summary* (Austin, Tex.: University of Texas, 1975).

[5]Defense Audit Service, *Report on the Review of Installation-Sponsored Education Programs for DOD Personnel* (Report No. 81-041, January 1981).

opment of Army Training Literature."[6] This manual attempted to help Army writers create performance-oriented training materials written at an appropriate level for Army readers and oriented to identified job reading tasks.

Project FLIT provides training in identified Army reading tasks using actual Army materials. It was extensively field tested and was found to result in gains in the performance of the job tasks trained. The ideas and techniques of the FLIT program were incorporated in a job-oriented reading program (JORP) for the Air Force, targeted at a different population and using different materials, a program also field tested with some success. Expansion of this program to include all "problem" job fields in the Air Force is being considered. The Navy JOBS program, a remedial program designed to prepare motivated, but otherwise ineligible, people for technical training is also a product of this technology. An additional product is a prototype job reader's task test developed for the Army and now being modified and reformed.

PREST Program. In the future, the services may be forced to enlist a greater number of marginally qualified recruits because of manpower shortages. In response to this, the Navy is expanding its Academic Remedial Training (ART). The Chief of Naval Education and Training contracted for the development and testing of a computer-based approach known as the Performance-Related Enabling Skills Training (PREST) program. PREST involves on-line reading and study skills instruction via the PLATO system, augmented by Navy-related off-line drill and practice. An automated system such as this was thought to be an attractive alternative to increasing the number of instructors.

A 1980 cost analysis showed the automated program to be less cost effective than increasing the number of military instructors. The usage charge for PLATO with its centralized mainframe was found to be the chief reason. This difference in cost should, however, steadily decline in future years. Advances in computer technology will make stand-alone systems more attractive economically than the centralized mainframe for this type of fixed instruction. In addition to project PREST, Navy R&D efforts are under way to examine the feasibility of teaching phonics by a computer-driven voice synthesizer. If this is successful, there are plans to computerize vocabulary development, reading comprehension, and study skills.[7]

Simulation Programs

Flight training simulations are extremely varied in scope, purpose, and fidelity of realism. They save expense and training time because the simulator can be repositioned to some starting point in flight without taking the actual time and fuel to fly there. Moreover, simulators provide the opportunity to interrupt the flight at any point to give the student immediate feedback on particular aspects of pilot performance. Finally, the simulator can be used for training in emergency maneuvers that are inherently dangerous to actually attempt.

In 1970, the U.S. Air Force Human Resources Laboratory's Advanced Systems Division contracted with the Singer Co. to build the most sophisticated flight simulator yet devised, the Advanced Simulator for Pilot Training (ASPT). Unlike other simulators, it was intended for research as well as for flight training, giving it a multipurpose potential for transference of research results to the civilian sector.

The Army Research Institute for the Behavioral and Social Sciences (ARI) is engaged in the development of computer-assisted simulation of tactical communications as part of an overall effort in the area of simulation-based training systems. This effort will provide the Army with the capability to simulate battlefield communications between leaders in the field and support personnel, such as artillery fire direction controllers, and the superior and subordinate commanders. Battlefield communications are typically very structured and stereotyped. For instance, the exchanges between an artillery forward observer in the field and the fire direction controller are specified in Army regulations.

Training simulations are used to replicate many military situations—from tank driving to elaborate ship docking. The Army tank driver simulators are fully automatic and include audiovisual as well as motion cues. Such devices simulate malfunctions such as brake failure or engine shutdown. Many of these procedures and malfunctions appear more than once throughout the programs, and thus allow for repeated practice. The device also simulates such activities as driving up hills and over obstacles.

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[6] R. P. Kern, T. G. Sticht, D. Weltz, and R. N. Hanke, *Guidebook for the Development of Army Training Literature* (Arlington, Va.: U.S. Army Research Institute for the Behavioral and Social Sciences, November 1976).

[7] R. A. Wisher, *Computer-Assisted Literacy Instruction in Phonics* (NPRDC TR 80-21) San Diego, Calif.: Navy Personnel Research, May 1981.

In maintenance simulation, the Navy through the NPRDC is developing an Electronic Equipment Maintenance System that will simulate electronic receiver and radar systems, using a microprocessor. This system shows promise in facilitating the management of troubleshooting problems through electronic equipment. NPRDC has also developed a program that teaches how to solve dynamic problems involving the variational analysis of current flow in complex electronic circuits.

The interchangeability of technology transfer is demonstrated through the Army's adaptation of a commercial coin-operated game by Atari called "Battlezone" to train tank operators. "Battlezone" is a three-dimensional war game in which the operator moves around the battlefield at will and shoots at targets as they appear. Because the game is very realistic, trainees' reflexes and operating skills are improved with practice. Atari has redesigned the keyboard to mimic an actual control panel and realistically simulate the actions of a tank.

Video Disks in Military Training

The military services, particularly the Army, have been very active in video disk research. Most of this work has been initiated or coordinated by the Army Communicative Technology Office (ACTO) at Fort Eustis, Va. ACTO's mission is to get the Army "off paper" and into electronic media for storage and communication. Both the Defense Advanced Research Projects Agency (DARPA) and ARI have also supported a number of video disk research projects for training purposes.

One of the first ACTO projects was a "Call for Fire" disk that demonstrated the potential of video disk for packaging multimedia self-study training materials. This disk involved a specially designed computer-controlled video disk system. A number of different existing training materials (field manuals, training extension course lessons, video tapes, films, and skill qualification tests) used to train forward observer skills were integrated on a single video disk, a good illustration of the economy of video disk storage. Cost studies conducted for ACTO around this integrated training package indicated that it would result in savings over the existing materials on the basis of reductions in duplication and distribution costs alone.

A second innovative use is the SIDE (Soldier Information Delivery Equipment) project, which involves the use of video disk for tank turret maintenance training. This project utilizes a computer-controlled video disk system called TMIS (Training Management Information System). Video disk is used to store the contents of a large volume (that is, thousands of pages) of maintenance manuals and skill performance aids. By means of a 5-inch cathode ray display tube connected by cable to the TMIS computer/video disk station, soldiers are able to use the system while actually doing maintenance inside a tank. With their electronic maintenance manuals, the trainees have more information at their fingertips than would normally be possible in the confined space of a tank turret.

A third innovative project is the use of video disk for a satellite communications ground station repair course (MOS 26Y10) at the U.S. Army Signal Center, Fort Gordon, Ga.[8] The satellite communications equipment needed for the course costs about $12 million, and each repair involves $200 to $2,000 worth of parts. There is a great need to minimize equipment usage by unskilled students wherever possible. The video disk provides low-cost hands-on equipment and repair practice without using the actual equipment or parts. A lightpen is used by students to identify switches, select switch positions, plug in jacks, or indicate faulty parts to be replaced. In addition to reducing the need for actual equipment, it is now possible to measure student performance in accuracy or speed and to provide feedback while the student is learning.

Yet another innovative effort is the Video Disk Interpersonal Skills Training and Assessment (VISTA) project at Fort Benning, Ga. VISTA involves the study of interactive video disk for leadership training and assessment. It is used in a two-screen paradigm to present conflict scenarios that might arise between an officer and a subordinate. The officer trainee or candidate is first presented with a dynamic, visually simulated situation, including the initial remark of the subordinate on the screen. The trainee must select a response with the lightpen from four options presented visually on the screen control. The trainee then sees the subordinate's reaction to this response on the color monitor.

The disk features two modes: an experimental mode in which the interaction simply proceeds on the basis of the responses and a pedagogical mode in which feedback is immediately provided on the appropriateness of the response selected. A total of eight disks are planned that will provide over

[8]W. D. Ketner, "The Video Disk/Microcomputer for Training, " *Training and Development Journal* May 1981.

100 leadership scenarios. A major use of these disks is seen to be an effective, objective, and inexpensive assessment of officer candidates.[9]

A number of other application areas are being explored by the Army. One area is the use of video disk for recruiting. The Joint Optical Information Service (JOINS) allows local recruiters to show visually what type of duties and training are associated with a specific military occupational specialty (MOS). Currently, some 30 MOSS are available on JOINS.[10] In the equipment simulation areas, WICAT, Inc. has developed an electronics troubleshooting video disk for the Hawk missile system. Perceptronics Inc. has developed a video disk-based simulation for the M60 tank gunnery training. Both of these projects were supported by DARPA.

A number of video disk projects are also under way in the basic skills area. The U.S. Army Europe is supporting the development of functional literacy instruction using a particular job category (MOS 63, Vehicle Maintenance) as a focus. Also, DARPA is exploring the use of the video disk-based Spatial Data Management System (SDMS), originally developed at the Massachusetts Institute of Technology for training in various life-coping skill areas (e.g., spatial orientation, study skills, listening).

In addition to these application projects, which have resulted in the development of actual video disks, the Army and DOD have supported research projects that explore theoretical or procedural aspects of the technology. For example, ARI has supported studies of how video disk relates to the standard instructional system development methods used to develop training materials in the military. The Navy supported an early study of video disk authoring approaches.[11] ACTO has supported research on the electronic conversion of print media to video disk and the optional presentation features for electronic delivery systems. (See table A-7 for a summary of these applications.)

These research projects have all involved interaction between a number of different Army/DOD agencies and contractors. They have also involved a variety of different hardware configurations. It is noteworthy that all of the video disk applications discussed have involved externally programed interactive capability. Although the Army has conducted a few projects with manual and internally programed interactive video disks (not discussed here), it appears that the Army believes the type of interactive capability provided by external microcomputer control *is* necessary for the instructional applications involved in military training. In contrast, industrial training applications have focused on the manual and internally programed level of interactive video disks, possibly because industry cannot afford the greater costs of an externally controlled system.

Direct To The Home

All of the information technologies currently used by schools, the military, libraries, museums, and industry can also be used in the home. The increasing availability of these technologies coupled with their rapidly declining cost, presents a unique opportunity for learning in the home. While most of the present applications have been directed at a specific age group, the focus is now shifting to provide programs for more diverse populations,

[9] F. N. Dyer, et al., "Interactive Video for Interpersonal Skills Training, " 1981.

[10] J. Tice, "Video Disk Could Get Army 'Off Paper', " *Army Times,* Aug. 31, 1981, p. 14.

[11] H. D. Kribs, "Authoring Techniques for Interactive Video Disk, " *Journal of Educational Technology Systems,* 8(3), 1980.

Table A-7.—Summary of Military Video Disk Projects

Project	Groups involved	Hardware involved (player, microcomputer)
Call for fire	ACTO/WICAT Inc.	Magnavox, Pascal MicroEngine (custom)
SIDE	ACTO/Hughes Aircraft	Thompson, Hughes (custom)
MOS 26410	ACTO/Signal School	DVA 7820, Apple II
VISTA	ARI/ACTO/TDI Litton-Mellonics	DVA 7820, Apple II
JOINS	ACTO/Recruiting Cmd.	DVA 7820, Apple II
I HAWK	DARPA/WICAT Inc.	DVA 7820, Pascal MicroEngine (custom)
LCP-I	ARI/Perceptronics Inc.	DVA 7820, ? (custom)
MOS 63	USAEUR/University Utah/ University Maryland	DVA 7820, Apple II
SDMS	ARI/DARPA/HumRRO	DVA 7820, Cromeco (custom)

SOURCE: Office of Technology Assessment

Findings

- There has been a dramatic increase of microprocessors, hand-held devices, and information services provided via cable or public television in the home.
- Educational products and services are increasingly being marketed directly to the home.
- In response to market forces, these educational products and services are targeted predominantly at professionals and families with relatively large disposable incomes.
- As with other educational markets, there is a need for materials that review and evaluate these products and services.

Adult Market

An estimated 37,000 to 73,000 adults participate in some sort of educational program. Adult programs are offered in a wide variety of institutional settings—in elementary and secondary schools, universities, private institutions, businesses, libraries, and museums. Adults, the fastest growing segment of American society, represent a potentially large sector, of the educational market. However, while many adults might benefit from continuing education, a large proportion of them have, as yet, remained uninvolved.

Apart from their number, there are several reasons why adults might be expected to constitute a growing sector of the educational market:

- Approximately one-third of all American adults are changing or considering changing their careers and realize the need for additional education.
- More and more States require additional educational programs for professionals; e.g., for recertification of physicians. Continuing education has become one condition for license renewal in many areas.
- Within certain fields, education requirements are being upgraded, increasing the need for continued educational

Adult participation in instructional activities has been limited by situational, dispositional, and institutional factors. Situational barriers are, for example, lack of money, insufficient time because of job and home responsibilities, lack of child care, and lack of transportation. Attitudes and self-perceptions form the basis of dispositional barriers. Thus, an aged person may feel incapable of learning or a high school dropout may feel inadequately prepared in basic knowledge to do well in another formal instructional setting. Institutional barriers are exemplified by high tuition charges, inconvenient scheduling of courses, and the lack of student services geared to adult needs. Educational services delivered directly to the home via both existing and new technologies may overcome many of these barriers.[2]

Instructional Television

In an innovative effort to capture this expanding market, 600 colleges and universities in cooperation with the Public Broadcasting Service (PBS) provide college courses for credit via local public service stations. These courses are aired nationally by over 200 stations (80 percent of the public TV stations). Although institutions and stations can choose from up to nine programs, most offer two per semester. In the fall of 1981, enrollments exceeded 20,000. An increase was expected for the spring semester.

Recognizing the large, virtually untapped home market, PBS has already designed courses for the undergraduate student, and, in the near future, plans to provide informal learning courses as well as professional and career development programs. Current courses, such as "The American Short Story" and "Personal Finance and Money Management, " are of both general and professional interest. Colleges and universities participating in the program provide materials and counselors on campus, and give midterm and final examinations. They pay PBS a licensing fee and a small charge per student enrolled. The student pays approximately $150 per course, which covers materials.[3]

PBS is not alone in providing educational services via television. Community colleges such as those in the Coast Community College District, Dallas Community College District, and Miami-Dade Community College District have also been actively involved in instructional television endeavors. Cable television companies also supply educational materials nationwide. Columbia Cablevision of Westchester Inc., and Qube, in Columbus, Ohio, offer courses with an interactive capability that allow students in the home to answer

[1] Public Broadcasting Service, "program Service, Section IV, Exhibit P-l, " Washington, D. C., Jan. 6, 1982.

[2] C. Dede, *Potential Clients for Educational Services Delivered by Information Technology,* contractor report to OTA, March 1981.

[3] Public Broadcasting Service, PTV-3/Adult Programing Department, *Background Paper on the Partnership Between Public Television and Higher Education to Deliver Adult Learning Courses,* Washington, D. C., n.d.; and Public Broadcasting Service, *Adult Learning Programing Schedule* Fact *Sheet for Colleges and Universities for Fall 1981,* Washington, D. C., n.d.

questions posed by the instructor in the classroom. Qube (Warner Amex) currently has 50,000 subscribers, approximately 34,000 of whom receive its interactive programs. ' This company offers courses for credit from four institutions: Ohio State University, Capital University, Columbus Technical Institute, and Franklin Institute. Because of its interactive capabilities, the Qube system is educationally unique.

A proposal that could greatly expand educational services in the home is now under consideration by PBS. The proposed "National Narrowcast Service" would establish a resource to nationally distribute educational, professional training, cultural, and information video materials. This service would also alter the local PBS stations' role, transforming them into local telecommunications centers. Using a satellite distribution system to interconnect local PBS stations, and Instructional Television Fixed Service (ITFS)* to connect the stations, colleges, and other users, programing in the following areas would be available:

> Training material in special skills; safety programs; material designed for rehabilitation of the aged, infirm, or mentally disturbed; clinical studies; new arts and crafts; material intended to keep professional and semi-professional people abreast of the state-of-the-art in various fields; in-service training for teachers; instructional material for purposes of entertainment or cultural advancement. [b]

Multimedia Instruction

The School of Management and Strategic Studies of the Western Behavioral Sciences Institute offers a management program that relies heavily on information technology. The program is designed for executives in the private and public sectors (Federal and nonprofit). Following a short study program in LaJolla, Calif., participants continue their studies via on-line services, telephone conversations, teleconferencing, and electronic mail. The terminals and other equipment are included in the cost of tuition and are retained by the user at the conclusion of the formal program. Participants install the technology in their homes or offices. This approach has a number of benefits: the participants continue to work for their sponsoring organization throughout the course of study (thus, no work time is lost); information gained from the program can be employed immediately in a working environment; the users become familiar with the technology, which is not usually the case for most higher level executives; and users are networking with both members of the program and with others following completion of the program.'

Electronic Learning Devices

Approximately 18 million electronic devices—microprocessor games such as "electronic baseball" and hand-held devices such as Speak and Spell-were sold between 1979 and 1980. Typically, the price for these games ranges from $10 to $3,000, the cost of a microcomputer. Users of these devices can be as young as four, or they can be adults. The growth of this market has been rapid and impressive. Although these games and learning devices were not introduced until the mid to late 1970's, there are a vast number on the market. While OTA has made no attempt to evaluate their effectiveness—and particularly the effectiveness of those designed for learning, their uses in the home will be briefly described.

Given the relatively low cost of production and a growing desire by parents for enhanced educational services, the market for microprocessor games has grown so fast that some major manufacturers been unable to keep up with it. Sales of nonvideo electronic games have skyrocketed from $20 million in 1977 to $1 billion in 1980.[7] The experience of Texas Instruments in the home market provides some insight into the development of learning technologies. One of the early leaders in this field, Texas Instruments originally sought to develop a market in schools and not in the home. Their first product was a Texas Instrument calculator accompanied by a package of instructional materials that was designed to assist teachers and students in the classroom. With it the company hoped to demonstrate the use of the calculator as a learning device. Although this initial package was unsuccessful, it led the company to focus on the home market and to market directly to the individual consumer. Their next product, Little Professor, was a hand-held device that provides a series of mathematical problems and answers designed to become increasingly difficult. Since the introduction of Little Professor, Texas Instruments has developed and successfully marketed

'LINK, *Survey of Selected U. S. Videotex/Two- Way CA TV/Teletext Operations* (New York: LINK, June 15, 1981).

*ITFS is a short range multiple distribution technology allowing for an unlimited number of users in a specific area. PBS is proposing the use of four ITFS channels in each community served by a public service station.

'Public Broadcasting Service, op. cit., 1982.

[6]TALMIS Conferences, Chicago, Ill., Feb. 18-19, 1982.

[7]"Newest Trends in Toys," *Ebony Magazine*, November 1980.

several similar games. One of these, Speak and Spell, differs from earlier games in that it has a synthesized voice that helps the user to spell.

Other manufacturers have also introduced mathematical games—e.g., National Semiconductor's Quiz Kid. There are also other kinds of hand-held learning devices such as Coleco's Quiz Wiz, a multiple-choice game which asks and provides answers to 1,001 questions on a wide variety of subjects such as sports, movies, television, and history.

Video Disk

Since the video disk is relatively new, there are very few examples that demonstrate its educational applications in the home. Disks that are available for school use are, however, equally applicable for use in the home. Some examples of these are the films of Jacques Cousteau, the National Gallery's art masterpieces, movies such as "Tom Sawyer" or "Better Tennis in 30 Minutes. "

The first video disk designed specifically for children, the "First National Kiddisc, " is an interactive video disk produced by Optical Programing Associates. It allows for individually paced instruction. Games on this disk include The Flag Game, in which the user identifies national flags, and A Trip to the Zoo, by which the child can learn to identify 40 animals. Another section of the disk uses the unique two-channel audio available on the video disk players to explain pig latin. On one channel, a child on camera explains in pig latin how to speak pig latin; on the other channel there is a voice-over translation. In a section on sign language, the manual alphabet is taught by showing the sequence in slow motion.

Publishers of educational materials and others are currently planning new video disk projects. Walt Disney Production, Children's Television Workshop, and Scholastic Productions as well as encyclopedia publishers are among those who plan to utilize this new technology.

In addition, Arete Publishing in cooperation with the International Institute for Applied Technology (II AT) has produced an experimental interactive optical video disk with information from Arete's *American Academic Encyclopedia.* Sound and films were added to articles and illustrations chosen from the encyclopedia. The more than 20 segments on the video disk demonstrate the capabilities of the technology. Starting from a general section on the species of dinosaurs, a user may branch off to find more information about a specific type of dinosaur. The segment on Ludwig von Beethoven presents his biography, illustrations of his life and musical scores, and musical segments from the composer's works. Designed to be experimental, this disk does not yet cover all 21 volumes of the encyclopedia, although ARETE hopes to put the entire encyclopedia on disk in the future. Still in the research and development phase, these disks are not commercially available for use in the home. When they come on the market, each disk will cost about $500. After purchasing a disk, each year the consumer can exchange it for an updated version for about $100.[8]

Impacts of Information Technology

Of all the information technologies available for the home, the personal computer is the one that is expected to have the greatest use and for which there is expected to be the largest and fastest growing market. Furthermore, the microcomputer, in conjunction with other technologies such as the video disk or two-way interactive cable, appears to have the greatest potential for home use.

With the increasing use of microcomputers in the home, the educational applications are growing at a fast pace. The personal computer market was estimated to be a $1.5 billion to $2 billion industry in 1981. One recent figure notes that the home market accounts for over $100 million in sales of both hardware and software.[9] The number of personal computers purchased between 1977 and 1980 was estimated at around 1 million, and a similar figure was estimated for sales in 1981. Sales are expected to increase substantially for several reasons: greater exposure to the technology in the schools or in business, the introduction of cable services, the availability of information resources such as The Source and Dow Jones/ Retrieval Service, the development of more consumer-oriented software, and the declining cost of the microcomputer.[10] Also, manufacturers will be actively marketing their equipment to the consumer.

Together, these factors will lead to a serge in the market. Microcomputers are now available for as little as $100. At this price, the microcomputer can be used for games or simply to familiarize the user with the technology. Advertising emphasizing the

[8]LINK, Optical *Videodisc Applications (New* York: LINK, NRM, vol. 3, No. 1, First Quarter, 1982).
[9]B. Isgur, W. Paine, and H. Mitchell, personal communications, January 1982.
[10]LINK, *Using Personal Computers (New* York: LINK, NRR, vol. 3, No. 1, Second Quarter, 1982).

educational applications in the home has increased enormously. In fact, these commercials recall the earlier ones of the encyclopedia salesmen, their sales pitch being that the microcomputer will assist the student in school.[11] Moreover, the proliferation of computer stores and the retailing of the technology through department stores and the like has given rise to increased purchases. For example, Texas Instruments plans to sell their microcomputers through national chain stores such as J. C. Penney.

The growing diversity of home applications such as gaming and word processing, and the development of financial and statistical packages such as Visicalc and others appeal to a wide range of users. One indication of this is the formation of a large number of computer clubs. All of the clubs swap hardware and software information. Some provide training sessions; some are affiliated with a specific manufacturer (e.g., Crab Apples and Crab Polishers); and some are directed at specific interests (e.g., Theater Computer Users in Dallas, Tex., and the Behavioral Sciences Specialists in Murfreesboro, Term.[12]

There are hundreds of software packages available to assist students in all grades and age groups in many subjects such as mathematics, the sciences, reading, writing, and spelling. The rapid expansion of the personal computer market should result in a greatly increased volume of educational software together with a demand for evaluative materials. As in all other markets for educational software, there has been very little evaluation of new software. While there are catalogs for consumers, there are few reviews of most educational packages. Users must depend for their evaluations on a limited number of sources: computer newsletters, computer magazines, an underground network, and the few computer manufacturers who have begun to produce evaluative reports.

Many analysts believe that the market for home and business microcomputers will be driven by the need to use the technology to retrieve information and to perform transactions. The technology allows a user to connect to on-line data bases and other services via a modem, a device that connects the microcomputer to a telephone line. Home users can now connect to services such as The Source, CompuServe, the Dow Jones News/Retrieval Service, and others. The Source, available through Telenet and Tymnet packet switch networks, offers games, electronic mail, news, the "electronic college," and other services. The college, although limited to three courses this year, plans to expand its listings within the next few years. CompuServe, very similar to The Source, acts with the Associated Press as the system operator for 13 U.S. newspapers in an experiment of electronic newspaper delivery. Viewtron, a videotex experiment in Coral Gables, Fla., offered slightly different services to home users. Knight-Ridder Newspapers and AT&T sponsored news, shopping, travel, banking, games, learning aids, consumer advice, and more to over 700 sites via modified television sets. Similarly, Cox Cable Communications is developing INDAX for use by its cable franchises.[13]

The introduction of cable services in the home will give rise to a large number of new educational projects. An estimated 28 percent of the homes in the United States are wired for cable. It is predicted that 38 percent will be wired by 1985 and 50 percent by 1990.[14] Educational services such as those provided by Cox Cable, Qube, and others are expected to grow quickly.

Information Technology and Special Education

Technologies that are now being developed may offer great benefits to individuals that require special educational services-a group that includes the gifted and those with learning, physical, and emotional disabilities. Since special education is a field, and not an institution, OTA did not fully explore the uses, impact, and effects of these technologies on special educational services. However, because the technologies will have a considerable effect on schools overall, OTA examined some of their applications for the gifted and handicapped.

Findings

- Providing educational services for students with special needs is costly and requires more effort than providing for students in general.
- Information technologies will be particularly valuable to students with special needs because they will reduce the cost of their education and they will provide them self-paced, individualized instruction.
- Using information technology could ease the financial and resource burdens placed on the

"A. Pollack, "Price Decline Spurs Sales," *New York Times,* June 17, 1982, pp. D1,6.

[12]LINK, op. cit., 1982.

[13]LINK, *Op.* cit., 1982.

[14]LINK Executive Conference, New York City, May 26, 1982.

schools by laws mandating education for the gifted and handicapped.

- The overall cost of R&D to address the specific needs of this diverse group is very high, and in some instances, even prohibitive. Each disability may require a unique technological application. It has been suggested that increased Federal funding is merited to support the R&D efforts needed to encourage the marketing of these technological applications.
- Although a number of technological applications to help handicapped persons are available, they have not been marketed because they are too costly.
- Information technologies can help train many handicapped persons for productive work.

Information technologies may offer greater benefits to the gifted and the handicapped than to any other segment of the education market. These students benefit from specialized individualization, a capability of many emerging instructional technologies. For example, computer programs can be designed to translate written material into speech that is understandable to the blind, or to instruct retarded children on a step-by-step basis. Overall, such capabilities can help to make handicapped people more independent. Other types of programs can help maximize the abilities of gifted students. Recognition of the special needs of these two groups have led to the passage of two laws–Public Law 142 and Public Law 80-313. These laws require that, using formula grants and preschool incentive grants, handicapped and gifted children be provided with special services to be funded in part by the Federal Government.

Information technologies have several attributes that make them particularly useful for addressing the special needs of gifted and handicapped students.[1] Because their individual situations vary significantly from case to case, these students most often need to have individualized instruction that can best be provided by highly specialized personnel. Thus, their education is generally labor intensive, and very costly. The new information technologies can provide self-paced and individualized instruction at a considerably lower cost.

The cost and difficulties entailed in developing these technologies may, however, preclude their widespread application. Although the overall population of gifted and handicapped students is statistically large, it is very small when measured in terms of individual disabilities or needs. When designed to meet the needs of a particular group, these technologies can be too costly to produce.[2] Moreover, the time required from their development to their production may take as long as 20 years.[3] For these reasons, it has often been proposed that the Federal Government provide support for research and development in this area.

Technology for Administration

The use of information technology to administer special education programs is only now in the process of being developed, tested, and evaluated. There is a large potential for data management applications in this field, particularly given the requirement that each student participate in Individualized Education Programs (IEP). An IEP defines a student's disability(ies) and appropriate education program. This exercise is a very time-consuming process that could be greatly facilitated by the judicious use of information technology. Computerized diagnostic models are now being developed. One model, developed by Columbia Learning Systems, generates a computerized IEP based on diagnostic information supplied by specialists. It contains information about student needs, their areas of deficiencies and suggested ideas and material for remedying them. It also monitors the student's progress. Other programs such as these are becoming more and more common.[4]

The development of diagnostic remedial information technology procedures is relatively new in the United States. This type of program tracks students to discover their strengths and weaknesses in specific skills and how they relate to a student's approach to a specific problem. This information can then be used to determine a course of remedial action. Most diagnostic models are for mathematics, [5]

Information technologies can also be used to schedule the handicapped in specialized working or instructional groups using criteria such as in-

[1]C. Dede, *Potential Clients for Educational Services Delivered by Information Technology*, contractor report to OTA, March 1981.

[2]V. W. Stern and M. R. Redden, Draft *Case Study of Selected Telecommunication Devices for the Deaf* contractor report to OTA, December 1981. Much of the work done to develop teletypewriters for the deaf was done on a volunteer basis, donated by handicapped or concerned individuals. The present rapid advances in information technology, along with declining costs, may reduce this developmental time.

[3]Ibid., p. 11.

[4]M. Lindsey, *State-of-the-Art Report; Computers and the Handicapped* (Medford, Oreg.: Northwest Regional Educational Laboratory, August 1981), p. 133. There is, for example, the Organized Resource Bank of IEP Text (ORBIT), and Programing for Individualized Education (PIE).

[5]Ibid., p. 133.

structional needs, student academic levels staffing requirements, and availability of staff and space.[6]

Technology As Prosthetic Devices

By enabling handicapped persons to speak through video and speech synthesizers, some information systems can serve as prosthetic devices. For example, the Total Talk Full Speech Computer Terminal, developed by Maryland Computer Services, converts computer-transmitted data and information into synthetic speech. The system has an unlimited vocabulary. It uses rules for enunciation, and inflection for clarity. Total Talk, which costs around $6,000, can provide two-way information. Similar devices, the VS-6 and ML-1 voice synthesizers, developed by the Votrax Division of Federal Screw Works, produce electronically synthesized speech from a low-speed, digital input. Both of these systems are designed for persons with visual impairments, and both enable the users to work in the areas of computer programing, information processing, and information retrieval.

Many such projects have been successfully introduced through joint efforts between the Federal Government and the private sector. One example is the caption decoder, developed under the sponsorship of the Department of Health, Education, and Welfare (now the Department of Education), the Corporation for Public Broadcasting, the National Broadcasting Co., and the American Broadcasting Co. When attached to a television set, these decoders allow deaf viewers to see captions on selected networks and programs. Costing $269, they are available through Sears, Roebuck, & Co.[7]

Another example is Optacon. This device, designed for the blind, produces images of printed letters using small, raised, vibrating wires. With one hand the user guides the pick-up along the printed page, while the fingers of the other hand detect the images on a stationary device. The Kurzweil Reader, also developed for use by the blind, "reads" a page of text aloud, using electronic voice synthesis. For these projects, Federal funds were invested in the R&D efforts as well as in purchasing equipment for the users.[8]

Technology As Instructional Aids

Information technologies have many applications as instructional aids. CAI, for instance, is used for a number of different handicaps or disabilities. Early use of CAI for the deaf began at the Institute for Mathematical Studies in the Social Sciences (IMSSS) at Stanford University. Assessments of this work with CA I show general increases in the mathematical skills of 3,000 deaf students. Nonspeaking autistic children have also benefited from the use of CAI. Having witnessed a display of 1,000 different audiovisual experiences on a television-like screen, 13 out of 17 children began to use some level of speech. The effectiveness of using a computer to teach extremely mentally retarded children was also demonstrated, when substantial gains were noted in the reading ability of 40 children.

In Chicago, students with hearing, visual, mental, or other learning disabilities have participated in a project sponsored by the South Metropolitan Association for Low Incidence Handicapped. The project used CAI programs-in math, reading, and the language arts-that were prepared by the Computer Curriculum Corp. Although evaluations are still underway, student progress has correlated with the amount of on-line access to programs.

In an ongoing study at Utah State University's Exceptional Child Center, computer and video disks are used with the mentally handicapped. The technologies allow for self-paced and individualized instruction. The project programs focus on discrimination between sizes, shapes, and colors; on telling time; on identification of functional words; and on the identification of colors. If successful, this project will not only assist mentally handicapped nonreaders but also those with other disabilities.[9]

To "encourage research in devising methods to assist handicapped individuals, " NSF and Radio Shack sponsored a contest in the fall of 1981. Its purpose was to "create a partnership between personal computing and the rehabilitation, educational, and handicapped communities."[10] There were 900 entries in the contest. A few sample projects were:

[6]Ibid., p. 134.
[7]Department of Education, *The Historical Role of the U.S. Department of Education in Applying Electronic Technology to Education* (Washington, D. C.: Department of Education, February 1981).
[8]Ibid.

[9]R. Throkildson, W. K. Bickel and J. G. Williams, "A Microcomputer/Videodisc CAI System for the Moderately Mentally Retarded, " *Journal of Special Education Technology*, vol. II, No. 3, spring 1979.
[10]"Prizes Awarded in Search for Microcomputer Applications to Aid Handicapped People, " *Electronic Learning*, vol. 1, No. 3, January/February 1982, p. 12.

- A pocket-sized computer to assist deaf people to communicate over telephone lines-a Radio Shack pocket computer with a coupler and a miniprinter.
- An "Eye Tracker" to aid severely handicapped individuals to express words via an infrared camera and a computer. The camera notes the position of the user's eyes with a specific word and the computer "speaks" the word.
- A computer that teaches deaf children to read lips by outlining lips, mouth, and tongue on a screen and then moving them to pronounce words.

The entries in the contest used off-the-shelf technology. Most of the projects could be made available immediately and would be of some use to a disabled person. The contest demonstrated that there is no immediate need for extensive R&D. What is needed instead is a way of identifying and encouraging the reformatting of the technology to address the diverse needs of the handicapped population.