DOCUMENT RESUME

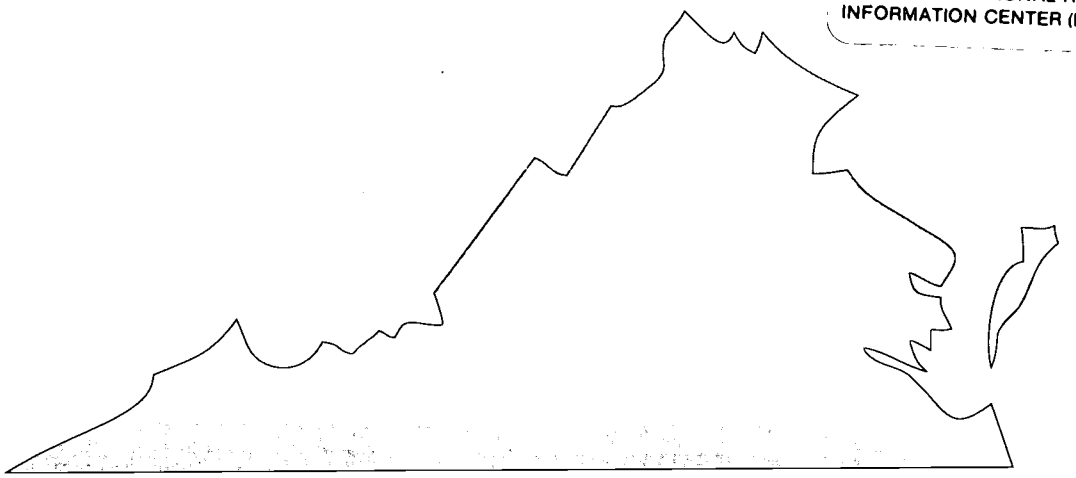
ED 398 869 IR 018 048

TITLE	Six-Year Educational Technology Plan for Virginia.
INSTITUTION	Virginia State Dept. of Education, Richmond. Div. of Technology.
PUB DATE	Jun 96
NOTE	65p.; Developed by the Virginia Technology Advisory Committee.
AVAILABLE FROM	Virginia Dept. of Education, Division of Technology, P.O. Box 2120, Richmond, VA 23218-2120.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Access to Information; Computer Networks; *Computer Uses in Education; *Educational Development; *Educational Planning; *Educational Technology; Elementary Secondary Education; Needs Assessment; Program Evaluation; Program Implementation; Public Schools; Staff Development; State Programs; *Statewide Planning
IDENTIFIERS	Technology Integration; *Technology Plans; Telecommunications Infrastructure; *Virginia

ABSTRACT

The Six-Year Educational Technology Plan for Virginia places emphasis on constructing and retrofitting schools for local and wide area networking; utilizing current and newer technologies in curriculum, instruction, and school management; providing training and technical assistance to all educators; and expanding access to effective teaching and learning through the use of technology. The state's plan is designed to serve as a guide for the development of plans by public schools. The current status of technology in Virginia is outlined. Needs, goals, recommendations, results and strategies, dates, and rationales are discussed for five aspects of planning: (1) infrastructure; (2) technology-based instruction; (3) training and technical assistance; (4) administrative services; and (5) evaluation. The implementation plan for 1996-1998 is then provided for classroom computers and networking; graphing calculators for mathematics; and scientific probes and sensing devices for science. Appendices include: Virginia Educational Technology Advisory Committee (VETAC) Resolution; discussion of the implications of research results; glossary of technology terms; bibliography; and lists of VETAC membership and Virginia Department of Education staff. (Contains 38 references.) (AEF)

Six-Year Educational Technology Plan For Virginia



Virginia Department of Education, Division of Technology

Six-Year Educational Technology Plan For Virginia

Presented to:
The Virginia Board of Education
September 1995

William C. Bosher, Jr.
Superintendent of Public Instruction
Virginia Department of Education

Developed by:
The Virginia Educational Technology Advisory Committee

In Cooperation with:
The Division of Technology
Virginia Department of Education

June 1996

Foreword

The Six-Year Educational Technology Plan for Virginia is the culmination of many surveys, forums, focus groups, conferences, interviews, on-line information inquiries, and visits with educators, parents, and business and community leaders in the Commonwealth. The plan places emphasis on constructing and retrofitting schools for local and wide area networking; utilizing current and newer technologies in curriculum, instruction, and school management; providing training and technical assistance to all educators; and expanding access to effective teaching and learning through the use of technology.

The technology initiatives proposed by the Governor and the budget committees and approved by the 1996 session of the Virginia General Assembly, fund some of the recommendations of the six-year technology plan. These funded initiatives will set the course for K-12 in-school technology applications prior to the year 1999. Concurrent with these funded initiatives are the implementation of technology standards of learning for students and technology competencies for teachers pending adoption by the Board of Education.

The state's plan serves as a guide or blueprint for the development of plans by public schools. Implementation strategies contribute to the development of problem-solving and critical-thinking skills, increase teacher and administrator productivity, expand access to information, and promote improvement in education for more than one million students in kindergarten through grade 12 in Virginia's public schools. As an evolving, flexible, and open-ended document, the plan should bring technology, teachers, and students together in meaningful ways and prepare them for the challenges of the next century in Virginia and the world. Copies of this plan are available from the Virginia Department of Education. Please forward your request to the Division of Technology, P. O. Box 2120, Richmond, Virginia 23218-2120 or telephone 1-800-292-3820.

William C. Bosher, Jr.
Superintendent of Public Instruction

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Executive Summary

In February 1994, a Board of Education resolution authorized the Superintendent of Public Instruction to develop the Commonwealth of Virginia's second Six-Year Educational Technology Plan. The thirty-one member Virginia Educational Technology Advisory Committee (VETAC), with representatives of the business community, provided advice and assistance in developing the plan. The information gathered for the plan included information from focus groups, research literature reviews, teleconferences, surveys, interviews, electronic mail, and presentations to the Superintendent's Advisory Council and regional study groups.

A chronology of governmental and departmental actions that contributed to the development of this plan began when the Virginia Board of Education was authorized in 1988 to develop a K-12 educational technology plan. This initial authorization was followed by Standards of Quality for Public Schools in 1992 calling for local school biennial plans with a technology component, identification of the use of technology as one of the Department of Education's five focus areas, and the approval by the General Assembly of Senate Joint Resolution #352 in March 1995, authorizing continuation of the Select Committee of the Senate Finance Committee, the House Appropriations Committee, and the Committee on Equity in Public Education's study.

The February resolution by the Board of Education charged the Virginia Educational Technology Advisory Committee with the responsibility to lead in formulating a new technology plan for the public schools.

Educators in Virginia today must face the challenge of preparing students to lead productive lives in the 21st Century. Confronting the challenges means dealing with fundamental societal conditions. The class of 2006 will graduate from high school into a society where expanding technology redefines how people will live, learn, work, and play. Electronic villages, where homes, businesses, schools, and libraries are connected will be commonplace.

Citizens will be active participants in the democratic process using modems, fax machines, and cellular telephones. Access to the various communications media will create a more global lifestyle.

Solutions to 21st Century problems need to be bold and innovative with realistic expectations. To meet the technological needs in education, alternative funding strategies and sources must be identified. Business and industry partnerships and grants are two solutions to secure funding for technology programs.

Current Status Of Technology In Virginia

As a result of previous state initiatives under the 1988 -1994 Six-Year Technology Plan for Virginia, locally funded efforts during the same period, and the 1994-96 Library Automation Initiative, a broad base of technology is in place in Virginia schools. Distribution of technology through the 1988 -1994 plan made a difference in teaching and learning. Supported with funding provided by the General Assembly, more than 10,000 computers and relevant software were provided to strengthen instruction for middle school students, especially those deemed at-risk of failure. Over 300 satellite dishes and receiving equipment made distance learning courses in AP Calculus and AP English available to students in every high school. Teachers and administrators received entry-level training in technology utilization, and foundation levels and standards were established for instructional media.

School divisions, stimulated by the state subsidies, added their own financial resources to expand their technology programs.

Thus, in the early 1990s, through the collaborative efforts of the General Assembly, the Board of Education, the Department of Education, and schools, Virginia was recognized as a national leader in instructional technology.

Reports show that only 31 percent of Virginia schools have local area networks. Much needs to be done to install the necessary infrastructure to meet technology-based instruction for the future. Virginia's Public Education Network (PEN) is a statewide Internet system serving K-12 education. Today there are approximately 18,000 users on the system. Current costs and demand for additional service are imposing severe limitations to continuing the network as it is currently structured.

The Department of Education funds and administers distance learning, satellite, and broadcast networking through the Virginia Satellite Educational Network (VSEN). In 1994-95, VSEN enrolled over 1,400 students in 65 school divisions in Virginia and over 200 students in 20 other states. Thirty percent of VSEN students are enrolled in the ten most disparate school divisions. Instructional television resources are offered statewide through the cooperative efforts of the Departments of Education and Information Technology, five public television entities, and 134 local school divisions.

Library automation has been advanced through state funds to the Department of Education to establish a foundation level of library automation in all secondary and middle schools. Multimedia/telecommunications workstations, electronic reference materials, and wiring infrastructure to network all library workstations complete the automation picture.

New Initiatives from the General Assembly during the 1995-1996 school year include funds for library automation in elementary schools in addition to a $10,000 grant for every K-12 school to assist with preparations for networking.

For over a decade microcomputers in schools have provided the core of technology-based instruction. The most recent year in which survey data are available, there was an average statewide ratio of one computer to every 10.5 students. Schools with the lowest composite index have fewer microcomputers and, therefore, a higher ratio of students per microcomputer.

During the period of the previous Six-Year Plan, staff development grants in excess of $690,000 were given to all school divisions. Despite these efforts, lack of accessible training opportunities and technical assistance continue to be major obstacles to the full integration of technology in the curriculum.

Under the previous Six-Year Plan, the Department of Education 19launched the Communication Automation Transition System (CATS), an initiative to plan and implement a statewide administrative computer network. Today, some 1,100 schools in 108 school divisions use Columbia software for tracking and reporting student data, known as VASIMS, the Virginia Student Information Management System. Approximately 68 school divisions use the state licensed RDA financial software. All school divisions use VA.PEN to file federal food service reports, completing the necessary forms directly online.

The Six-Year Plan

The scope of this plan integrates equity, excellence, and connections within the context of five major components of implementing technology in a K-12 environment: Infrastructure, Technology-Based Instruction, Training and Technical Assistance, Administrative Services, and Evaluation. Each component is presented separately, yet they are all interrelated in the K-12 technology program.

Goals and recommendations contained in the plan reflect the consensus of stakeholders. Strategies were developed for each recommendation to take advantage of the interrelationships among the various technologies in each of the components.

Infrastructure

The first goal of the plan is to integrate voice, video, and data networks capable of providing communications at the school, division, state, and national levels.

Three recommendations included in this goal propose upgrades and retrofit to facilities for fully developed buildingwide networks, assistance to all schools for Internet access, and conversion of VSEN to a fully digital satellite network.

Technology-Based Instruction

The second goal is to improve teacher and student access to technological resources in classrooms and other learning centers through equitable distribution of grants, equipment, software, and technical assistance. Five recommendations provide for multimedia microcomputers, classroom computers to achieve a 5 to 1 student-to-computer ratio, graphing calculators and scientific probe devices for mathematics and science, educational technologies for use in students' homes, and assistive devices for special needs students.

Training and Technical Assistance

The third goal is to enable the Department of Education and school divisions to establish training programs and incentives to enhance teaching and learning through the use of educational technologies. Two encompassing recommendations promote specialized training for a broad spectrum of technology educators and help establish competency levels and endorsement requirements. The recommendations also offer technology and professional development for all school personnel.

Administrative Services

The fourth goal is designed to assure that educators and administrators have direct access to technologies that provide for the full maintenance, reporting, and analysis of student and administrative data. The one recommendation under this goal completes and expands administrative initiatives begun in the Department of Education.

Evaluation

The fifth goal is to provide for a system of on-going evaluation of technology initiatives as expressed through the various recommendations in the plan. These assessments will establish a continuous set of benchmarks to measure the success of state and local educational technology.

THE VISION

Virginia students will be empowered to use current and emerging technologies for continued learning to become productive, creative citizens of the 21st century.

"Students and teachers who master cutting edge technology will have a great advantage in their education and careers."

Michelle Easton, President
Virginia Board of Education

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Charge and Governance

In February 1994, a Board of Education resolution authorized the Superintendent of Public Instruction to develop the Commonwealth of Virginia's second Six-Year Educational Technology Plan. The Board's resolution focused on the key elements that became the organizational framework for the plan. The Virginia Educational Technology Advisory Committee (VETAC), with representatives of the business community, provided advice and assistance in developing the plan. The thirty-one member VETAC and business groups assisted in developing the new Six-Year Technology Plan through a variety of information gathering mechanisms. These included focus groups, literature reviews, teleconferences, surveys, interviews, electronic mail, and presentations to the Superintendent's Advisory Council and regional study groups.

A chronology of governmental and departmental actions that have contributed to the development of this plan is as follows:

July, 1992 - Standards of Quality for Public Schools in Virginia, §22.1-253.13:6. Standard 6. Planning and Public Involvement: ... "Each local school board shall revise, extend and adopt biennially a divisionwide six-year improvement plan which shall be developed with staff and community involvement. The division- wide six-year improvement plan shall include . . . a technology component consis-

". . . I have proposed a $125 million (75 million K-12) investment in classroom technology in this biennium — the first installment in a multi-year effort to support the aquisition of classroom computers, networking systems, and instructional equipment related to the new standards of learning for science and math . . ."

Governor George Allen

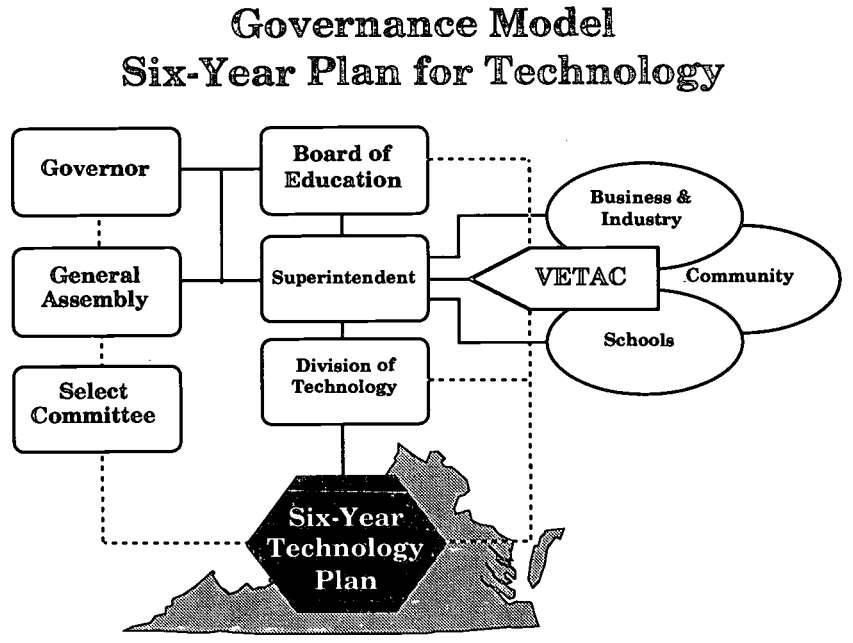


Figure 1.
Governance for the Six-Year Plan

tent with the six-year technology plan for Virginia adopted by the Board of education . . . ."

January 1994 - the Commission on Equity in Public Education endorsed educational technology as one of four core elements in recommendations to the 1994 General Assembly.

February 1994 - the Board of Education authorized the Superintendent of Public Instruction to develop a Six-Year Plan for Educational Technology in Virginia (1996-2002) with advice and assistance from the Virginia Educational Technology Advisory Committee (VETAC) and the business community.

March 1994 - the General Assembly approved Senate Joint Resolution #157 and established the Select Committee of the Senate Finance Committee, the House Appropriations Committee, and the Committee on Equity in Public Education to study educational technology funding.

April 1994 - the Superintendent of Public Instruction identified the use of technology as one of the Department of Education's five focus areas for education in the public schools in Virginia.

March 1995 - the General Assembly approved Senate Joint Resolution #352, authorizing continuation of the Select Committee's study.

June 1995 - the Board of Education approved revised Standards of Learning in language arts, history and social sciences, mathematics, and science which incorporate applications of learning technologies.

The relationships between the different organizations, agencies, governing bodies, and institutions are represented in the Governance Model illustrated in Figure 1.

Preface

The class of 2006 will graduate from high school into a society where technology expands and redefines how they will live, learn, work, and play. An electronic village, where homes connect to each other, to businesses, to schools, and to libraries will be commonplace. Citizens will be active participants in the democratic process using computers with modems, fax machines, and cellular telephones. Individual creativity in music, art, and science will increase. Access to the various communication media will create a more global lifestyle.

Education in 1995 must face the challenges of preparing Virginia's students to lead productive lives in the 21st Century. Confronting the challenges means dealing with fundamental issues: What basic facilities and equipment will schools need to support use of emerging technologies? What technology resources should be available in the classroom for student use? What will be the training needs of teachers and administrators? What technologies do administrators need to manage effectively the operation of schools? Which technologies are more effective in an instructional setting?

Solutions to 21st Century problems need to be bold and innovative with realistic expectations. Educators will need to engage in a planning process to ensure that technology meets instructional needs. Technology is an expensive investment. In addition to state and local funding, alternative funding strategies and sources need to be identified. Business and industry partnerships and grants are two solutions to secure funding for technology programs.

In 1989, the Board of Education approved the Six-Year Educational Technology Plan for Virginia. This plan was Virginia's first organized effort to equalize educational opportunities through the use of new and innovative technologies. The plan focused on achieving equity, excellence, and connections in education through the use of technology.

Initiatives developed from the 1989 plan resulted in support for distance learning and the placement of microcomputers in grades 4 - 6 for remediation in reading, writing, and mathematics. Sections of the plan also established foundation levels and performance standards for hardware and administrative computing.

The 1989 plan promoted the use of online communication systems to provide immediate access to information through modems and video technologies. The potential instructional benefits of connecting schools to other schools, to other types of libraries, and to information networks and databases were supported with a number of recommendations.

Experience shows that during the past six years the core values of equity, excellence, and connections continue to be vital to the successful integration and use of technology. Virginia's Six-Year Educational Technology Plan 1996-2002 reflects these values in its strategic approach for K-12 technology uses. The plan details goals, recommendations, strategies, timelines, and implementation guidelines.

"...VEA supports the Board of Education's proposed Six-Year Technology Plan and the appropriation by the General Assembly..."

Virginia Education Association

Developing initiatives around the goals contained in each of these elements will

- unite all aspects of educational technologies — curriculum and instructional applications, management, research, communications, personal productivity, and staff development and training;
- prioritize educational technology for elementary, middle, and secondary education;
- promote the expansion of school-based and wide-area networks for communications and information access;
- encourage the development of innovative strategies to create quality programs and comprehensive technological systems for K-12 and alternative and adult education for students with diverse backgrounds and interests;
- promote quality teacher training and staff development in the use of technology;
- identify best practices in the use of technologies; and
- seek alliances with higher education and business and community organizations to accomplish the vision for technology in Virginia's schools.

The scope of this plan integrates equity, excellence, and connections within the context of five major components of implementing technology in the K-12 environment: Infrastructure, Technology-Based Instruction, Training and Technical Assistance, Administrative Services, and Evaluation. Though each component is presented separately, all are interrelated in a K-12 technology program. The strategies were developed to take advantage of these interrelationships.

The development of the goals and recommendations contained in this plan reflect a consensus of stakeholders. It was important that before any goals or recommendations were developed teachers, library media specialists, principals, administrators, and representatives of the business community would agree to a set of guiding principles. The principles are designed to assure that:

- recommendations are supported by strategies that assure the delivery of quality technology applications to the classroom;
- proposed technology applications support local technology planning and evaluation;
- local school divisions have flexibility in the implementation and practice of technology support systems;
- recommendations are clear, concise, and include implementation strategies;
- recommendations reflect the concerns and interests of the community, parents, teachers, and school administrators; and
- the recommended technologies are research based and represent market-driven developments and exemplary practices.

Current Status Of Technology In Virginia

As a result of previous state initiatives under the 1988 -1994 Six-Year Technology Plan for Virginia, locally funded efforts during the same period, and the 1994-96 Library Automation Initiative, a broad base of technology is in place in Virginia schools. The distribution of technology through the 1988 -1994 plan made a difference in teaching and learning. Supported with funding provided by the General Assembly:

- more than 10,000 computers and software were provided to strengthen instruction for middle level students, especially those deemed at-risk;
- over 300 satellite dishes and receiving equipment made distance learning courses in AP Calculus and AP English available to students in every high school;
- some 11,200 teachers and administrators received entry-level training in technology utilization; and,
- foundation levels and standards were established for instructional media.

School divisions, stimulated by state subsidies, added their own financial resources to expand their technology programs. Thus in the early 1990's, through the collaborative efforts of the General Assembly, the Board of Education and the Department of Education, and public schools, Virginia was recognized as a national leader in instructional technology.

During the period from 1992–1995, several surveys and studies were conducted by the Department of Education. Based upon data from this research, as well as records of the various state initiatives and anecdotal evidence from on-site observation by Department of Education staff, a picture of the current status of technology in Virginia schools emerges. But, in acknowledging the gains of the past, it is recognized that any attempt to describe the present level of technology in the school environment also must take into account the age, condition, and capabilities of the existing base as well as questions concerning the accessibility of technology and the readiness of educators to use it effectively.

Infrastructure

In 1994, the Virginia General Assembly appropriated funds to the Department of Education to establish a foundation level of library automation in every secondary and middle school. Through this initiative school divisions received matching grants in 1994-95, adjusted for composite index, to enable every high school and vocational center to acquire:

- library automation software for cataloging, circulation, and management;
- multimedia/telecommunications workstations and electronic reference media; and,
- the wiring infrastructure to network all library workstations.

The initiative further specified that funds equivalent to at least 5 percent of the grant be spent for training teachers to use these information access resources. During the 1995-1996 school year, middle and combined school library media centers will receive funds for similar library automation.

While the library automation initiative, in the 1994-1995 school year, provided each high school with hardware and networking for the library media center, an online survey, conducted by the Department of Education in March of 1995, revealed only 33 percent of the responding schools

reported a building-wide LAN (local-area network).

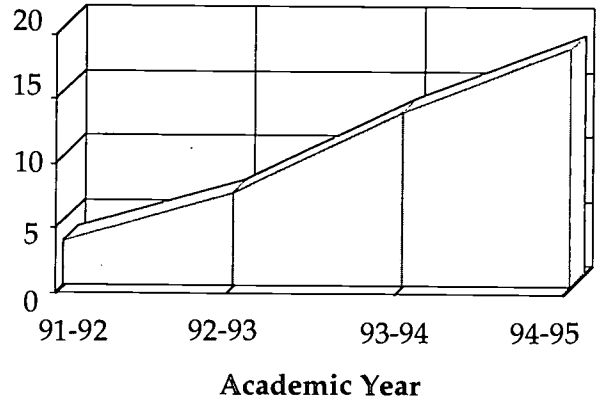
The 1995 General Assembly appropriated $47 million to include all elementary schools in the library automation initiative during 1995-96. The appropriation included funds to provide each K-12 school a $10,000 grant to assist with preparations for networking the building.

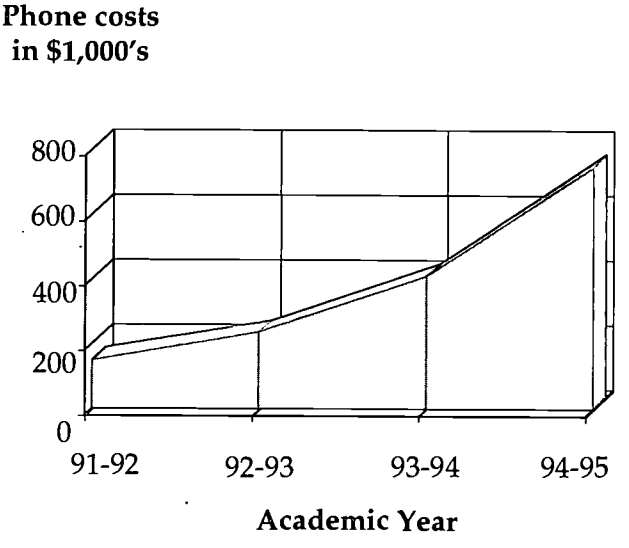
The networking grant initiative is a first step to help schools deal with a widespread and persistent infrastructure problem: having the "behind the walls" systems to fully use technology. In a recent national report, Virginia was among a number of states in which more than 50 percent of the schools indicated they had insufficient infrastructure to support newer technologies. In Virginia the specific areas of greatest need included network cabling, electrical wiring, and phone lines for modems and instructional applications.

Virginia's Public Education Network (PEN) is a statewide Internet system serving K-12 education. The name "Virginia's PEN" was designed to convey its intended use as an instrument of communication, just as a quill pen served as an instrument of communication in Jefferson's day.

A major feature which makes Virginia's PEN unique among virtually all state networks is the wealth of resources available for teachers and students through its "Electronic Academical Village." More than simple bulletin boards where teachers can post ideas, the Village "pavilions" contain resources and services which directly support classroom instruction in core academic areas. In the winter of 1994-95, for example, "Live from Antarctica" was featured in the Special Projects pavilion. In this program, a Virginia elementary teacher was part of an expeditionary team in Antarctica. Par-

Figures 2a & 2b.
VA.PEN User Growth and Cost Increases





ticipants designed and monitored, via Virginia's PEN, projects in science, geography, and language arts in which hundreds of students in dozens of schools took part.

In addition to instructional initiatives, a number of administrative initiatives have been implemented through the state K-12 network. Superintendent's memos are distributed through Virginia's PEN; and several systems have been implemented to test a methodology for using the network for the collection of administrative data.

Due to the range of educational resources available, both instructional and administrative, the system has grown rapidly (Figure 2a), so that, by December 1995 there were approximately 18,000 users on the system. This growth has caused a concomitant increase in the cost of operation (Figure 2b). Because of this tremendous growth, the Department of Education has been forced to take certain measures to contain costs, such as: placing a moratorium on student accounts, and limiting dial-in access to one hour per day.

Virginia's PEN has undergone several changes in network architecture and organization in response to this growth in users and to an evolving technologic environment. Currently, it is undergoing a transition from a dial-up terminal emulation access system to a client-server architecture combined with an evolution to WAN-LAN connections as a preferred access method. These changes will result in an improved user interface while making more efficient and economical use of network resources. However, the fundamental strength of Virginia's PEN is not technologic; its strength rests upon the network of volunteer curators who maintain its Electronic Academical Village, substantially extending the network's educational capabilities.

Through the Virginia Satellite Educational Network (VSEN), the Department of Education funds and administers a state and nationwide distance learning program. VSEN is designed to help alleviate educational disparity by offering 14 advanced level and foreign language credit courses to students where a qualified teacher is not available, or the number of qualifying students is too small to justify employment of a full-time teacher. In 1994-95, VSEN enrolled over 1,400 students in 65 school divisions in Virginia (Figure 3.), and over 200 students in 20 other states. Thirty percent of VSEN students are enrolled in the ten most disparate school divisions. Two and one half percent of the students enrolled in grades 8 - 12 are VSEN students. VSEN also supports student enrichment programs, public information forums, teacher in-service training, and

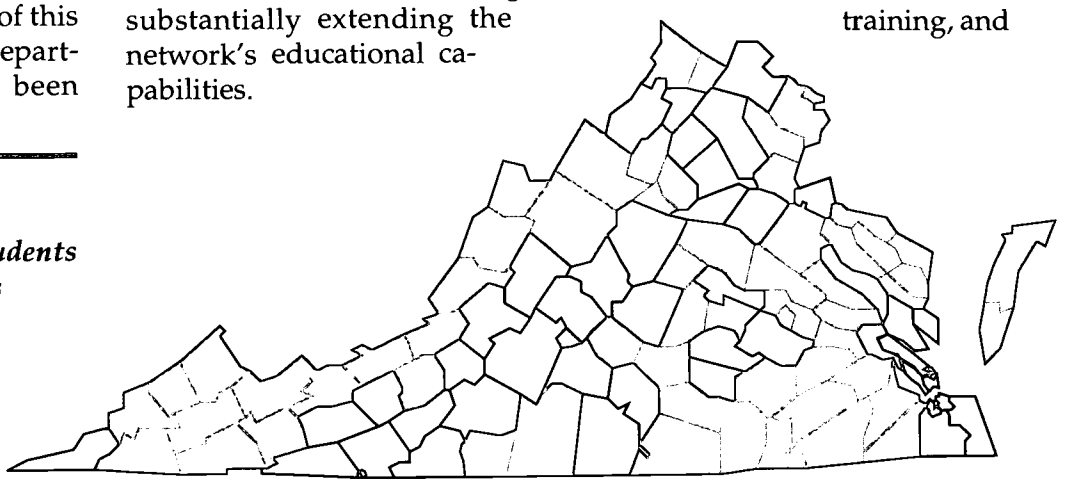


Figure 3.
School Divisions with Students Enrolled in VSEN Courses
(shown as shaded)

graduate-level recertification courses via satellite for Virginia teachers. An example of this latter service is the SOAR project ("Stretch Out and Reach"), a two-year course of studies which retrains teachers to obtain an endorsement in Special Education, an area in critical need of qualified personnel. For the 1995-96 school year, some 150 teachers are enrolled in the SOAR program. Another successful use of VSEN for teacher training is the six-hour series, Using the TI-82 Graphing Calculator, telecast in January and February 1996. Based on requests for the teacher guide to the series, more than 1,000 teachers are participating.

A small but growing number of school divisions are developing fiber-optic, interactive video networks, most often in partnerships with their local telephone companies. These networks are used for distance learning and staff development. Examples of these networks exist in divisions in Southwest Virginia and in Shenandoah County; others are in planning stages. These fiber-optic video networks are being developed through local rather than state initiative; however, they serve as demonstration sites for the application of this emerging technology.

Instructional television resources are offered statewide through the cooperative efforts of the Commonwealth's Departments of Education and Information Technology, five public television entities, and 134 local school divisions. Through this system of resource delivery,

- 238 series or programs in all subject areas have statewide use rights;
- 98 percent of schools, K-12, receive the signal of a PTV station;
- 70 percent of schools, K-12, are connected to cable television; and
- 72 percent have building-wide television distribution systems.

Technology-Based Instruction

Technology-based instruction includes the various technology elements which teachers and students use to enhance instruction and learning. Among these are microcomputers, CD-ROMs, laserdiscs and VCRs. Each of these technologies makes its unique contribution to instruction, and teachers and students need access to each together with a rich variety of instructional applications. However, the microcomputer is the foundation upon which these other technologies, except VCRs, are implemented.

For over a decade the number of microcomputers in schools has steadily increased; but, despite this increase, the accessibility of microcomputers to students remains limited in all but a handful of schools. A Department of Education survey conducted in January 1996 revealed an average statewide ratio of one computer to every 9 students. A more detailed look at the survey results shows a total of 118,260 microcomputers used for instruction in the 1807 schools reporting, or an average of 65.45 computers per school. But considering only averages of data makes it easy to lose sight of the many schools that are not able to meet the average, typically because of the disparity between more and less affluent schools. Closer analysis of the January 1996 survey data reveals that, while the state average for microcomputers per school is 65.45, the standard deviation is ±55.53. In other words, schools within only one standard deviation from the mean could have as many as 120 or a few as 10 microcomputers available for instruction.

However, the total number of computers in a school does not translate directly into student accessibility. A small school may

have fewer computers than its larger counterparts; but, at the same time, provide greater access because it has a smaller enrollment. Creating an "index of computer availability" combining factors such as the number of classrooms, enrollment, and the number of computers gives a better sense of the school's relative ability to provide students access to technology. On the resultant scale of <1 to 10, the higher the index, the greater the availability of microcomputers. Figure 4 plots the number of schools in relation to this index. With some 75% of schools having an index of 2 or less, it is clear that Virginia's schools are limited in their capacity to meet student needs.

Moreover, the numbers from the January 1996 survey include instructional computers regardless of age, as well as those in specialized settings (e.g., business labs) not normally available for use by a majority of students. A random sampling of the schools in the survey determined that **50% of all instructional computers are more than five years old**. A corollary survey revealed that the percentage of classrooms with one or more computers varies widely among school divisions. In Figure 5, the 86 (of 134) school divisions reporting are grouped from very low to very high, based on their percentage of classrooms with computers.

Figure 4.
Index of Relative Availability of Instructional Computers in Schools

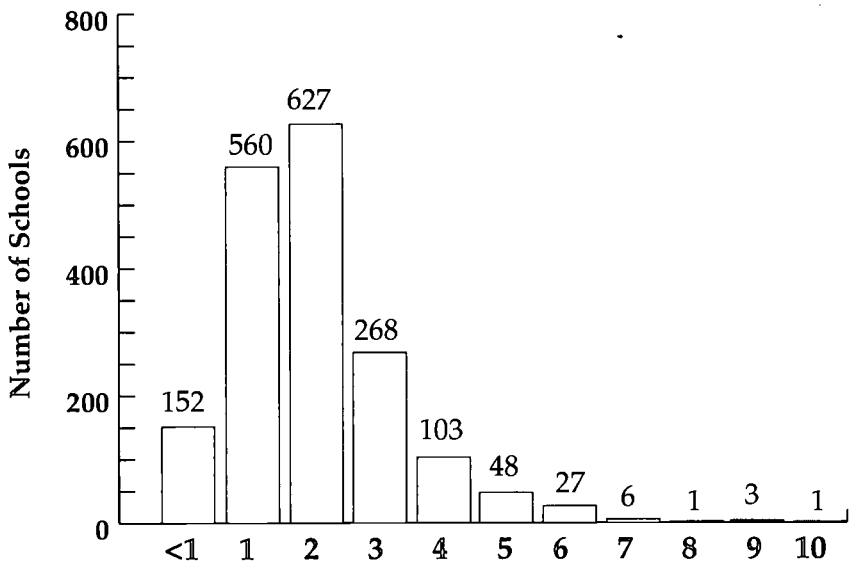
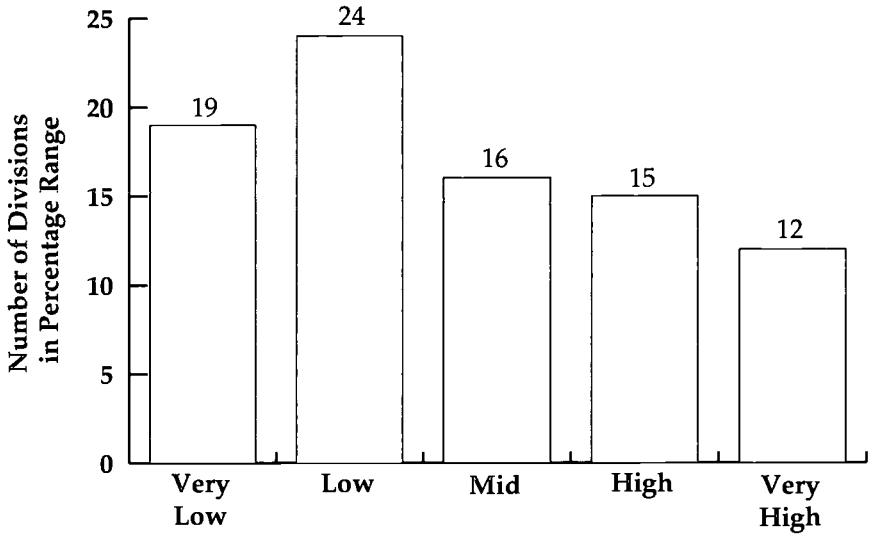


Figure 5.
Percentages of Classrooms With At Least One Computer as Reported by School Divisions



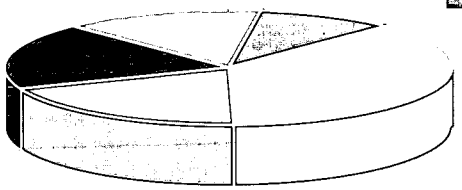
Having microcomputers deployed directly in the classroom makes them more readily accessibile and, arguably, more effective for instruction. Yet, as seen in Figure 5, half of the divisions (43) report low to very low percentages of classrooms with at least one microcomputer.

Training And Technical Assistance

During the period of the previous Six-Year Plan, staff development grants in excess of $690,000 were given to all school divisions. These funds provided locally administered training for over 11,200 administrators and teachers. The Department of Education's Technology Division and school divisions continue to provide staff development and technical assistance. The Department of Education maintains a Technology Examination Center and Training Classroom for this purpose.

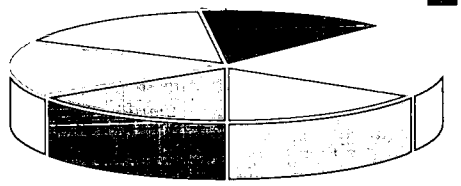
Several regional consortia also operate to help meet staff development and training needs. The Southwest Virginia Public Education Consortium focuses on the technology training and planning needs of its member school divisions. Other technology consortia are managed by several of the state's public television stations to serve the school divisions in their coverage areas.

Figure 6.
*Top Five Technology Needs**



* *Legends are listed in clockwise order.*

Figure 7.
*Technical Assistance Needs**



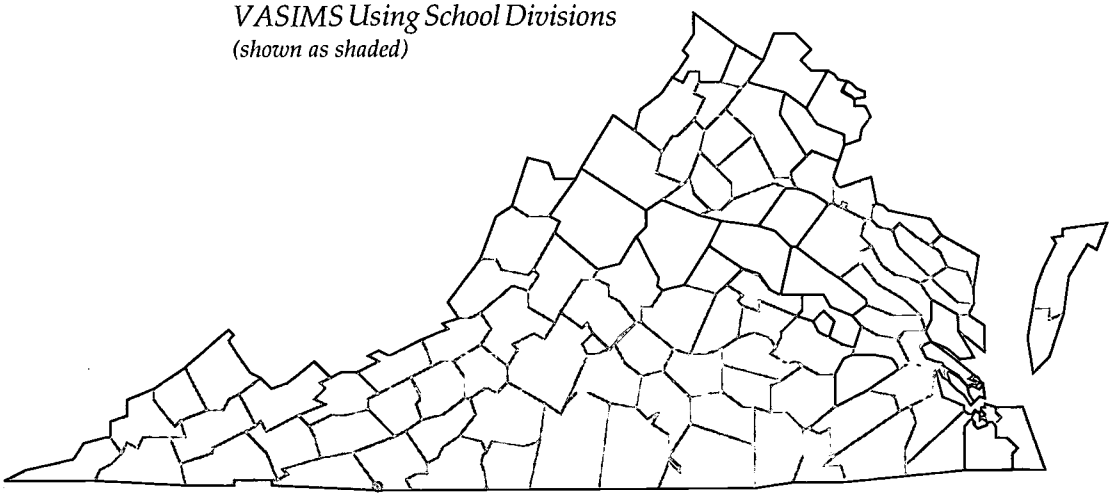
Despite these efforts, lack of accessible training opportunities continue to be a major obstacle to the full integration of technology in the curriculum. A 1993 study conducted by the Department of Education convened nine regional focus groups of educators from all grade levels representing 128 school divisions who cited training as one of the top five technology needs facing schools (Figure 6). In March, 1995, the Division of Technology conducted a unique online survey of VA.PEN users to get their views on technical assistance needs. Figure 7 profiles the responses to the survey and need for staff development in a variety of instructional technology applications.

Administrative Services

Under the previous Six-Year Plan, the Department launched the Communication Automation Transition System (CATS), an initiative to plan and implement a statewide administrative computer network. While the goal of full online exchange of all administrative data and reporting has yet to be realized, the CATS initiative laid a solid foundation for administrative automation in virtually all schools in Virginia. Today, some 1,100 schools in 108 school divisions use Columbia software for tracking and reporting student data, known as VASIMS (Virginia Student Information Management System). Sixty-eight school divisions use the state licensed RDA Financial Software (Figure 8).

But the use of VA.PEN as a means of administrative information exchange is growing steadily. All school divisions use VA.PEN to file federal food service reports, completing the necessary forms directly online. Other important administrative documents are now available on VA.PEN, including Superintendent's Memoranda, the Virginia Educational Directory, the Fall Membership Report, Sources of Funding, and the revised Standards of Learning. In 1995, the Department of Education established a site on the World-Wide Web, thus making the resources of the Electronic Academical Village and other Department information services available to all.

Figure 8.
VASIMS Using School Divisions
(shown as shaded)

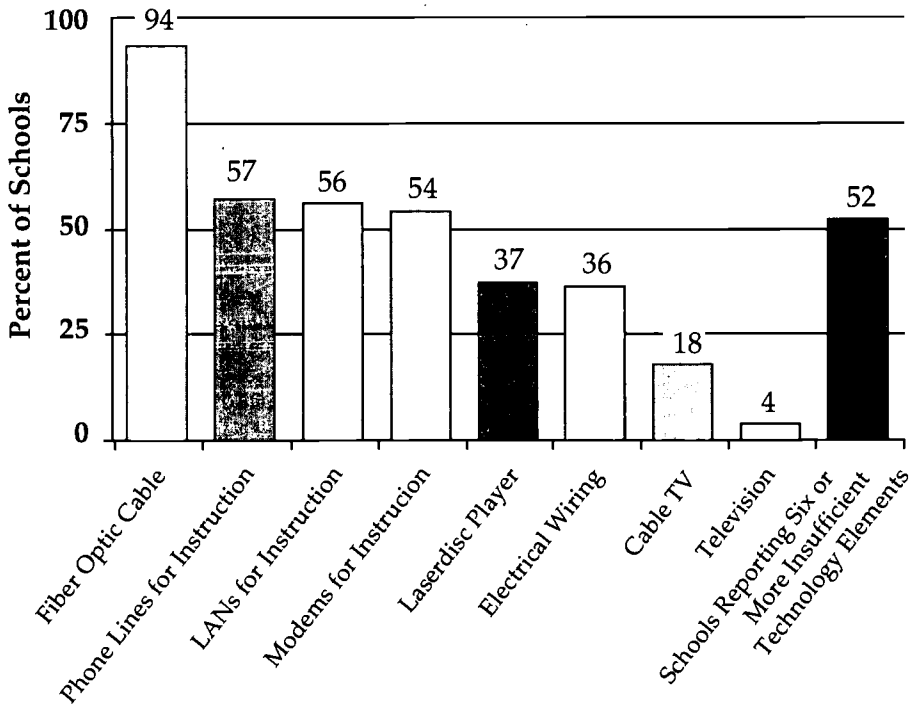


Summary

Throughout Virginia technology is making a difference in teaching and learning. Many exemplary programs are demonstrating the "best practices" in the use of technology in education; however, the profile of the current status of technology clearly indicates that much remains to be done. The wide disparity that exists among Virginia's schools means that many students are denied adequate access to the most basic technology; and few schools are adequately equipped with the new emerging learning technologies. As Figure 9 shows, the majority of Virginia schools report insufficient infrastructure to support technology in instruction. Over 50% of schools report inadequate capability in six or more technology elements.

Overcoming this disparity and providing all students and teachers with the learning resources necessary to meet educational needs now and in the future is a challenge to all of Virginia's public schools, communities, businesses, the Board of Education, and the General Assembly. This Six-Year Plan for Educational Technology charts a course of action to meet this challenge.

Figure 9.
Percent of Schools Reporting Insufficient Capability to Support Technology



The Six-Year Educational Technology PLAN

Infrastructure

School buildings and classrooms need appropriate cabling, telephone lines, outlets, wiring, and power receptacles to support the use of existing and future communication and multimedia educational systems. Such systems include networking of voice, data, video, instructional television and voice communication to and from each classroom. Without the proper infrastructure, school divisions and individual schools cannot participate in wide area networks

"Electronic information will become the great equalizer for our schools: Rural students will be able to tap the world's information as readily as students from large metropolitan areas. To take advantage of such resources, learners must acquire and practice skills in problem solving and information handling."

Beverly Hunter & Erica K. Lodish, Online Searching in the Curriculum: A Teaching Guide for Library Media Specialists and Teachers, *1989.*

Needs

Technologies available in local school systems are often insufficient and outmoded. A 1993 VPI&SU survey reported that 12 percent of Virginia's public schools had a network that served building-wide access to microcomputers.

The 1995-96 Educational Technology Initiative included $10,000 grants per school for the improvement and development of technology infrastructure (facilities and mechanical systems). This funding should be continued during 1996-2002 for school divisions to develop the infrastructure required to support networking and telecommunications. The initiative completes a foundation level of library automation for each school in the Commonwealth.

Safety is a major concern in schools today. For the past two years, legislation has been introduced to require telephones in every classroom. Implementation of voice communication to every classroom will enable teachers, administrators, and parents or guardians to remain actively connected to promote safety and efficiencies in classroom and administrative management. Safety will be enhanced by incorporating telephones into the school network, allowing each classroom teacher instant access to school officials and individuals outside the facility.

As wide area telecommunications networks are activated by local cable and telephone providers, all learning resources in a school become easily accessible to everyone. Citizens of all ages in homes, day care centers, community service agencies, and business and industry will form a truly integrated electronic village. Examples and prototypes of these electronic villages exist in communities across America.

Virginia's Public Education Network (VA.PEN) provides students, teachers and administrators with local, state, national, and global telecommunications capability. The Virginia Satellite Educational Network (VSEN) addresses disparity by providing distance learning credit courses to middle and high school students.

Telephone and cable television transmission technologies have increased communications between local and distant locations. Broadband network technology should be installed across the state to expand the capacity

of these transmission technologies for interactive video and high-speed data. School divisions require funding and technical support to identify and implement networking and telecommunications applications and systems.

GOAL I.

To integrate voice, video, and data networks capable of providing communications at the school, division, state, and national levels.

Recommendation 1: Assist school divisions to upgrade and retrofit facilities and mechanical systems to use existing or emerging network technologies.

Recommendation 2: Assist all schools to connect to the Internet and improve their access to VA.PEN. This includes the expansion of electronic data transfer between school divisions and DOE and the electronic publication of DOE reports.

Recommendation 3: Retrofit the existing Virginia Educational Satellite Network (VSEN) downlinks to receive compressed video; and expand distance learning opportunities to all K-12 schools using satellite, cable and other technologies

Results Of Implementing Recommendation 1, 2, and 3:

- Students have access to library resources from classrooms and homes.
- Teachers and students have immediate access to courseware and information in various formats from multiple locations.
- Data queries and information updates regarding attendance, grade reporting, and scheduling originate from individual workstation.
- Classroom security and safety is increased.
- Students' reading, writing, and research skills improve through repeated use of VA.PEN and Internet resources.
- Students access to information and resources are unimpeded by economic, geographic, or technological constraints.
- Each school has direct access to Internet.
- Each school has teleconferencing capability.
- Each school has access to distance learning programs.
- A 25 percent increase in VSEN course delivery capacity.
- The cost of networking to school divisions is reduced.
- Local government and community networks form partnerships with schools to expand communication opportunities.

Recommendation 1: Assist school divisions to upgrade and retrofit facilities and mechanical systems to use existing or emerging network technologies.

Strategies	*Dates*	*Rationale*
Conduct a survey to determine the status of network capabilities for each school division.	1996-1997	Data derived from the analysis of a survey of schools will provide the benchmark for establishing the next step in building-wide infrastructure.
Develop and distribute guidelines (standards) for building-wide networking to support voice, video, and data.	1996-1997	Defining the minimum recommended operational and performance standards for networks will create a uniform network infrastructure with consistent features across state.
Assist schools to upgrade and replace equipment and facilities to allow for networking of voice, video, and data.	1996-	Building-wide networking provides the opportunity to integrate technology into all aspects of the curriculum. Students and staff will have the capability to access, share, and present information and resources.
Collaborate with agencies and institutions responsible for design and implementation of statewide and national infrastructure to assure compatibility and connections to all schools.	1996-	Development of standards by the National Information Infrastructure (NII) and Virginia's Council on Information Management (CIM) has significant implications for the creation of a telecommunications infrastructure for Virginia's schools.

Recommendation 2: Assist all schools to connect to the Internet and improve their access to VA.PEN. This includes the expansion of electronic data transfer between school divisions and DOE and the electronic publication of DOE reports.

Strategies	*Dates*	*Rationale*
Provide financial support to assist all schools to establish connections to the Internet.	1996-	Providing each school a direct connection to the Internet and using that connection as a gateway to VA.PEN is an equitable and cost effective solution for access to the educational and information resources found on both VA.PEN and the Internet.

Recommendation 3: Retrofit the existing Virginia Educational Satellite Network (VSEN) downlinks to receive compressed video; and expand distance learning opportunities to all K-12 schools using satellite, cable, and other technologies.

Strategies	*Dates*	*Rationale*
Convert all state-purchased analog downlinks at high and middle schools to digital, utilizing local cable systems and existing division television networks to expand satellite reception to all Virginia schools.	1998-	Higher education and distance learning providers are changing to digital transmission. Compressed video increases distance learning capacity while reducing delivery costs.
Develop communications guidelines (standards) including equipment specifications for various levels (within school divisions and intrastate) of digital networking capabilities.	1996-1997	Seventy percent of Virginia schools are connected to local cable systems. These systems are in the process of upgrading systems for bi-directional transmission of video, voice, and data. Telephone companies are replacing transmission devices with fiber optic lines throughout communities.
Provide assistance to school divisions to implement plans for digital networking.	1997-1999	Some divisions with limited personnel and funding resources require assistance with planning and securing the funding to create a network.
Collaborate with other state agencies to develop and implement a plan to connect localities' digital networks statewide with high capacity data trunks	1996-	A state plan for networking, telecommunications, and resource sharing ensures that the efforts of school divisions, colleges and universities, and the business and private industry community are not counterproductive.
Maintain collaboration with Virginia public broadcasting entities for the continued delivery of distance education courses, of instructional television services, public information forums, staff development, and engineering expertise.	1996-	Collaborations between Department of Education and Virginia public television stations have allowed Virginia students, teachers, and citizens access to educational opportunities and experiences that would otherwise be unavailable to them because of economic or geographic constraints.

Technology-Based Instruction

Classroom access to current technologies enables students to become skilled in the knowledge and use of multimedia computers. Instruction and the learning experience take on a different dimension when personal inquiry is encouraged and can be supported. Instruction is enhanced and can be designed to meet the needs of students with a wide range of learning abilities. Assistive technology for disabled students allows these students to replicate the learning experiences of their peers. The presence of handheld portable technology for mathematics and science instruction inspires process learning and problem-solving approaches to these subjects. While the number of computers in homes is increasing, they are scarce in the homes of at-risk students.

Needs

According to a 1992 survey of Virginia schools, the student-to-microcomputer ratio was 14.5 students to 1 microcomputer. Computers in specialized areas are generally intended to provide central access for all students. However, the 1992 study revealed that these special area computers are not normally available for use by most students. In a more recent survey (1995) of Virginia schools, the student-to-microcomputer ratio is 10.5 to 1.

The 1995 survey also revealed that most of the existing technology equipment does not meet hardware specifications necessary to operate videodisc and CD-ROM programs. It also showed that many workstations are not able to be networked at current standards. Outdated equipment needs to be replaced. Additional equipment needs to be acquired to create equitable access for students and teachers.

Access to microcomputers by teachers and students is an important determinant of the effective use of technology in the classroom. Research results from national studies and case studies of Virginia schools support this fact. Case studies in demographically diverse Virginia schools that adopted a strong base of technology revealed extensive support for making microcomputers available in classrooms, labs, library media centers, and teacher resource centers. Furthermore, these schools insured that exemplary technology-using teachers had their own microcomputers for in-school and at-home use. The International Society for Technology in Education (ISTE) recommends a microcomputer on every teacher's desk and one in his or her home.

Microcomputers placed in the homes of students produce positive results. In the Indiana "Buddy" pilot program, students using microcomputers daily for extended periods in the home achieved a higher level of proficiency, when compared with other students.

Among technologies that must be available for students to use are graphing calculators and scientific probes that are compatible with portable and desktop microcomputer workstations. These items are specifically mentioned in the recently adopted Virginia Standards of Learning for mathematics and science. These devices, when joined with microcomputers to support and encourage the writing process, with software ap-

" . . . Information literacy, the ability to locate, process, and use information effectively, equips individuals to take advantage of the opportunities inherent in the global information society. Information literacy should be a part of every student's education experience."

Association for Supervision and Curriculum Development, Resolution #8, 1991. (from Christina S. Doyle, Information Literacy in an Information Society: A Concept for the Information Age, 1994.)

plications in a multitude of academic disciplines, and with interactive connections to videodisc technology, endow the classroom with technology that maximizes intellectual opportunities. Placement of this broad mix of classroom-based technology is a key variable in defining access and in decreasing disparity and inequity in education.

The use of technology is incorporated in the proposed 1995 Standards of Learning recently developed for mathematics, science, English/language arts, and history and social sciences. This integration introduces technology in meaningful ways in the learning process and also in teacher training. Incorporating technology into the curriculum in each school must embrace higher order thinking skills, real world problem solving, improvement of skills in reading and writing, and incentives for technology to be used as a tool for learning.

GOAL II.

To improve teacher and student access to technological resources in classrooms and other learning centers through equitable distribution of grants, equipment, software, and technical assistance.

Recommendation 4: Provide a network-ready multimedia microcomputer for each classroom for use by teachers and students.

Recommendation 5: Assist schools to achieve a 5 to 1 ratio of students to microcomputer by providing partial funding for network-ready microcomputers for classrooms.

Recommendation 6: Assist schools to acquire appropriate numbers of graphing calculators and relevant scientific probes and sensors for the study of mathematics and sciences.

Recommendation 7: Assist schools to provide students with educational technologies for home use and to develop a technology fund for innovative practices.

Recommendation 8: Aid in providing assistive devices for disabled students to use with microcomputers.

Recommendation 9: Increase in each school availability of software for instruction and teacher productivity.

Results Of Implementing Recommendations 4, 5, 6, 7, 8, and 9:

- Individualized instruction is commonplace.
- Teachers use multimedia to create innovative classroom presentations.
- Students demonstrate an understanding of the relationships between mathematical operations and applied results.
- Students develop skill in using various forms of technologies to complete assignments.
- Students use technology in science and mathematics classes to analyze data and to conduct research.
- Teachers effectively manage administrative tasks.
- Students have access to microcomputer technologies in multiple learning environments.
- Students with disabilities use appropriate assistive technology equipment to access information and use instructional resources.
- School divisions are encouraged to develop microcomputer loan projects.
- Instructional alternatives for at-risk students are increased.
- Technology support for implementation of the Standards of Learning for History and Social Sciences and for Language Arts.

Recommendation 4: Provide a network-ready multimedia microcomputer for each classroom for use by teachers and students.

Strategies	*Dates*	*Rationale*
Provide a network-ready multimedia microcomputer in K-12 classrooms.	1996-	The classroom management needs of teachers and instructional needs of students require diverse information and media resources and the ability to make presentations to groups. Multimedia devices provide the methods that makes these productions possible. In addition, many current microcomputers are obsolete, i.e., unreliable, incapable of running high quality and sophisticated software,and most are not able to run on current networks.

Recommendation 5: Assist schools to achieve a 5 to 1 ratio of students to microcomputer by providing partial funding for network-ready microcomputers for classrooms.

Strategies	*Dates*	*Rationale*
Provide for network-ready microcomputers for classrooms to help schools achieve a 5 to 1 student to microcomputer ratio.	1996-	Creating equitable access for students and teachers and related electronic resources is a critically important component in the classroom of the future. In addition, many current microcomputers are obsolete, unreliable, incapable of running high quality and sophis-ticated software, and are not networkable.

Recommendation 6: Assist schools to acquire appropriate numbers of graphing calculators and relevant scientific probes and sensors for the study of mathematics and sciences.

Strategies	*Dates*	*Rationale*
Provide baseline support for the purchase of graphing calculators for all students enrolled in secondary mathematics courses.	1996-1998	The use of graphing calculators in mathematics has been demonstrated to contribute to student engagement (time on task) in key mathematics concepts and to problem-solving situations. The calculators play an expanding role in using higher levels of math to demonstrate work related technology applications. These devices, in sufficient numbers and available at the appropriate levels in each school, support a curriculum based upon implementation of the Standards of Learning for Mathematics.
Assist schools to acquire a sufficient number and variety of scientific probe kits and sensing devices to support science instruction at appropriate grade levels.	1996-1998	Analytical instruments and sensing modules that interface with microcomputers offer students tools that are in daily use in the workplace and in the research laboratory. Such instruments encourage research and inquiry-based learning in the life, physical and earth sciences as indicated in the Standards of Learning Objectives for Science.

Recommendation 7: Assist schools to provide students with educational technologies for home use and to develop a technology fund for innovative practices.

Strategies	*Dates*	*Rationale*
Encourage pilot projects to permit students to check out microcomputers for home use	1996-	A computer loan program provides students with the opportunity to use the same technology at home that is available in school.
Create a statewide trust fund to encourage partnerships between the Commonwealth of Virginia and one or more private companies to promote innovative instructional applications such as placement of microcomputers in homes of at-risk students for access to remote resources for learning.	1996-	Placing microcomputer technology in the home of at-risk students will serve to motivate them, increase learning opportunities, encourage independent learning, and promote parental involvement.
Assist schools that participate in the pilot and trust fund technology initiatives with the development of a continuous technology training program.	1996-	An organized, continuous technology training program encourages appropriate applications of technology. Students, teachers, parents, and guardians who are skilled users of technology serve to promote the expansion and strength of technology-based instructional programs.

Recommendation 8: Aid in providing assistive devices for disabled students to use with microcomputers.

Strategies	*Dates*	*Rationale*
Assist school divisions with the purchase of assistive devices for special needs students.	1996-	A number of specialized devices are available that enable the disabled student to access and use technology hardware. Many school divisions need assistance with funding for the acquisition of this hardware and technical assistance in putting it into service and meeting state and national guidelines.

Recommendation 9: Increase availability in each school of software for instruction and teacher productivity.

Strategies	*Dates*	*Rationale*
Explore the establishment of state contracts and group purchase discounts with software providers.	1996-	Competitively negotiated contracts with software providers and group purchase discounts allow schools to acquire larger libraries with funds available.
Increase funding to schools for software acquisition	1998-	Schools need direct financial assistance to acquire the rich variety of instructional software in various formats, e.g., computer software, CD-ROM, Laserdisc, videos, etc., keyed to the Standards of Learning, essential to creating effective learning environments.

Training and Technical Assistance

Ultimately, teachers are responsible for the use of technology in the classroom. The successful integration of technology depends largely upon the existence of a well-developed teacher training and technical assistance program. Such training must be ongoing and linked to current needs. A well-designed training program allows teachers and administrators to develop effective and appropriate links between technology and specific learning objectives. Good training programs produce local technology coordinators and technical support staff.

"If computer technology is to have an impact on teaching and learning, teachers must be comfortable with computers, seeing them as tools that enhance rather than interfere with their daily teaching. For this to happen, teachers need special training... thus, training for teachers should be seen as an ongoing requirement for professional growth."

U.S. Congress. Office of Technology Assessment. Power On! New Tools for Teaching and Learning, *1988.*

Needs

Most school divisions do not have a technology service. Full-time instructional media and training coordinators, or individual building technology designees are not available to develop and manage a program of technology staff development. Training opportunities for division coordinators and building-level specialists are limited, or nonexistent on the local level.

Classroom teachers need the consistent support and assistance of a building technology designee to show best technology applications for best teaching practices. Building technology designees can provide teachers with learning on demand. Training can consist of informal technical support and interactive technology training sessions during the workday within the school building.

GOAL III:

The Department of Education and school divisions will establish training programs and incentives to enhance teaching and learning through the use of educational technologies.

Recommendation 10: Promote specialized training for the technology designee in each school and conduct a study of guidelines for technology competencies and endorsement requirements.

Recommendation 11: Promote training and professional development on available technologies and software for school personnel across all levels and positions.

Results Of Implementing Recommendations 10 and 11:

- Technology training in network management, productivity and presentation software, and multimedia for building level designee and library media specialist is provided.
- Best instructional practices using technology are shared.
- Teacher confidence level regarding the use of hardware and software is increased.
- Training programs are linked to specific curriculum needs.
- Training is a component of the staff development program.

Recommendation 10: Promote specialized training for the technology designee in each school and conduct a study of guidelines for technology competencies and endorsement requirements.

Strategies	*Dates*	*Rationale*
Conduct regional summer institutes on educational technology applications for identified elementary school specialist.	1996-1997	Training and support of educators who integrate technology applications in teaching and learning are the most critical components of technology implementation in K-12 education.
Conduct regional summer institutes on educational technology applications for identified middle school specialist.	1996-1997	Training and support of educators who integrate technology applications in teaching and learning are the most critical components of technology implementation in K-12 education.
Conduct regional summer institutes on educational technology applications for identified high school specialist.	1998-1999	Training and support of educators who integrate technology applications in teaching and learning are the most critical components of technology implementation in K-12 education.
Collaborate with school divisions to recommend employment of technology specialists and changes in existing regulations or the creation of new endorsement provisions for professionals in educational technology.	1996-	The need for specially trained technicians and educators increases in proportion to the extent technology is integrated in the curriculum and in the school. Current certification and endorsement requirements need to be revised to reflect the need of school divisions to employ technology specialists.
Use the recent work of higher education and the National Council for Accreditation of Teacher Education (NCATE) to define teacher competencies in areas of instructional technology.	1996-1997	A foundation level of coursework and training prepares educators to be employed by school divisions where there is an infusion of technology.
Collaborate with community colleges and universities to ensure effective, affordable, high quality technology training for all teachers and administrators.	1996-	Community colleges and universities provide preservice and in-service training to all Virginia's teachers and administrators.

". . . Without enlightened principals and superintendents, capital expenditures for computers and telecommunications will not yield to the desired results because the necessary curricular changes, teacher in-service training, and assessment will not take place. The influence of the principal in determining the success or failure of academic restructuring has been well documented . . ."

Governor's Task Force for Technology

Recommendation 11: Promote training and professional development on available technologies and software for school personnel across all levels and positions.

Strategies	*Dates*	*Rationale*
Conduct an annual statewide leadership training conference on technology and regional drive-in symposia for lead teachers and technology specialists.	1996-	A forum which brings together school division technology decision makers provides continuous professional development opportunities to share and exchange knowledge and experiences. These meetings permit participants to remain current on the latest K-12 technology applications.
Offer incentives for each educator who completes five graduate-level hours of staff development toward recertification or endorsements.	1996-	Graduate-level coursework serves to motivate staff to a higher level of preparation; to integrate innovative technologies in instruction; and sets exemplary behaviors for colleagues.
Schedule broadcast of teleconferences to provide annual technology updates, and work with institutions of higher education to offer statewide university-level courses via distance learning to school division administrators, technology and media specialists, and teachers.	1996-	Teleconferences and distance learning represent cost-effective ways of reaching the greatest number of educators.
Establish guidelines and specifications for teacher training.	1997-	Guidelines will ensure that training programs address the standards recommended by the Advisory Board on Teacher Education and Licensure.
Increase the funding level for training as an essential component of state initiatives.	1998-	Training is consistently cited by schools as a critical need. Connecting training to the "local match" component of technology initiatives better ensures staff development designed to meet local circumstances.
Provide competitive regional grants for inservice training to be locally coordinated and conducted.	1998-	The training needs of each school division vary. Effective technology training activities need to be specific and highly focused and address the various levels of expertise of the educators involved.
Provide on-site technology consultation and training through DOE staff and/or contracted services.	1996-	It is essential to a successful technology program that school division personnel and building level educators have access to objective consulting services that provide accurate and unbiased information in a timely fashion.
Update the VDOE Technology Examination and Training facilities with the most current technologies.	1996-	The Technology Examination and Training facility serves as a training laboratory for local school division administrators, teachers, library media specialists, and Department of Education staff.

Recommendation 11: Promote training and professional development on available technologies and software for school personnel across all levels and positions. *(Continued)*

Strategies	*Dates*	*Rationale*
Work in partnerships with appropriate business and government representatives to conduct a series of symposia on the technical requirements for schools to access Internet.	1996-	School division staff need to have a clear awareness and understanding of the technology required to access the Internet.
Provide for teacher training on the use of graphing calculators in middle and high schools in all school divisions.	1998-	Proper use of graphing calculators in math classes will require teachers to be adequately trained. Different present-ation approaches to instruction and assessment promotes success in applying the technology.
Provide training programs for science teachers in the use of scientific probe kits and sensing devices and related software.	1997-	Effective use of probes, sensors, interface modules and software will require that teachers be trained on these new technical tools. The use of these tools will focus on student-centered instructional workgroups. This would suggest that specialized classroom management techniques also would be needed in the training for teachers.

Administrative Services

Attendance, scheduling, and grade reporting are three of the most labor-intensive administrative routines in school management. Analysis of this data is an important administrative task relating to planning and assessment. The use of certain technologies can make the administration of these and other tasks much more manageable.

"The concept and technology of internetworking can serve as a foundation for the collaboration and coordination of a wide array of disparate efforts by federal, state, and local agencies, including not only educational agencies, but also libraries, public health and human services agencies, and others with missions related to education."

Barbara L. Kurshan, Marcia A. Harrington, and Peter G. Milbury, An Educator's Guide to Electronic Networking: Creating Virtual Communities, *1994.*

Needs

The process of collecting, analyzing, and reporting required student information and business management data to local, state, and federal agencies is not fully automated in Virginia. Local education agencies obtained equipment and software for administrative automation through the Department of Education's 1988-94 technology plan and related initiatives. Hardware and software provided by the 1988-94 initiatives need upgrading and expanding.

The administrative software should be compatible on the hardware platforms available throughout the educational community. The software should either provide new capability or update existing capability in the areas of personnel, vocational education, special education, curriculum management, transportation management, building maintenance/facilities management, inventory, school food point of sale service, attendance, grade reporting, scheduling, budgeting, and general ledger and payroll support.

GOAL IV.

Educators and administrators will have access to technologies that provide for the maintenance, reporting, and analysis of student and administrative data.

Recommendation 12: Complete administrative initiatives begun in the Department of Education's Educational Technology Plan for 1988-94.

Results Of Implementing the Recommendations 12:

➢ Improved data management provides for enhanced data analysis allowing better planning and assessment.

➢ Teachers and administrators spend less time performing data reporting tasks.

➢ Options for upgrading existing management systems increase.

➢ Timeliness and accuracy in reporting data is improved.

Recommendation 12: Complete administrative initiatives begun in the Department of Education's Educational Technology Plan for 1988-94.

Strategies	*Dates*	*Rationale*
Adopt a comprehensive, standardized software package to support student and administrative data management, analysis, and reporting.	1998-	The process of collecting, analyzing, and reporting required student information and business management data to local, state, and federal agencies should be fully automated.
Study future incorporation of a classroom management system to interface with other administrative software.	1998-	Classroom management systems potentially offer teachers the opportunity to automatically track student performance. Currently, these systems are emerging on the technological scene. Any such system would necessarily have to interface directly with the administrative software initiative.

Evaluation/Assessment

Evaluation and assessment of technology involves providing practitioners with the information they require to maximize their expertise and creativity in the design, production, use, and improvement of instruction and information management. Assessment information is designed to provide users of technology with timely, accurate information which will contribute to decisions about the improvement, continuance, or deletion of implementation strategies

"Business has spent a trillion dollars on technology in the last 20 years and it's only recently made an appreciable difference. The moral of the story is that it takes a huge investment and a long period of time to see a big difference."

Dave Moursund, Executive Officer, International Society for Technology in Education (from "Speaking of Education," Virginia Journal of Education, March, 1995.)

Needs

Minimal assessments and evaluations of local technology programs are not conducted regularly by local administrators. Prescribed assessments need to be conducted on a consistent basis. Analysis of the results provides information needed to develop cost-effective best practices in administrative applications and curriculum applications.

The results must provide recommendations for continuation of technology activities. For example, how can school divisions adopt best technology practices with consistently significant positive effects on students and schools? How is technology best used in a management role in teaching? How is technology a means instead of an end?

GOAL V.

A system of ongoing evaluation will be established for state and local school assessment of technology applications, teacher preparation, and training.

Recommendation 13: To assess on a continuing basis the impact of technology in schools to learn which technologies provide the most benefit to student achievement.

Results Of Implementing the Recommendations 13:

- The impact of technology in Virginia schools is documented.
- Cost effective applications of technology are identified.
- A rationale is established for revision of the Six-Year Educational Technology Plan.
- Analysis of trends and changing systems prepare for the development of future technology initiatives.

Recommendation 13: To assess on a continuing basis the impact of technology in schools to learn which technologies provide the most benefit to student achievement.

Strategies	*Dates*	*Rationale*
Develop an instrument that can be used to assess progress in implementing the recommendations of this six-year plan.	1996-1997	The impact of placing technology in the schools serves as benchmarks for decisions of local school divisions, higher education, business and industry partners, the Department of Education, and state legislators regarding future uses.
Provide for consistent collection of data as input to the measurement tools developed above.	1997-	Raw data is necessary to respond to requests from the legislature, local school divisions, and regional and national organizations for a statistical description of technology infusion in Virginia's public schools.
Publish biennial reports showing the assessment of annual data on technology initiatives resulting from state or other funding collaborations.	1997-	A biennial report serves as a "report card" of the implementation of technology initiatives. This report provides a description of the uses of technology in Virginia's classrooms and assists in securing local, state, national and private sector financial support.
Conduct an annual survey of Internet Users, VA.PEN users and non-users to assess the effectiveness of telecommunications as an administrative and instructional tool.	1996-	This survey provides opportunities to determine user comments and serves as a basic information source for planning the future of the network.
Conduct an annual review of the Six-Year Educational Technology Plan; use data collected to revise the process and strategies that reflect the changing priorities of the Commonwealth, the Department of Education, and public schools in Virginia.	1996 -	The Six-Year Educational Technology Plan for Virginia is a flexible document. Though specific goals, recommendations, and strategies are detailed, they are presented so as to reflect rapidly changing technology. The plan must retain its relevancy and connection to realistic expectations and fiscal resources.

Implementation Plan for 1996-98

Classroom Computers and Networking

GOAL: Classroom Computers And Networking - ($26,300 per school in 1996-97 and $53,000 per school division plus $25,000 per school in 1997-98)

This initiative assists in meeting **Recommendations 1, 2, 4 and 5.**

Need

Data provided through surveys of Virginia Schools (1995) by the Department of Education indicate that approximately 48 percent* of the classrooms have at least one computer. These computers range from minimally functional stand-alone to state-of-the-art network ready computers. Additionally, computers used for instruction are housed in English, business, and other labs in some schools. According to a 1994 Children's Partnership Study, one-third of the nation's classrooms have at least one minimally functional stand-alone computer, but 80% of them are obsolete according to the U. S. Department of Education. School divisions in Virginia are providing more computers for instruction through local technology plans submitted for state review in 1995.

Virginia's recently adopted **Standards of Learning** contain computer requirements for core disciplines and technology. Computer requirements in the **Standards of Learning** for mathematics, science, English, history and social science, and technology include:

- Functional literacy for improved communication in reading, writing, organization and analysis of data, and resource management.
- Delivery and assessment of instruction.
- Communication through application software and research products.
- Shared instructional responsibility by teachers of all disciplines.
- Computer graphics and translation requirements in mathematics and science.
- Local school division technology plan implementation requirements.
- Minimum SOL computer technology skills required by the end of grades 5 and 8

**NOTE: Based upon responses from 91 of 133 school divisions and projections for remaining 42 school divisions.*

Assumptions

- State and local matching funds to provide training and software.
- Every school has a LAN in place, at least in the library, based on technology initiatives.
- Most schools (over 80%) have at least 10 computers less than 5 years old.
- New computers for K-12 classrooms
  - Network ready computers w/75 MZ processor, 8 MB RAM and multimedia upgrade capability
  - $1,900 per computer cost based upon state bid or vendor list
  - 50,500 total classrooms (estimate based upon 1800 schools with an average of 28 classrooms each.)
  - An overall 9 to 1 student -to-computer ratio in schools according to a January 1996 Department of Education survey, while commendable, did not consider the diversity and age of computers or a separation of uses between instruction and administration.

- The $10,000 networking grants for all schools, in 1995-1996, provided expansion of the existing Library LAN to classrooms.

- The 1996-1997 $26,300 grants to schools for additional classroom computers and networking capabilities might be used by schools to:

  - Expand the LAN beyond the previous initiatives $10,000

  - Purchase 8 new network-ready multimedia computers $16,300

- The 1996-97 $53,000 grants to school divisions could be used to implement:

  - A New Horizon's Model (Sun Workstation) network, as used at the New Horizons Governor's School — approximately $10,000 per school

  - An Asyncronous Routing network model, as used in Shenandoah County — approximately $2,500 per school

State Appropriation

Grants for Computers/Networks/Infrastructure/Retrofitting $100,000,000

Graphing Calculators For Mathematics

GOAL: Graphing Calculators For Mathematics (8-12 Grades)

This initiative implements **Recommendation 6.**

Need

The **Standards of Learning** (SOL) for mathematics require the use of graphing calculators for Algebra I, II, geometry, trigonometry, mathematics analysis, and calculus instruction. Science **Standards of Learning** employ the use of graphing calculators for physical science and other science courses. Graphing calculators will meet the following SOL needs:

- College Board requirements for advanced placement calculus
- Graphing utilities to enhance realistic applications through modeling and investigation of trigonometric functions
- Solving and confirming algebraic solutions
- Verifying solutions to equations and inequalities
- Work-related technology applications in science

Assumptions

- 215,000 graphing calculators for implementation of mathematics and science SOLs @ $78 each
  - Estimate for number includes all Algebra I students (80,000) and a base (135,000) for Algebra II, geometry, trigonometry, mathematic analysis, calculus, and physical science and other science courses.
  - Cost estimate per calculator is based on current cost price for Texas Instruments 82. State bid list slightly lower ($78.00 per calculator)
  - Graphing calculators TI82 are hand-held calculators that feature advanced functions which go beyond the capability of scientific or regular calculators. This hand-held technology will display and perform operations on mathematical expressions, equations, matrices, and data tables; and display and analyze graphs of data and advanced functions at the command of the user. The graphing calculator also allows for the statistical analysis (e.g., mean, mode, median, standard deviation, variance) of data stored in the calculator. The graphing calculator will interface or link with other hand-held technology and with computers.
- Presently, the base of calculators in schools is primarily student owned.
- Intent is to provide foundation level of calculators with no future upgrade or replacement.
- Allocation will assist school divisions with local technology plan implementation.

State Appropriation

Graphing Calculators
Quantity 215,000

Approximately $16.7 million

Scientific Probes And Sensing Devices For Science

GOAL: Scientific Probes And Sensing Devices For Science (probeware)

This initiative implements **Recommendation 6.**

Need

The **Standards of Learning** (SOL) for science require the use of technology for instruction and learning of science concepts, skills, and processes. Support for the use of scientific probes and sensing devices includes:

- Research and inquiry-based learning in life, physical, and earth sciences
- Analytical instruments and sensing modules to interface with computers for application in teaching laboratories at all levels
- Local school division curriculum development and technology plan implementation

Assumptions

- Probeware is a variety of hand-held electrical sensors designed to
  - measure and communicate physical attributes such as light intensity, temperature, voltage, motion, pressure, pH, and magnetic fields, and
  - interface those collected data directly with graphing calculators and other computers for mathematical analysis
- Current foundation level of probeware is limited in classrooms
- Scientific probes and sensing devices (probeware) for use in elementary, middle, and high schools:
  - 350 secondary schools, 315 middle schools, 1,100 elementary schools
- A secondary school would require at least 8 probe kits which would include 10 different probes and the necessary interface at a cost of $650.
- A middle school would require at least 6 probe kits which would include 7 different probes and the necessary interface at a cost of $425.
- An elementary school would require at least 2 probe kits which would include 3 different probes and the necessary interface at a cost of $250.
- Intent is to provide foundation level of probeware with no future upgrade or replacement
- Allocation will assist school divisions with local technology plan implementation

State Appropriation

Approximately $3.2 million

Appendices

Appendix A
VETAC Resolution

Aware of the growing influence of emerging technology in education and in the workplace, the Board of Education adopted a resolution on educational technology on February 24, 1994. This resolution charged the Virginia Educational Technology Advisory Committee with the responsibility to lead in formulating a new technology plan for the public schools.

The Board's resolution reads as follows:

WHEREAS, technology will play an increasingly vital role in Virginia's efforts to improve education and to set and meet higher academic standards for all students; and

WHEREAS, equal access to educational technology for all students, teachers, and administrators must be a central focus of the Board of Education's vision; and

WHEREAS, students must be able to explore ideas, integrate and manipulate text, audio and visual information, and to apply knowledge to real life situations as independent and successful lifelong learners; and

WHEREAS, locating, organizing, and using global information and multiple resources will continue to present a challenge to students as they enter the work force; and

WHEREAS, the teachers empowered to use technology as a tool for improving instruction and classroom management will enhance student access to content, improve learning and thinking skills, and better prepare students for using technology today and for the future; and

WHEREAS, students must use technology to link home, school, libraries, community service agencies, and higher education to make learning and life improvement goals a reality for all citizens; and

WHEREAS, all schools must stimulate innovative use of instructional technology in every classroom and laboratory to promote the use of technology in the development of new paradigms for teaching and learning; and

WHEREAS, other states have demonstrated leadership in providing technology for instructional purposes; and

WHEREAS, the Virginia Educational Technology Advisory Committee (VETAC) is recognized as the primary group representing local school divisions and is charged with the responsibility to provide the Superintendent of Public Instruction and the Board of Education both vision and advice on the use of educational technology in Virginia's public schools:

NOW, THEREFORE, BE IT RESOLVED that the Virginia Educational Technology Advisory Committee (VETAC), in consultation with other key education and technology leaders, and members of the Board of Education designated by the Board President, and in collaboration with the Virginia Department of Education instructional personnel, shall develop for the Superintendent of Public Instruction and the Board of Education, a comprehensive plan for an educational technology program to improve instruction in Virginia's public schools; and

BE IT FURTHER RESOLVED, that the Superintendent of Public Instruction create an advisory council of business leaders who are interested in public education and technology

to provide assistance in this project. The council would work in collaboration with VETAC in developing the educational technology plan, and would also provide support for the Board of Education in promoting and serving in an advocacy role for the plan; and

BE IT FURTHER RESOLVED, that the plan will contain a comprehensive vision of the use of technology which will result in computers and other technologies being readily available to students, teachers, and administrators so that they can use them to provide the most dynamic, comprehensive, and challenging instructional program available. This plan shall be presented to the Board of Education in June 1995. Through the application of this plan:

- students will improve their reading, writing, and verbal skills through increased use of word processing, electronic communications, and interactive technologies;
- students and teachers will be able to use information from any location through telecomputing and telecommunications;
- students and teachers will be more productive and efficient through the use of networking which allows the use of electronic mail and other data, video, and voice transfer; and
- students will increase their ability to analyze and solve complex problems through interactive multimedia programs, scientific probeware, and graphic design programs.

The plan must also include the following:

- the critical elements necessary in each school division's technology plan that assumes the improvement of the quality of student learning within the school division and that they are compatible with the statewide vision;
- a description of the hardware and software necessary to carry out the plan;
- an analysis, review, and recommendations concerning the level of technical support needed to successfully carry out the plan;
- a series of recommendations regarding the complex issues associated with specifications, installations, and maintenance of local and wide area networks (LANs and WANs); and
- a series of recommendations regarding the complex issues associated with linkage and utilization of existing telecomputing and telecommunications systems funded by local schools, consortiums, and the Commonwealth of Virginia; and
- a review of how other states have approached these educational technology planning challenges.

Appendix B

What Research Shows

Infrastructure

Telecommunication is the link connecting education to the world—communication between individuals and groups through telephone lines, dedicated lines, cable, and satellite transmission. Messages may be interactive: e-mail, computer conferences, and two-way audio or video conferences. One-way communication may involve television through cable or satellite systems. Through distance learning, telecommunication becomes a catalyst to equalize educational experiences for students who may be isolated in rural regions or for socioeconomically disparate schools and is a powerful instrument for equity.

The International Society for Technology (ISTE) in Education recommends that schools should be encouraged to establish internal networks to connect teachers and students within all locations in a district and should be subsidized by state funding to assure equitable distribution (Vision: Test, 1990). ISTE further recommends that students' and teachers' homes be connected to the network.

In a review of research on the use of networking for collaboration across classrooms in different geographic locations, Riel (1992) found evidence of improved academic skills. Spaulding and Lake (1992) noted improved writing skills by low-achieving students from New York schools, who collaborated on writing projects with students from four other states and France, and Germany via a telecommunications network. Weir (1992) found that fourth and fifth graders made significant achievement gains as a result of involvement in a National Geographic Kids Network (NGS) science project. In comparisons with a control group of non-networking students, the NGS students demonstrated significant increases in the use of graphs, improvement in data interpretation skills, and in the ability to identify map locations using longitude and latitude.

Martin and Rainey (1993) compared the effectiveness of satellite-delivered science instruction with the same instruction provided face to face. Using the same instructional materials, seven high schools receiving satellite instruction were matched with seven high schools receiving instruction in class. Matching included socioeconomic status, geographical characteristics, student enrollment, race, gender, and equivalence in science achievement prior to the study. Students who received satellite-delivered instruction achieved at a significantly higher level than students experiencing face-to-face-instruction.

"Teachers can be incredibly more productive on a network. Studies show productivity increases of as much as 30%. Networked teachers can exchange lesson plans, get tips from their colleagues, or obtain teaching materials from the Library of Congress, the National Archives, and the great museums."

Reed Hundt, Chairman, Federal Communications Commission "Town Meeting" on Telecommunications Reform and Cities Annual Congressional City Conference, National League of Cities, March 1995.

Technology - Based Instruction

Research studies have shown that educational technology has a significant positive effect on student motivation, academic achievement, and attitudes toward learning (Sivin-Kachala & Bialo, 1993). In a meta-analysis of 254 controlled evaluation studies covering students from kindergarten through college, Kulik and Kulik (1991) found that com-

puter-based instruction was 30 percent more effective than other forms of instruction. Ryan (1991) examined 40 comparative studies on the use of computers in elementary schools and calculated that computer-based instruction was 30 percent more effective than other forms of instruction. McNiel and Nelson (1991) conducted a meta-analysis of research on the cognitive achievement effects of interactive video (IV), resulting in a finding that it was 50 percent more effective than control group instruction. Significantly higher results were found when teachers used interactive video as a supplement to traditional instruction than when interactive video was used to replace traditional instruction. Bangert-Drowns (1993) found that use of a word processor as an instructional tool was 27 percent more effective than traditional methods and was 49 percent more effective in remedial writing classes. In a meta-analysis of 47 studies of higher education, military, and industrial training, Fletcher (1990) found that students receiving instruction via interactive video had achievement scores that averaged 0.50 standard deviations above the scores of students receiving conventional instruction. Pisapia and Perlman (1993) found increases in student achievement from .27 to .56 standard deviations for computer-based technologies when compared to traditional instructional approaches.

When educational technology was used, learning was found to be more student-centered and more cooperative in nature, with increased teacher/student and student/student interaction. Levels of effectiveness of educational technology were found to be influenced by the student population, software design, teacher role, grouping of students, and accessibility to technology (Sivin-Kachala & Bialo, 1993).

Training And Technical Assistance

Sivin-Kachala and Bialo (1993) concluded that university and in-service teacher training provides teachers with greater comfort in using computers, an increase in the desire to use computers, and an understanding of how to integrate software into the classroom curriculum. Ryan (1991) found that the amount of technology-related teacher training was significantly related to the achievement of students receiving computer-based instruction. Students of teachers with more than 10 hours of training significantly outperformed students of teachers with 5 or fewer hours. Cates, McNaull, and Gardner (1993) document research that lends support for the importance of teacher training. Compared to teachers with less training, teachers with more than 3 credit hours of university coursework and more than 3 contact hours of inservice training rated themselves higher on scales of computer expertise, had higher opinions of the usefulness of software, and reported significantly greater use of computers in the classroom.

Technology can help create a rich environment for learning. One of the most significant impacts of the computer is on teaching style, empowering the teacher to function as a facilitator of learning or as a coordinator of learning resources rather than as a transmitter or presenter of information. Teachers may use technology in different ways: drill and practice, tutorials, simulations, problem solving, or as a productivity tool. Critical to integrating technology into the learning process, teachers make decisions about the use of technology in everyday classroom activities. Powerful use of technology does not occur unless four interrelated conditions are met: (a) training in the skills needed to work with technology; (b) education that provides vision and understanding of state-of-the-art development and application; (c) support for experimen-

tation and innovation; and (d) time for learning and practice (U.S. Congress. Office of Technology Assessment, 1988).

Marshall, et al. (1989) found that the use of technology requires well-trained teachers, effective planning regarding how these tools will be used, high quality software, and reliable system maintenance. Shiengold and Hadley (1990) stated that the vast majority of teachers have little or no training on how to apply computers in teaching. Only about one third of all K-12 teachers have even 10 hours of computer training.

Integration of computers by classroom teachers takes time. Shiengold and Hadley (1990) noted that the basis for any time frame of integration is poorly established, but two and three year periods are not unusual. Becker (1992) estimates that it takes 5 or 6 years for teachers to truly master teaching with computers.

Access to computers by teachers and students is an important determinant of technology use in the classroom. Exemplary teaching was observed in schools that allowed teachers to borrow computers for home use (Becker, 1992). In comparisons with teachers who did not use technology, exemplary classrooms of technology-using teachers were 20% smaller than traditional classrooms, with fewer students per computer and an abundance of software. Becker noted that technology-using teachers were more likely to choose a computer to use at home for extended periods of time and to participate in more inservice training than teachers who did not use technology. Computer-using teachers were more likely to add new curriculum topics to their courses, to stress more classwork in small groups, to assign software on the basis of group needs, and to include students in the software selection process. Becker also found that exemplary computer-using teachers spend more than twice as many hours personally working on computers at school and have had more formal training in using and teaching with computers than other teachers. A consistent relationship was found between exemplary teaching practice using computers and substantial investment in supporting and training personnel.

Swan and others (1990) evaluated computer-based instruction in New York City and found that learning environments were more student-centered and cooperative, that teachers served more as facilitators of learning, and that learning was more individualized than in traditional classroom environments.

Recommendations vary on ratios of computers to teachers and students. Butzin (1992) recommends that computer ratios should be no greater than seven to one if meaningful integration is to occur. In The Basic School: A Community for Learning, Ernest Boyer (1995), president of the Carnegie Foundation for the Advancement of Teaching, recommends one computer for every five students in elementary schools.

Administrative Services

Computerized management systems can add much to administrative office practice. Time can be saved, efficiency improved, and human resources used for higher-order tasks. The best uses of administrative technology are those where tasks are labor intensive and repetitive in nature - those tasks that consume a great amount of clerical, staff, or executive administrative time, such as student scheduling (Cooper & Underwood, 1993).

A comprehensive computer program system designed for the implementation of statewide standards for all public schools in Georgia has been used successfully to assess legal compliance. The CES manages raw data entry; assesses individual standards and indicators; establishes

databases of evaluation results; and generates reports at the school, district, or state level (Song & Hebbler, 1991). Implemented in the adult education department of a community college and various off-campus locations, the management information system has effectively gathered and recorded student data. Compared to earlier data-entry methods, administrators and staff have affirmed that the system provided greater assistance in obtaining detailed student information, a reduction in paperwork, improved accuracy of student records, and decreased calculation time (Gross, 1992). The Chapter I Information Management Program (CHIMP), designed to help school districts maintain data and produce reports used in the evaluation of Chapter I programs, has proven useful for meeting the following state and federal reporting requirements: student participation counts; annual evaluation achievement information; sustained effect studies, lists of students not showing progress for two years, and aggregate gains by school; and Chapter I staffing (Chapter I Technical Assistance Center, 1990). The GENESYS (Generic Evaluation System of the Office of Re-search and Evaluation, Austin Independent School District, Texas) has streamlined data collection, evaluation, and reporting for a variety of projects, including student characteristics, achievement, attendance, discipline, grades and credits, dropouts, and retainees (Ligon & Baenen, 1990).

Evaluation

The primary role of evaluation of technology is to provide practitioners with the information required to maximize expertise and creativity in the design, production, use, and improvement of technology. A secondary use of evaluation information is to provide the designers and users of technology with timely, accurate information that contributes to decisions about the improvement, continuance, and/or expansion of programs (Anderson & Ball, 1978, cited in Cooley and Bickel, 1986). The point of evaluation studies is not to persuade decision makers, but to present them with all the elements of a decision.

Two key questions are often faced by school boards: (1) How much do new instructional technologies cost? (2) Are they worth the money? Inevitably, the cost question compels a series of even more difficult questions: Will the new learning tools be more effective than books? Could reductions in class size bring about similar achievement gains at lower cost? What type of computer-assisted instructional tool is most appropriate to a given school system's needs?

Some states are justifying educational telecommunications projects as a long-term cost-saver, using the rationale that shared telecommunications systems can deliver scarce, yet needed, instructional programs less expensively than a live, in-person traveling teacher (Hezel, 1991). Colleges and universities are using video conferencing to cut administrative travel budgets and improve productivity. Texas A&M University uses technology to link eight campuses and has noted declining costs (Mangan, 1991). Summative research to evaluate the cost effectiveness of using Asynchronous Computer Con-ferencing (ACC) to conduct high quality military training as compared to resident training indicated the following findings: (1) ACC training costs less than resident training; (2) there were no differences between resident and ACC students on objective performance measures; (3) ACC students perceived greater learning benefits than resident students; (4) ACC training had greater user acceptance; and (5) resident training takes less time than ACC training and has a better completion rate (Hahn, et al., 1990). Formal and informal evaluation findings indicate that 15 certification classes provided by Lockheed Space Operations Company to personnel at other National Aeronautics and Space Administra-

tion Centers via compressed video and two-way audio yielded an annual savings of $50,000 in travel expenses (Hosley & Randolph, 1993). An analytic review of interactive videodisc instruction used in defense training, industrial training, and higher education found that academic achievement was improved in all settings when interactive video was used. Effectiveness increased when more interactive features were employed. Videodisc instruction was less costly and was as effective as other instructional methods knowledge and performance outcomes (Fletcher, 1989).

Appendix C
Glossary of Terms Used in This Document

Access provider

A company or organization that supplies the hardware and/or software necessary to connect to a service, utility, or a network, e.g., the Internet.

Analog

Used to describe a signal made up of time varying currents and voltages. Analog devices are more complex than digital and can interpret a wide range of voltage and frequency information. The tones from a modem are an example of an analog signal.

Assistive technology device

Any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of children with disabilities.

Broadcast television (Open Broadcast Television)

Standard television transmission, such as those from public and commercial television stations, directed to nonselective receivers using traditional antenna.

Cable television (CATV, Community Antenna Television)

Television signals that are received locally with a master antenna and/or satellite dish and then sent through wires to cable subscribers who may pay a fee to view programming.

CCTV (Closed Circuit Television)

Uses coaxial cable, microwave, or satellites to transmit signals to predetermined receivers, unlike open broadcast which transmits to nonselective receivers. CCTV can exercise control over its reception and utilization. CCTV is also that portion of a school television system that handles the transmission of videotaped information and locally originated telecasts. There are other applications of CCTV in connection with security and surveillance systems.

CD-ROM (Compact Disc Read Only Memory)

Compact disc format used to hold text, graphics, and hi-fi stereo sound. A prerecorded, nonerasable disc that can store over 650MB of digital data equal to 250,000 pages of text or 20,000 Medium resolution images.

Client/server

In a communications network, the client is the requesting machine and the server is the supplying machine. It implies that software is specialized at each end. For example, in a network-ready database system, the user interface would reside in the workstation, and the storage and retrieval functions would reside in the server.

Computer architecture

Design of a computer system. It sets the standard for all devices that connect to it and all the software that runs on it. Its design is based on the type of programs that will run (business, scientific, etc.) and the number of them that must be run concurrently. Refers to the buss structure (ie., PCI, RISC, ISMA, etc.).

Compression

A technique used to reduce the bandwidth of a video signal by converting analog information into digital and then reducing the number of bits required to deliver the information. Compression allows for the distribution of more +channels+ in a given bandwidth and uses less disk storage space.

Data trunk

The communications path between two switches.

Database
(1) Set of interrelated files that is created and managed by a DBMS (data base management system). (2) Any electronically-stored collection of data.

Dedicated
A term used to describe hardware that is used for one purpose.

Digital
Pertaining to the use of discrete signals to represent data in the form of numbers or characters to any required degree of precision. Contrasted with analog, where data is continuous but the degree of precision is limited by the capability of the devices used to express the data.

Distance learning
The transmission of instruction from one geographic location to another via various modes of telecommunications technology.

Downlink
Communications channel from a satellite to an earth station.

Download
To transmit a file from one computer to another, usually in a client/server network.

E-mail (Electronic mail)
Transmission of memos and messages over a network.

Ethernet
A Local Area Network originally developed by Xerox, Digital and Intel, that interconnects personal computers via coaxial cable. It uses the CSMA/CD access method, transmits at 10 megabits per second and can connect up to 1,024 nodes in total.

Fiber optic
Communications systems that use optical fibers for transmissions.

Fiber optic cable
A cable that contains many fine strands of glass like material. Light, not electricity is conducted though the cable.

File server
A file-storage device on a local-area network that is accessible to all users on the network.

Gateway
Computer that interconnects and performs the protocol conversion between two different types of networks.

Gopher
Software which permits searching files on the Internet or remote hosts using layered menus. Text from these files can be read online or the files can be transferred to your computer.

Graphical User Interface (GUI)
Graphics-based user interface that incorporates icons, pull-down menus, and a mouse.

Hypermedia
A program that provides seamless access to text, graphics, audio, and videodiscs.

Hypertext
Linking related information. For example, by selecting a word in a sentence, information about that word is retrieved if it exists, or the next occurrence of the word is found.

Infrastructure
The basic facilities, equipment and installations needed for the functioning of a system.

Interface

Connection and interaction between hardware, software and the user. Hardware interfaces are the plugs, sockets and wires that carry electrical signals in a prescribed order. Software interfaces are the languages, codes, and messages that programs use to communicate with each other, such as between an application program and the operating system. User interfaces are the keyboards, mice, dialogues, command languages and menus used for communication between the user and the computer.

Internet

A vast international collection of networks enabling computers to communicate text and graphic information over a global seamless system.

ISDN (Integrated Services Digital Network)

International telecommunications standard for transmitting voice, video and data over a digital communications line.

ITFS (Instructional Television Fixed Service)

Type of low-powered microwave broadcasting, at super ultra high frequency (2500-2690 MHz), for the use of local school divisions. It provides an inexpensive point-to-point school service that is limited to small coverage areas and must be received by pretuned equipment.

Local area network (LAN)

The linkage of computers and/or peripherals (e.g., printer) confined to a limited area, usually less than two miles, that allows users to communicate and share information.

MARC (Machine Readable Cataloging)

A standard for the exchange of bibliographic information between automated library systems.

MATV (Master Antenna Television)

A system that delivers television signals to two or more TV sets from a common or master antenna. An MATV system is usually confined to one building or facility. The same basic design and construction technology as used in CATV systems is now being used in many MATV systems. Advances in component design now make it possible for MATV systems to carry over 35 channels. Presently, MATV systems are not regulated by the F.C.C.

MODEM (Modulator-Demodulator)

A communications device that converts digital computer signals into analog audio tones that can be transmitted over telephone lines (modulation) and also converts incoming analog audio tones received over telephone lines into digital signals the computer can use (demodulation).

Multimedia

The use of a computer to present and combine text, graphics, audio and video, with links and tools that let the user navigate, interact, create and communicate.

Network

A group of computers and peripherals that are connected by communications facilities. A network can involve permanent cables, like those found on local-area networks, or temporary connections made through telephones or other communications links.

Network administrator

The individual who has responsibility for the day-to-day operation of a network.

Network architecture

(1) Arrangement of objects that are interconnected. (2) In communications, the transmission channels and supporting hardware and software.

One-way video with two-way audio or two-way computer link

The ability to transmit or receive pictures in one direction with the capability to communicate in two directions (interactively) via computer or some audio method such as a telephone.

Online

Establishing a connection with another computer via telephone lines or through a network.

Online service

A dial-up service that provides news, information, and discussion forums for users with modem-equipped PCs.

Open system

Vendor-independent system that is designed to interconnect with a variety of products. It implies that standards for such a system are determined from a consensus of interested parties rather than one or two vendors.

OSI (Open Systems Interconnect)

Another set of network protocols.

Peer computing

A local area network that allows all users access to data on all workstations. Dedicated file servers are not required, but may be used. In peer-to-peer communications, both sides have equal responsibility for initiating the session.

POP (Point of Presence)

The physical location from which a communication carrier provides service to other carriers or end users.

Port

(1) Pathway into and out of the computer. (2) To convert software to run in a different computer environment.

PPP (Point-to-Point Protocol)

Allows a computer to use the TCP/IPC (Internet) protocols with a standard telephone line and a high-speed modem.

Proprietary software

Software owned by an organization or individual. Contrast with public domain software.

Protocol

In communications, a set of rules and regulations that govern the transmitting and receiving of data.

Remote log-in

A network service that allows a user on one machine to connect to another machine across a network and interact as if directly connected to the remote machine.

Retrofit

The act of installing appropriate cabling, conduits, outlets, etc., to an existing school to support the use of current and future communications and multi-media educational systems.

Router

A device that examines the destination address of a message and selects the most effective route. It is used in complex networks where there are many pathways between users.

Server

A LAN computer that provides resources to other computers to be shared by other network users.

Site license

License to use software within a facility. It provides authorization to make copies and distribute them within a specific jurisdiction or run a program simultaneously with multiple users on a network.

SLIP (Serial Line IP)
A protocol that allows a computer to use the Internet procotols with a standard phone line and a high speed modem.

Star Network
A communications network in which all terminals are connected to a central computer or central hub.

T1 Line
A telephone line capable of handling a digital transmission speed of 1.544 Meg (million) bits per second.

TCP/IP (Transmission Control Protocol/Internet Protocol)
Set of communications protocols developed for the Defense Advanced Research Projects Agency (DARPA) to internetwork dissimilar systems.

Telecommunication
Communicating information, including data, text, pictures, voice and video from one distant point to another.

Teleconferencing
Electronic techniques that are used to allow three or more people at two or more locations to communicate.

Telecomputing
A subset of telecommunications, which is the process of communicating electronically from one place to another. Telecomputing is a more specific term referring to computers communicating electronically, mainly over telephone lines.

Telnet
Act of connecting to another machine on the Internet.

Token Ring
A standard network architecture in which a ring topology is passed sequentially from station to station to prevent collision. Only that station processing the token can communicate on the network.

Topology
In a communications network, the pattern of interconnection between nodes; for example, a buss, ring, or star configuration.

Tower
Multiple CD-ROM drives in a vertical housing, or tower usually accessible via a network.

Transmission Control Protocol/Internet Protocol (TCP/IP)
Set of communications protocols developed for the Defense Advanced Research Projects Agency (DARPA) to internetwork dissimilar systems.

Two-way video and audio
The ability to transmit and receive picture and sound simultaneously in real time.

Videodisc
Read-only optical disc that can hold up to two hours of video data.

Video conferencing
A conference among several users provided by video cameras and monitors set up in-house or in a public conferencing center.

Virginia Satellite Education Network (VSEN)
A distance learning program that provides, via satellite, credit courses for high school and middle school students, and which coordinates the satellite and open broadcast of enrichment programs for students and staff development programs for educators.

Virginia's Public Education Network (VA.PEN)

A telecomputing network that links all of Virginia's public schools. VA.PEN is linked to Virginia Educational Research Network (VER-NET) which links Virginia's universities. This connection permits educators in the public schools to communicate with students and faculties in Virginia's universities. Virginia's telecomputing network in turn is linked to the Internet.

Wide area network

A network which covers a large geographic area. A data communications linkage designed to connect computers over distances greater than the distance transmitted by local area networks (e.g., building to building, city to city, across the country, or internationally), that allows users to communicate and share information.

Workstation

(1) High-performance, single user microcomputer or minicomputer that has been specialized for graphics, Computer-Aided Design (CAD), Computer-Aided Engineering (CAE), or scientific applications. (2) In a LAN, a personal computer that serves a single user in contrast with a file server that serves all users in the network. (3) Any terminal or personal computer.

World Wide Web (WWW)

A system of hypertext-based documents that are linked across the Internet.

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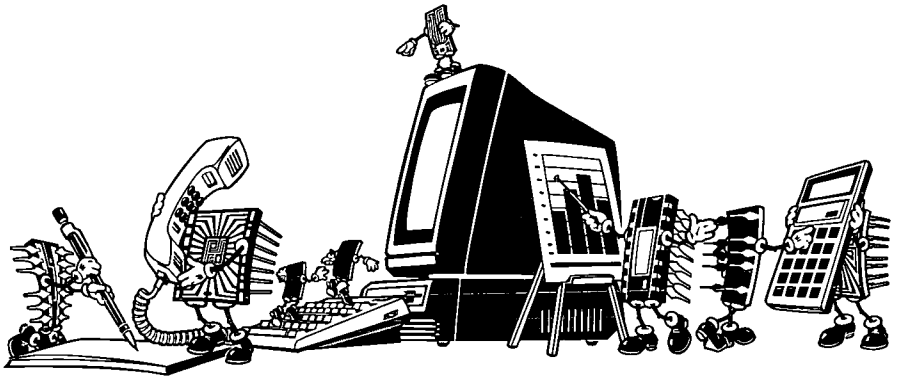

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