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ABSTRACT

With the increasing importance of information technology and access to local, state, and global information networks, it is vital to have a statewide plan for providing all elementary and secondary students with the knowledge and skills to manage and use information. Without a statewide plan, large groups of schools and their students will be left behind, unable to stay abreast of continuously changing technologies. This report provides the framework for a statewide Minnesota information technologies system. It covers trends in information technologies; findings regarding information technologies, and ten recommendations for a comprehensive information technologies system. Recommendations are provided on the following topics: (1) student engagement and access to technology; (2) curriculum and instruction; (3) learning assessment; (4) computerized student records; (5) computerized financial management and record keeping; (6) parental and community engagement; (7) professional development; (8) access and connectivity; (9) leadership; and (10) funding. Appendices include: information technology history and trends; task force meeting dates, locations, and presentation topics; task force biographies; and resource team biographies. (SWC)

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Minnesota Task Force on Information Technologies

Minnesota Department of Education

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CONTENTS

Appendices

PREFACE

Information blankets American society. It has become a commodity influencing living and work patterns. Data, voices, and images flow through underground cables and bounce off satellites, but the benefits of the information revolution are not universally shared. Those who have the best information first have the edge.

Technologies to manage information have existed for centuries. A common example is the telephone which has been connecting people for more than 100 years and remains a key part of modern communication systems. More sophisticated technologies also help manage information. Electronic cash registers automatically track price and inventory for store owners. Supercomputers help the National Weather Service determine how a hurricane will affect international weather patterns. As accurate and timely information has become critical to competitiveness, information technologies have become more prominent and sophisticated.

There are few places as information-intensive as a school. Learning requires managing and giving meaning to information, yet schools have few information technologies. While some schools in Minnesota have invested heavily to provide information technologies to teachers and students, the majority of schools have few information technologies in the classroom to assist in the learning process. In addition, some families are able to purchase these technologies for their children to use at home; however, the majority of schools and parents lack the resources to fund information technologies to support the learning process.

Increasingly, schools and individuals with information technologies are the "haves." They can access information via local, state, and global networks. These schools have the tools to provide learning tailored to individual learning styles. They can provide teachers with efficient and effective means to manage student information and develop curriculum based on the latest research. These schools are equipped with the information technologies needed to help learners achieve in an information-intensive society and workplace.

Schools without information technologies are the "have nots." They must try to meet the challenges of the information age without the tools that most organizations see as critical to effective and efficient operation. These schools try to help students learn how to manage information without the technologies they use at home and work. Without the information technologies, however, even the most committed schools and skilled teachers will not be able to prepare their students fully to succeed in a world driven by information.

The striking difference between the "haves" and "have nots" underscores the need for a statewide approach to implementing information technologies in Minnesota schools. All of today's students who will become tomorrow's workers and community members need to understand how to manage and use information technologies to meet their work and personal needs. Employers and parents want students to develop these skills.

Without a statewide strategy, large groups of schools and their students will be left behind, hoping to find a few extra dollars to stay abreast of continuously changing technologies. This will create two classes of students: those with the current knowledge and skills to use information technologies and those without. Students with the skills will be ready to work and live in a technological world. Students without the skills will founder, trying to gain skills as they go. Their success is less than certain.

Minnesota needs a purposeful, concise statewide plan for creating an information technologies system. All students need the knowledge and skills to manage and use information. The report of the Minnesota Task Force on Information Technologies provides the framework for such a statewide information technologies system. The challenge before us is clear.

EXECUTIVE SUMMARY

FINDINGS

Based on the trends in information technologies and an understanding of Minnesota's educational system, the Task Force on Information Technologies reports the following findings:

1. The implementation of information technologies in Minnesota schools must support and improve student learning.

2. Information technologies foster new ways of addressing educational needs.

3. Effective implementation of information technologies can increase success for all Minnesota students.

4. Minnesota's schools do not have equal access to information technologies.

5. Little coordination exists among elementary, secondary, and postsecondary schools, along with other state and local agencies, to build a statewide system for information technologies.

6. There is no statewide vision for the implementation and use of information technologies in education.

7. There is a need for the state to develop, adopt, and endorse standards for information technologies to ensure that students, educators, and vendors develop and adopt systems that are compatible with each other and meet statewide needs.

8. Minnesota's schools lack resources for information technologies.

9. Rigid state education funding regulations do not allow local schools flexibility in implementing information technologies.

10. Professional development is instrumental to implementing information technologies in Minnesota's schools.

11. Information technologies require substantial and consistent technical support to keep them efficient and effective.

12. Creating a system of information technologies requires commitment to continuous improvement.

RECOMMENDATIONS

Based on these findings, the Task Force on Information Technologies made the following ten recommendations for a comprehensive information technologies system for elementary and secondary education in Minnesota.

1. Student Engagement. The Minnesota Task Force on Information Technologies recommends that the State of Minnesota provide each student with equitable access to information technologies that improve their learning.

Desired Outcomes: All students need to use technology at least one hour each day to make technology an integral tool for their learning. There are two primary reasons for this need:

A. Students must develop the skills needed to use various technological tools to solve problems and access and understand information.

B. In the information age, students need to use technology to access and reference the instructional resources now available through networks.

The new Minnesota Graduation Standards, along with the national Goals 2000 Educate America Act, are defining new standards for learner achievement and education reform. These goals, directed toward all students, are providing a coordinated mission for public education. Under this mission, Minnesota's students need to be prepared to analyze, synthesize, and communicate information and engage in lifelong learning as they face multiple career changes and complex roles as citizens. Teachers must use new teaching strategies focused on student learning and skills development. If schools adopt these higher standards and take responsibility for achieving them, students need to be given the opportunity to use new resources and materials in more effective and flexible learning environments. Successfully integrated information technologies provide such environments by engaging students according to their individual learning styles, strengths, information needs, and goals.

Being able to use technology to learn, work, and participate is and will continue to be a key skill in state, national, and global economies. More and more information will be available exclusively in electronic formats and only to those with the skills and access to manipulate information technologies. Students who can use these technologies will be better prepared for their adult roles as learners, workers, and citizens. Those who cannot will lag behind educationally and economically. To prevent further proliferation of the "haves" and "have nots," the state must provide a basic level of information technologies for every school district.

2. **Curriculum and Instruction.** The Minnesota Task Force on Information Technologies recommends that the State of Minnesota provide teachers with the opportunity to acquire the knowledge and skills to use information technologies to improve curricular development and instructional delivery.

Desired Outcomes. The Minnesota Graduation Standards and Goals 2000 will shift the educational focus from traditional curriculum, teaching, and learning models to performance-based learning. This shift requires rethinking the way teachers teach and students learn. New and emerging information technologies play a key facilitative role in the transformation process. These technologies will allow students in different schools to communicate and learn cooperatively. They will simulate real-world situations to engage students in hands-on learning. Outcomes and expectations must be developed to provide standards for the deployment of technology in districts, schools, resource and media centers. These standards must focus on using technology to help students learn effectively and efficiently. New types of technology use will not happen, however, unless teachers are given the opportunity to develop the knowledge and skills to use information technologies to support classroom learning.

In a performance-based system, students demonstrate what they know and can do. Curriculum is organized so that students can achieve the integrated knowledge, skills, and attitudes needed to be proactive, contributing adults. Technology can help teachers create a learning environment that closely simulates the communities and businesses in which students will live and work. To accomplish this, students and teachers will need tools such as telephones, calculators, computers, Internet, video, CD-ROM, and other communications devices routinely used by community members. These tools, however, will not support student learning unless teachers understand how to use them to support curriculum development and instructional delivery.

3. **Learning Assessment.** The Minnesota Task Force on Information Technologies recommends that

the State of Minnesota provide teachers with knowledge and skills to use information technologies to perform ongoing and comprehensive student assessments.

Desired Outcomes. An ideal assessment system flows from learning goals. The new Minnesota Graduation Standards, as well as Goals 2000, will expect students to develop and demonstrate specific skills related to their current and future work, family, and community roles. Therefore, a learning assessment system must provide immediate, ongoing, and comprehensive information on learner skill development and demonstration. This system must also provide assessments that are useful and informative for students, parents, teachers, and administrators because each of these groups has a stake in learning.

Technology can provide this system by allowing teachers and students to measure learning progress on a task-by-task and monthly basis. It can automatically tell students how well they are doing while telling teachers where students need work. It can compile this information in a variety of formats depending on the user's needs. For example, parents may want different information than administrators.

4. Student Records. The Minnesota Task Force on Information Technologies recommends that the State of Minnesota develop a statewide information technologies system that supports computerized student record-keeping using open architecture standards to ensure compatibility with other computer operating systems and network protocols.

Desired Outcomes. The current student records meet minimal state and local needs; however, revised record keeping systems are required to meet the needs of the new Minnesota Graduation Standards and employers who want to verify the skills of high school graduates. A statewide information technologies system will allow for direct electronic transfer of data among districts and the state. Currently, districts submit tapes to the state but rarely share data electronically among themselves. Efficient and timely transfer of data is critical to appropriately assess students' progress and meet their learning and other needs. It is also critical to provide consistent and timely data to the state in order to calculate state aid payments and meet state and federal reporting requirements related to learner and school district demographics and learner needs.

To ease transfer of records, elementary and secondary record keeping systems must be compatible with higher education systems. "Speedy Express" standards, which are generally accepted by other states and the federal government, should be tested and implemented. Standardized electronic transfer of records will enable post-secondary institutions to admit and place students more quickly and fairly. Record keeping systems should also be linked with other service providers and state agencies. Data collected and processed by the MDE should be shared with human services, health, and corrections agencies where feasible. Sharing data will help provide more effective and efficient delivery of services to the learner.

The state must support the development of "state-of-the-art" software for student records as required by the Minnesota Graduation Standards. Recording student progress and skill attainment is critical to implementing the skill-based model of learning supported by the graduation standard. These records must: (a) signal when teacher intervention is needed to help a struggling student, (b) provide students with a permanent record of their high school achievement, (c) give parents a clear explanation of their child's educational progress, and (d) provide schools with data to measure the quality of their programs and services. This is a tall order, but necessary to make sure that schools are effectively and efficiently helping students learn.

In developing the systems architecture, the state should develop standards and protocols for software while allowing school districts to contract with vendors who meet these standards and protocols. The state should not become the sole vendor nor choose a sole vendor for these systems. Competition is critical to motivate vendors to continuously improve their systems and offer them at affordable prices.

5. Financial Management. The Minnesota Task Force on Information Technologies recommends that the State of Minnesota develop statewide standards for school financial management and record keeping using open architecture standards to ensure compatibility with other computer operating systems and network protocols.

Desired Outcomes. In the future, the financial management component must be a network-based system to provide better communication between the state and school districts to ensure accurate funding and financial planning. Clearer data and regular information exchanges will help improve the use and allocation of resources by and between the state, districts, and schools. These different users must work collaboratively to define information needs and timelines. The financial management component also needs to be integrated with learner record and personnel payroll systems to ensure fiscal accountability, efficient aid payment, and program expenditures.

6. Parental and Community Engagement. The State of Minnesota develop standards and models for using information technologies to involve parents and communities in enhancing and measuring student learning.

Desired Outcomes. Parental and community involvement is critical to education reform. Network technology can be utilized to provide new avenues for parental involvement. As more homes have computers, schools can utilize networks to communicate electronically with parents individually or in groups.

Priorities, models, and standards should be developed which help schools see how information technologies can be used to engage parents and communities. These models should be developed in collaboration with other organizations that provide services to students. State and community service providers will need to plan and adopt shared data bases. The school should provide parents with access to technology so they can support their children's learning and assessment. Electronic mail could provide a way for parents to communicate with teachers about their children's progress and needs. Electronic access to media and resource centers can provide 24-hour availability for parents and students. The Internet could be used to provide information to parents and community members. These and other forms of information technologies can encourage parents and students to learn together outside of the classroom.

7. Professional Development. The Minnesota Task Force on Information Technologies recommends that The State of Minnesota designate funds and actively support professional development for all educators on how to use information technologies.

Desired Outcomes. Professional development must be provided to current and future teachers on how to successfully use information technologies to support curriculum, instruction, and learning. This professional development should focus on helping teachers use technology to support student achievement. Achieving this requires collaboration among those who receive, influence, and provide professional development opportunities, including teachers, teacher educators, administrators, content experts, policy-makers, and business people. A task force should be created to facilitate this collaboration.

The state and school districts are responsible for providing high quality professional development on how to use information technologies. Teachers and other school personnel are responsible for taking advantage of staff development once it is available on a consistent basis. Hiring and assessment processes should hold teachers accountable for developing and using information technologies skills.

8. Access and Connectivity. The Minnesota Task Force on Information Technologies recommends that the State of Minnesota create, fund, and provide access to one statewide information system for all state and local public organizations.

Desired Outcomes. In the ideal situation, all schools would have networks that connect students and teachers within and among school districts in order to help teachers and students to share information and learn in collaboration with their peers throughout Minnesota. The ideal way to achieve this is to provide each student and teacher with their own computer that is connected to a local area and wide area network within Minnesota as well as international networks such as the Internet. These networks should connect parents, students, teachers, and community members at school, home, and work. The Minnesota Information Access Council should include representatives from elementary and secondary education so they can help plan Minnesota's statewide information technologies system.

9. Leadership The Minnesota Task Force on Information Technologies recommends that the Minnesota Department of Education (MDE) provide leadership in the development, management, and continuous improvement of an information technologies system to support student learning.

Desired Outcomes. Ongoing, cutting-edge leadership is crucial to creating an information technologies system that meets the current and future needs of students and teachers in Minnesota. Leadership will help ensure that systems are high quality and meet student needs. Lack of strong leadership has helped create the current lack of coordination and common vision for information technologies in Minnesota's schools.

The MDE should ensure that standards, guidelines and strategies are provided to help districts implement information technologies. This clearinghouse function should provide research on the best practices for using information technologies to support all school functions. Increased elementary and secondary education representation on the Minnesota Telecommunications Council will help to ensure that all clearinghouse information is current and compatible with statewide goals and strategies.

The MDE should also involve representatives from a broad cross-section of public and private organizations in developing standards for telecommunications hardware and software to ensure that public and private systems are compatible.

The MDE should also perform a biennial assessment of the status and quality of information technologies in Minnesota's schools. This will measure the quality of the current deployment of information technologies and provide information for future goals and strategies.

The MDE can provide the framework for district implementation of technology and also share information and research with district technology and media specialists. Developing and sharing this information could be accomplished by establishing a technology leadership committee. This committee would help representatives from state and local agencies, school districts, and businesses work together to develop standards and practices for the implementation of information technologies in Minnesota's schools.

10. Funding. The State of Minnesota provide equitable funding to school districts for the acquisition, maintenance, and support of information technologies, as well as the necessary staff development to allow teachers and other school staff to effectively and efficiently use the technologies to support learning.

Desired Outcomes. The State of Minnesota should adopt a system for funding an information technologies infrastructure using the following principles:

- Cost should be shared by the state and local school districts,
- A large initial investment is provided to establish a basic level of information technologies in districts,
- Continued funding will be needed to maintain and upgrade hardware and software (at lower level than start up),
- Funds could come from sale of short term bonds and be repaid through connect charges and/or user fees,
- Funding should support a K-12 information technologies system that fits into Minnesota's overall information technologies infrastructure, not a "stand-alone" system.

To help local school districts purchase information technologies hardware and software, the state should:

- Provide an equalized aid and levy program so that all school districts have the necessary resources,
- Provide appropriate funding per pupil unit with a minimum revenue to connect all buildings. To be eligible for connectivity funding, the school district must have a technology plan, and buildings must have a minimum number of students or quality for sparsity aid, must continue being used for a given number of years, and must meet safety requirements.
- Revenue could be provided as an addition to the capital equipment or interactive television formulas, or as a new categorical aid,
- The funding level may start high as districts acquire hardware, software and connect buildings, and then decrease to a level needed for ongoing maintenance and continued upgrading on an annual basis, and
- The review and comment process for facilities construction should require that new buildings accommodate information technologies

Staff development is a critical component of an information technologies system. Schools must provide a significant ongoing investment to help staff develop the skills to use information technologies to effectively support learning and administration. In addition, staff development will need to be ongoing to keep teachers current with new technology.

CHAPTER ONE: TRENDS IN INFORMATION TECHNOLOGIES

HISTORY AND STATUS OF INFORMATION TECHNOLOGIES IN MINNESOTA'S SCHOOLS

During the past 30 years, Minnesota elementary and secondary education has witnessed major changes in the use of information technologies. The initial introduction of information technologies into the educational system was in the early 1970s, when mainframe computers used for instruction were time-shared through the Minnesota Educational Computing Consortium (MECC). Seven Elementary Secondary, Vocational (ESV) Regional Management Information Centers (ESV regions) provided system support, computing power, and software to meet administrative information processing needs.

In the mid 1980s, a personal computer market led by Apple Computer, Inc. provided affordable microcomputers that significantly changed the instructional usage of computers. Mainframe timeshare services were displaced by microcomputers. Today, almost all instructional software runs on microcomputers. Networking of these desktop computers is a recent development.

Minnesota schools have recently started to connect to the Internet to access information worldwide. To support this trend, the Minnesota Department of Education has funded InforMNs, a pilot project that connects schools to the Internet. Each school district has at least one InforMNs account, and about 900 schools are connected to the Internet. InforMNs connections are "dial-up," which limits them to one user per account. As districts implement network technology among schools, most microcomputer work stations will have access to the Internet. There is a potential for unlimited access as schools begin to develop computer networks and subscribe to the Internet on their own. Only a few school districts have the network technology to achieve unlimited access at this time.

The Legislature discontinued funding for administrative systems beginning with the 1994-1995 school year. A free market approach, allowing districts to choose and pay for software options, was implemented. Vendors are now developing systems for single user and networked personal computers. While about 80 percent of school district administrative processing for finance, student accounting, and personnel/payroll is still performed on ESV regional mainframes; increasingly powerful microcomputers are beginning to take on these administrative functions, thus shifting mainframe usage to storage of large quantities of student, staff, and finance data.

The manner in which districts receive support for information technologies varies. Historically, administrative system support was separated from instructional system support. ESV regions provide the majority of support for administrative computer systems. Some ESV regions assist districts with network and instructional information technologies. Educational Cooperative Service Units (ESCUs), Education Technology Cooperatives, and Education Districts provide some support for the use of classroom and network technology. Private companies have also been hired by districts for assistance. There is wide variance within schools regarding who champions and manages technology.

Thirty-four interactive television cooperatives help member districts share classroom courses. Although they are independent, the interactive television cooperatives plan and work together through the Minnesota Interactive Television Network (MITN). This organization helps cooperatives reach agreement on common goals for the application of interactive television and

related information technologies. Most secondary and postsecondary interactive television sites collaborate with neighboring sites on programming and other interactive television uses. Elementary and secondary education also use satellite transmissions, VCRs, laser discs, and CD-ROM to provide instructional support and materials.

There is currently no clear, unified framework or state policy for the deployment of information technologies in the classroom. In addition, there are no statewide resources available to provide a basic level of informational technologies to all students, teachers, and schools. This means that: a) many students do not have access to technology that can prepare them for work, b) there is no clear direction or models for districts and schools to build a technology infrastructure to support students, and c) there are no guidelines for hardware and software purchases that support curriculum and instruction.

HARDWARE AND SOFTWARE TRENDS

The emergence of the information age, fueled by technological advancements and decreasing hardware and software prices resulting from expanded economies of scale, is having a significant impact on the everyday lives of Minnesotans. Critical events include:

1. Shift in focus from mainframe to microcomputers.
2. Installation of integrated chips capable of complex commands into appliances, games, toys, automobiles, and other common devices, causing an explosion in the consumer electronics market.
3. Introduction of computer-aided design (CAD) and computer-aided manufacturing (CAM), creating new ways to manage industrial processes.
4. Augmented telephonic transmission services due to expanded switches, managed by complex software, increasing the capability to move information.
5. Digital information integrated into a wide variety of products.
6. Rapid growth in the home computer market.
7. Modem and telecommunications capabilities expanding rapidly.
8. Increased levels of direct customer support for products, such as on-line help services.
9. Increased storage capacity.
10. Increased processing power and speed.
11. New, sophisticated software which can take advantage of improved storage capacity, processing power, and speed.
12. Introduction of network technology through telephone lines.

The net result of these trends is that the wide-scale availability of and increased demand for new consumer electronics have created larger economies of scale and further cost reductions. Consumers are now aware of and accustomed to advanced technology applications.

GENERAL INFORMATION TECHNOLOGIES TRENDS

Cost Performance. The rapid advance of information technologies is a result of continued cost reduction coupled with performance increases. In other words, more powerful technologies are available for less money. The cost performance trend shows no signs of slowing. As costs have decreased, new ways to interface with the computer have emerged. Users are no longer restricted to keyboards. Infrared devices, voice recognition systems, touch screens, video interfaces, telephone integration, and electronic pens have been introduced. Output devices such as photo realistic printers, video, audio, speech, and real-time environmental controllers are also becoming affordable.

Digitization of Information. Underlying the "information age" is a fundamental trend toward digitizing information. Digitizing adapts nature's analog

signals such as audio, light, and radio waves to data or numbers that computers can process, reformat, and output in life-like representations. Today, telephone systems are migrating to digital telephonic standards (ISDN). Television broadcasters have committed to digital transmission for High Definition Television. Cellular transmissions are moving toward digitizing. This trend is affecting all industries using information technologies.

Voice, Video, and Data Convergence. Movement toward digitization has fostered the convergence of voice, video, and data and has spurred the development of performance and operating standards to make different technologies compatible. This is different than analog technologies, which have few commonalties.

Physically and technologically, convergence and integration will force major renovations within traditional telecommunication companies. For example, telephone companies lack the bandwidth for video and the computer capabilities to process data. Cable television companies are not equipped to handle two-way communications or telephone features. Computer networks have delay and capacity problems in handling voice and video. Convergence requires major technological and operational changes which will call for massive infusions of capital.

There will be significant user and regulatory impacts of voice, video, and data convergence. Traditional delivery systems for telephone, television, radio, computer data, and others will merge and develop common standards. Intermixed voice, data, and video technologies, as demonstrated by interactive television, will be commonplace. Two-way communications will supplant single direction broadcasting in many areas. Regulations based solely on one mode of communication, such as telephone or television, or via one transmission medium, such as satellite or cable TV company fiber optics, will become obsolete. This will require a new model of public and private regulation for information flow and access.

Interactive Environments. Computer systems have become capable of real-world response and replication. Interactive electronic environments react to user inputs. Computers will soon deliver virtual worlds that personally involve the user. This is currently demonstrated by flight simulators that help new pilots learn how to fly a variety of different airplanes and land in a variety of different airports without ever leaving the ground.

Interactivity will demand that vast amounts of information be transmitted two-way. Most traditional transmission systems lack the capacity to carry the volume of information required. Consequently, television, telephone, satellite, microwave, computer and other carriers will need to increase the capacity of their infrastructures.

Storage Systems. Improvements in storage capacity technologies have enhanced computing performance. New media types, such as CD-ROM and optical disks, can store large amounts of data in small, easy-to-use packages. Increased internal random access memory (RAM) has recently raised capacity and speed for handling video. Retrieval and storage speeds have also been rising. In addition, compression techniques are reducing storage requirements and network transmission volumes. These techniques are crucial to storing and transmitting larger amounts of more sophisticated data.

Proliferation of Electronic Information. A significant trend for education is the explosive expansion of information providers. The proliferation of personal computers continues as storage capacity improvements provide more cost-effective media. As a result, video clips, images, reference materials, interactive text, games, software, and manuals are being delivered on

CD-ROM. Videocassette tape revenues exceed theater ticket sales. Libraries are converting traditional texts and material into electronic formats. Movie productions of instructional videos are expanding.

The Internet is expanding daily. The federal government is managing issues surrounding the Internet and its replacement, the National Information Infrastructure (NII). While providing for national management of issues such as privacy, security, network management, universal access, and intellectual property rights, the federal government has made it clear that the individual states are responsible for building the infrastructure. Many states, such as Iowa and North Carolina, have funded and begun construction of their infrastructures.

Standards and Interoperability. To allow information sharing, the majority of the telecommunications industry has created standard practices and protocols. Industries of all types are developing open national and international formats and protocols to allow information to be shared among different computers. An example of this is the agreement between IBM and Apple Computer Inc. to create compatible operating systems. The integration of voice, data, and video will spur continued creation of these open formats and standards. Interoperability issues are crucial to any multi-vendor system, including school districts.

Computing Architecture. Computing architectures are also evolving toward higher performance and storage requirements. Computers are being strengthened to handle extremely demanding multimedia applications and higher storage requirements. Voice and video demand that high volumes of data be delivered and processed reliably, quickly, and without interruptions and delays. Programming languages and tools are being revised to take maximum advantage of the new hardware and operating systems. To accommodate easier installation and maintenance, software and hardware are being designed that allow users to turn their computers on, follow user-friendly software installation procedures, and immediately use their computers.

Networking. The need to share information has caused the widespread growth of networking over the last decade. A significant network trend is the ever-increasing demand for capacity, or bandwidth. Digital voice, video, and data transmissions over LANS and WANS, known as Asynchronous Transfer Mode (ATM) technologies, are emerging products and services. ATM technology allows large pieces of information that include voice, video, and data to be transmitted together across current fiber optic networks. The introduction of ATM marks a new era in which voice, video, and data will not have to be separated for transmission. Once technology is better able to deal with bandwidth capacity, advanced applications of two-way voice, video, and data transmission will become readily available.

Wireless Telecommunications. Wireless communications, such as cellular phones and pagers, have become prevalent over the last decade. Wireless technologies now exist that enable radio and infrared frequencies to transmit information over networks. This trend continues to develop. Technologies that allow miniaturization, wireless communication, and portable power are spurring the development of mobile systems. Wireless communications allow users to be connected while moving or in remote areas. Devices are personalized to user needs and can travel with them wherever they go.

IMPACT OF INFORMATION TECHNOLOGIES ON MINNESOTA'S SCHOOLS

As information technologies have advanced over the past 30 years, schools have become increasingly aware

of the implications for learning and student preparation for the workplace and society. Even though some schools have high levels of information technologies available regularly to students and teachers, other schools have none. As information technologies become a regular part of daily life, they will be increasingly critical to creating a school environment that is relevant to the outside world.

Computer-based curriculum products can permit both instruction and assessment of students. Major companies throughout the world are developing computer-based learning products, and a variety of courseware is available for most disciplines. Students are beginning to demand immediate access to a variety of different information formats that meet their individual learning needs. Still, the integration of information technologies into schools has lagged behind that of business, government, and the home. Even though learning is inherently information-intensive, students are not using information technologies on any significant scale.

Information Technologies and Learning. Inherent in information technologies are characteristics particularly appealing to learning. These include: (a) hands-on learning, (b) the ability to experience outside environments without leaving the classroom, (c) the removal of time constraints by allowing access to information according to user demand, and (d) instruction to and from geographically remote locations.

Information technologies have the potential to provide for engaged learning that is geared toward individual teaching and learning styles. However, there is no cohesive plan or policies to guide schools in purchasing and deploying information technologies to improve their instructional and administrative systems. Schools lag behind other major sectors in using information technologies to improve efficiency and effectiveness of learning and school management.

Other technological trends will benefit special education students. Assistive tools required by special needs student are becoming affordable for all users. Examples include: (a) text-to-speech conversion, (b) scanning, (c) visual enlargement, (d) tablet and keyboard interfaces to graphic systems, (e) voice recognition, and (f) medical monitoring devices. Costs are decreasing as the user base expands. An example is the drop in price for voice recognition systems, which has decreased over the last four years from $8,000 to $1,000 with further reductions anticipated. Voice recognition systems replace labor-intensive keyboarding, thus the funds being spent for an assistant to take dictation from a physically impaired student can now be invested in equipment. This can reduce costs for schools and improve independence for students.

Financial Constraints for Schools. In general, financial constraints have slowed the integration of information technologies in schools. Most districts lack the funds to implement state-of-the-art networks and purchase the latest computers. Ed Veneers, PC Discovery, told the Task Force on December 15, 1994, that 95 percent of the computers used in education are five years old or older. Schools need funds to fully support and maintain technology such as CD-ROM, interactive multi-media programs and the Internet. By delaying purchase, schools can buy older technology for a reduced cost; however, graphic user interface software such as Windows and multi-media programs are driving the need for newer, powerful computers like those used in business and industry.

State and federal government and private business have readily funded pilot projects; however, these programs are rarely extended to all schools because new resources are required for implementation or the technologies have changed before the projects can be evaluated and policy changes implemented. While the federal government has invested heavily in the planning of a National Information Infrastructure (NII), it has

clearly stated that individual states must fund its construction. While other states have been implementing statewide networks, Minnesota has not yet developed a plan.

Some school districts have initiated referenda to fund information technologies acquisitions. Even in a "no new taxes" climate, some of these referenda have been approved by voters, thus providing evidence that public support for information technologies in schools exists. However, that buying equipment accounts for less than one quarter of the cost of implementation. Computerized systems and networks require ongoing expenditures for technical support, upgrades, and user training. Referenda currently allow bonding for only the hard assets such as computer hardware and other equipment.

Schools lack the funds to provide system support and staff development. Typically, training and support expenses should be equivalent to the outlay for physical equipment. Without professional development, teachers are not able to learn the full potential of information technologies for supporting engaged learning. In addition, training depends on equipment availability. Teachers and students forget their computer skills unless they have hardware and software on which to practice and integrate their skills. Finally, teachers lack the time and flexibility in their schedules to maintain current knowledge of constantly changing technology. While teachers must be supported in learning information technologies skills, they have a responsibility to take advantage of training to develop these skills.

Future of Information Technologies. The rate of technological advancement in industry and society will continue to increase. Learning how to use and manage information technologies has already become a basic skill in modern society. Teachers and students need the tools and hands-on experience to learn how to use information technologies to support learning goals. The future success of students depends on their ability to manage information technologies today.

CHAPTER TWO: FINDINGS REGARDING INFORMATION TECHNOLOGIES

Based on the trends in information technologies and an understanding of Minnesota's educational system, the Task Force on Information Technologies finds:

1. The implementation of information technologies in Minnesota schools must support and improve student learning.

Schools have generally used information technologies as administrative tools; however, student learning is the core goal of a school. Therefore, information technologies must be used to meet student learning needs and goals. Teachers and school districts that focus technology on individual student needs are seeing how technology enhances the learning process. Computers can create complex learning environments like business management simulations, political debates, and audio and visual communication around the world. Technology can also assist in the practice of repetitive skills such as computation. The use of information technologies in the classroom must be driven by student learning needs.

2. Information technologies foster new ways of addressing educational needs.

Information technologies can be used to accomplish old tasks faster. However, the technology's greatest promise is supporting learning in new and different ways. Learning can take place at any time and any place. Information technologies can help students in different schools across the district, state, country, and world to work collaboratively. Statewide plans must be coupled with incentives and models that enhance student access to information technologies.

The implementation of information technologies must foster creativity. Master teachers, new curriculum, and innovative instructional strategies will come from unlikely sources within and outside of the school. Systems innovation must not be stifled by staffing and implementation regulations. Resources should be consistently invested in research and development that increases the potential of information technologies as learning tools.

3. Effective implementation of information technologies can increase success for all Minnesota students.

Different students have different learning styles. When deployed properly, technology enhances the delivery of curriculum and instruction to satisfy nearly all learning styles. For example, a study by the North Central Regional Educational Laboratory (NCREL) demonstrates how low and high performance technologies support both active and passive learning. The findings from this study are summarized in Table One.

The reduction of technology costs makes learning possible in nearly every community, school, business, and home through networks like interactive television. Communications technologies such as voice mail and remote retrieval give parents more opportunities to be involved in their children's learning when they are outside of school. While electronic learning is occurring in parts of Minnesota, it is a global trend that must be made available to learners of all ages throughout the entire state. This will help make learning a shared and cooperative experience for all Minnesotans.

TABLE ONE
LEARNING AND TECHNOLOGY INTERFACE[1]

Technology Performance: Low ═══ High

Examples (C) • Closed integrated learning systems focused on low-level objectives and standardized, objective assessments. • Traditional distance education used to transmit information from a central source and focused on low-level objectives and assessments (talking head). • Connections to homes that are linked only to closed networks for the school and vendor and perhaps to other schools using the same vendor.	**Examples (A)** • Networked projects with challenging tasks; access to Internet; integrated multimedia capabilities including CD-ROM, two-way video conferencing, access to professionals. • Distance education networked with computers; challenging tasks; linked to work with real-world professionals and data; two-way video. • Advanced tools and high-technology museum exhibits that are interactive and support high-level thinking.
Examples (D) • Computer-based instruction/drill and practice focusing on low-level objectives. • Instructional television focused on low-level objectives. • Video and audio used to transmit information as a lecture or talking head. • Teaching a computer language or word processing as an end in itself as technology literacy.	**Examples (B)** • Projects using multimedia experiences and data provided by CD-ROM for authentic and challenging learning. • Local file sharing allowing students access to all files for communal editing and development. • E-Mail for inquiry collaborations. • State network support for schools using the Internet for projects.

Passive Learning ═══ Active Learning

4. Minnesota's schools do not have equal access to information technologies.

To ensure that all students have equitable access to learning resources, the state must provide all school districts with a basic level of access to current information technologies. Some schools have more funds available for information technologies than others. Some students have regular access to current information technologies while other students have none. Most cities and school districts must pay long distance telephone charges to have the same access to worldwide

[1] Beau Fly Jones, Jeri Nowakowski, Claudette Rasmussen, Gilbert Valdez, Designing Learning and Technology for Educational Reform Oak Brook, Illinois, North Central Regional Educational Laboratory, 1994), 71.

data bases that others receive with free local calls. Training opportunities and support services are more available in some places than others. Providing quality information technologies to every one of Minnesota's students must be a primary goal of any statewide system.

The primary measure of access is the actual amount of time that students can use a computer and other information technologies to do their school work. Equitable access can be achieved by ensuring that a basic level of funding is provided to every school to make a certain number of information technologies available to students on a daily basis. A key to providing equitable access is the creation of a statewide communications backbone that is available to all schools in Minnesota. Creating this framework will require coordination of efforts between governmental agencies, private telephone companies and other private and public ventures.

5. There is little coordination existing among elementary, secondary, and postsecondary schools, along with other state and local agencies, to build a statewide system for information technologies.

There must be state-level leadership to coordinate a K-12 information technologies and telecommunications system with those being developed by other state and local agencies and educational institutions. These organizations recognize the need for collaboration. This is demonstrated by the Higher Education Telecommunications Council and the Information Policy Office of the Department of Administration. However, efforts need to be more inclusive to prevent the state from developing duplicative and possibly conflicting systems and policies. Interagency state-level planning must provide the cohesive infrastructure for Minnesota's "information super highway." Community-based planning must include governmental, nonprofit, and private agencies so local area networks are compatible and meet a variety of needs. The LUMINET project in Winona is an example of the kinds of community-wide network planning that must take place.

6. There is no statewide vision for the implementation and use of information technologies in education.

There is currently no statewide vision or plan for the deployment and use of information technologies in Minnesota's schools. Without an articulated plan containing clear standards and goals, school districts could take a long time to build a system that may or may not be compatible with local and state systems. The Governor and Legislature must work with state and local agencies to boldly chart plans for the creation of a statewide network for information technologies.

State government has a role in clearly defining student outcomes through the Minnesota Graduation Standards. This can be aided through state-level definition of a telecommunications system capable of linking all educational institutions and other local organizations through electronic networks. State government should also help negotiate low-cost licensing fees, demonstrate workable information technologies projects, and develop models to help staff learn how to use information technologies to support student learning. In addition, a state level policy will help ensure that every student in Minnesota will have access to a computer at any place and any time.

7. There is a need for the state to develop, adopt, and endorse standards for information technologies to ensure that students, educators, and vendors develop and adopt systems that are compatible with each other and meet statewide needs.

Developing a statewide network requires compatible technologies. State-level standards will provide local school districts and vendors with clear specifications

for compatibility with a statewide system. These standards, however, must not eliminate local control over adopting and tailoring technologies to the needs of students, teachers, and individual communities.

The state should continue its process of defining standards and approving vendor products that meet these standards. State-level standards provide clear parameters for vendors interested in developing products to meet the needs of schools and maintain competition within the market which encourages the development of high quality, cost-effective products. The MDE's role is to define common standards for communication, data storage, and access that are currently undefined. These standards need to address many areas including, but not limited to:

- Interoperability,
- Network types and protocols,
- Wiring,
- Data element definition,
- Assessment standards,
- Security levels,
- Archiving,
- Specifications for information technologies in the facilities construction review and comment process, and
- Definition of student electronic portfolios for use at home, school, postsecondary institutions, public health clinics, juvenile justice centers, workplaces, and other locations.

8. Minnesota's schools lack resources for information technologies.

Current resources available for information technologies in Minnesota schools are inadequate to build a statewide system that meets student learning needs. Creating a statewide system requires investment that goes beyond a single school district. Some districts have been able to get some computers and other information technologies tools in the hands of students and teachers, but few, if any, schools are able to provide students and teachers with regular access to these tools.

This inability to provide access to technology is exacerbated by deficiencies in time and resources for staff development and support services. Most of the teachers who will lead students into the 21st century are working now. Helping teachers learn how to use information technologies to meet learning needs requires giving them the time, training and funds to learn how to use information technologies effectively. It will also require reallocation of staff development funds.

U.S. industry has invested heavily in technology to maintain competitiveness in the global marketplace. There must be a parallel investment by education to increase learning productivity. Increased and ongoing funding is needed for: a) capital expenditures in hardware and software, b) investment in staff development, and c) technical support.

9. Rigid state education funding regulations do not allow local schools sufficient flexibility in implementing information technologies.

There are many rules governing the uses of capital expenditure funds, excess levy referendum proceeds, and categorical funds within the general fund of school district budgets. Expenditures on information technologies do not always fit neatly into existing categories. Districts often have to manipulate different funds to pay for hardware, software, staff training and support. These resources should be deregulated so that districts can have maximum discretion in funding information technologies in the schools. Broad waiver authority should be granted to the MDE to allow districts to creatively address funding needs.

The state must clearly outline which level of government has the authority to make which decisions. However, the state should not mandate school district membership in a regional structure. User groups with common interests should be allowed to organize in whatever ways best meet their needs.

10. Professional development is instrumental to implementing information technologies in Minnesota's schools.

Ongoing commitments to staff development will help teachers learn how to use information technologies that encourage students to pursue knowledge through discovery and practice. To implement information technologies in classrooms, school staff members must have easy access to hardware and software, expert guidance in its appropriate use and ongoing support to handle technical problems. Staff development and support expenditures should total one-half of hardware and software investments. Industry has learned that this investment is critical to an efficient and effective deployment of technology. Teachers do not currently receive this level of staff development for information technologies. In addition, they lack the time in their schedules and access to hardware to pursue this training.

The state must require postsecondary institutions to help teacher candidates learn how to use information technologies in the learning process. Demonstrating this ability could become a requirement for teacher licensure. Local schools must provide time for ongoing in-service activities that help current teachers learn how to use information technologies. Teachers would be responsible for using training resources to develop and apply skills in the use of information technologies that support engaged learning. Information technologies skills should become a major factor in both the employment or teacher assessment process.

11. Information technologies require substantial and consistent technical support to keep them efficient and effective.

Increased hardware and networking within schools will require ongoing technical support. New software needs to be appropriately installed. System problems are inevitable and need to be quickly remedied so that learning is not interrupted. The state and schools need to commit funds and expertise to system service and support.

12. Creating a system of information technologies requires commitment to continuous improvement.

State-of-the-art educational systems will change year after year. Long term leases for equipment and "once-in-a-career" staff development opportunities will not help teachers and students understand how to use rapidly changing technology. Current industry experience suggests a three-year life span for new technology. This means that school districts must implement the "plan, do, check, act" cycle of continuous quality improvement to ensure that information technologies meet current and future learning needs.

CHAPTER THREE: RECOMMENDATIONS

The Task Force on Information Technologies recommends the following ten components to create a comprehensive information technologies system for elementary and secondary education in Minnesota. Each is described according to its current condition and desired outcome to explain where Minnesota's schools are and where they need to go.

1. **Student Engagement.** The Minnesota Task Force on Information Technologies recommends that the State of Minnesota provide each student with equitable access to information technologies that improve their learning.

Current Condition. Student access to technology varies considerably across Minnesota. Some students and teachers have daily access to computers and information networks such as the Internet. Other students rarely see a computer. When available, computers are often viewed only as tools to help students "drill and practice" rote skills such as computation. Few schools are using technology to facilitate students' mastery of problem-solving skills. In the SCANS report produced by the federal government, employers identified problem-solving as a critical skill for a flexible worker who is able to adapt to constant technological change.

Desired Outcomes: All students need to use technology at least one hour each day to make technology an integral tool for their learning. there are two primary reasons for this need:

A. Students must develop the skills needed to use various technological tools to solve problems and access and understand information.
B. In the information age, students need to use technology to access and reference the instructional resources now available through networks.

The new Minnesota Graduation Standards, along with the national Goals 2000 Educate America Act, are defining new standards for learner achievement and education reform. These goals, directed toward all students, are providing a coordinated mission for public education. Under this mission, Minnesota's students need to be prepared to analyze, synthesize, and communicate information and engage in lifelong learning as they face multiple career changes and complex roles as citizens. Teachers must use new teaching strategies focused on student learning and skills development. If schools adopt these higher standards and take responsibility for achieving them, students need to be given the opportunity to use new resources and materials in more effective and flexible learning environments. Well-integrated information technologies can engage students according to their individual learning styles, strengths, information needs, and goals. Technology that promotes engaged learning, connectivity, and easy access to information will help meet these needs.

Being able to use technology to learn, work, and participate is and will continue to be a key skill in the state, national, and global economies. More and more information will be available exclusively in electronic formats and only to those with the skills and access to manipulate information technologies. Students who can use these technologies will be better prepared for their adult roles as learners, workers, and citizens. Those who do not will lag behind educationally and economically. To prevent further proliferation of the "haves" and "have nots," the state must provide a basic level of information technologies for every school district.

2. **Curriculum and Instruction.** The Minnesota Task Force on Information Technologies recommends

that the State of Minnesota provide teachers with the technology skills and tools needed to support learning that engages students.

Current Condition. In most schools, subject matter is delineated by specific curricular areas that are not directly related to each other. A chief means of instruction continues to be lecture and drill. Students answer questions generated by their teacher, read textbooks, and do work mainly in the classroom. In general, learning technology in schools, if present, has primarily supported this traditional model.

Desired Outcomes. The Minnesota Graduation Standards and Goals 2000 shift the educational focus from traditional curriculum, teaching, and learning models to performance-based learning. This shift requires rethinking the way teachers teach and students learn. New and emerging information technologies will provide a key facilitative role in the transformation process. These technologies will allow students in different schools to communicate and learn cooperatively. They will simulate real-world situations to engage students in hands-on learning. Outcomes and expectations must be developed to provide standards for the deployment of technology in districts, schools, resource and media centers, teachers and students. These standards must focus on using technology to help students learn effectively and efficiently. This will not happen unless teachers are given the opportunity to develop the knowledge and skills to use information technologies to support classroom learning.

In a performance-based system, students demonstrate what they know and can do. Curriculum is organized so that students can achieve the integrated knowledge, skills, and attitudes needed to be proactive, contributing adults. Technology can help teachers create a learning environment that closely simulates the communities and businesses in which students will live and work. To accomplish this, students and teachers will need access to tools such as telephones, calculators, computers, the Internet, video, CD-ROM, and other communications devices routinely used by community members. These tools, however, will not support student learning unless teachers understand how to use them to support curriculum development and instructional delivery.

3. Learning Assessment. The Minnesota Task Force on Information Technologies recommends that the State of Minnesota provide teachers with knowledge and skills to use information technologies to perform ongoing and comprehensive student assessments.

Current Condition. Learning assessments are those processes that teachers use to measure a learner's progress and proficiencies in certain subject areas, and administrators use to measure the progress of an entire school compared with other schools. Most elementary school teachers in Minnesota use a linear grading scale to assess learner performance according to accepted norms for development. These teachers also provide some narrative that describes a specific learner's skills and deficits. Most elementary school administrators use a norm reference test to compare learner achievement with peer groups. The results of these norm reference tests are generally used to measure the overall quality of schools more than individual learner achievement. Middle school and high school teachers generally use the traditional "A-F" grading system to measure learner performance. About 70 percent of Minnesota's middle and high schools also use a norm reference test. Currently, information technologies are used to compile and report the results of learning assessments at the classroom, district, and state level.

Desired Outcomes. An ideal assessment system flows from learning goals. The new Minnesota Graduation Standards, as well as Goals 2000, will expect students to develop and demonstrate specific skills related to their current and future work, family, and community

roles. Therefore, a learning assessment system must provide immediate, ongoing, and comprehensive information on learner skill development and demonstration. This system must also provide assessments that are useful and informative for students, parents, teachers, and administrators. This is because each of these groups has a stake in learning.

Technology can provide this system by allowing teachers and students to measure learning progress on a task-by-task and monthly basis. It can automatically tell students how well they are doing while telling teachers where students need work. It can compile information in a variety of formats depending on the user's needs. For example, parents may want different information than administrators.

4. **Student Records.** The Minnesota Task Force on Information Technologies recommends that the State of Minnesota develop a statewide information technologies system that supports computerized student record-keeping using open architecture standards to ensure compatibility with other computer operating systems and network protocols.

Current Condition. School administrative data collection and reporting has received the most state level support. Minnesota's administrative record-keeping has served as a model for other states. Districts choose from either the state ESV administrative software or about 16 other vendor software systems. Learner records currently include individual learner demographic, scheduling, grade report, family, health, attendance, disciplinary incident, civil rights, and transportation data. The MDE has set standards for data on students. This data is transferred to the department twice each year through the ESV regions and is used to determine district aid payments and demographic profiles.

Desired Outcomes. The current student records meet minimal state and local needs; however, revised record keeping systems are required to meet the needs of the new Minnesota Graduation Standards and employers who want to verify the skills of high school graduates. A statewide information technologies system will allow for direct electronic transfer of data among districts and the state. Currently, districts submit tapes to the state but rarely share data electronically among themselves. Efficient and timely transfer of data is critical to appropriately assess students' progress and meet their learning and other needs. It is also critical to provide consistent and timely data to the state in order to calculate state aid payments and meet state and federal reporting requirements related to learner and school district demographics and learner needs.

To ease transfer of records, elementary and secondary record keep systems must be compatible with higher education systems. "Speedy Express" standards, which are generally accepted by other states and the federal government, should be tested and implemented. Standardized electronic transfer of records will enable post-secondary institutions to admit and place students more quickly and fairly. Record keeping systems should also be linked with other service providers and state agencies. Data collected and processed by the MDE should be shared with human services, health, and corrections agencies where feasible. Sharing data will help provide more effective and efficient delivery of services to the learner.

The state must support the development of "state-of-the-art" software for student records as required by the Minnesota Graduation Standards. Recording student progress and skill attainment is critical to implementing the skill-based model of learning supported by the graduation standard. These records must: a) signal when teacher intervention is needed to help a struggling student, b) provide students with a permanent record of their high school achievement, c) give parents a clear explanation of their child's educational progress, and d) provide schools with data to measure the quality of

their programs and services. This is a tall order, but necessary to make sure that schools are effectively and efficiently helping students learn.

In developing the systems architecture, the state should develop standards and protocols for software while allowing school districts to contract with whatever vendors meet these standards and protocols. The state should not become the sole vendor or choose a sole vendor for these systems. Competition is critical to motivate vendors to continuously improve their systems and offer them at affordable prices.

5. **Financial Management.** The Minnesota Task Force on Information Technologies recommends that the State of Minnesota develop statewide standards for school financial management and record keeping using open architecture standards to ensure compatibility with other computer operating systems and network protocols.

Current Condition. Minnesota's current system provides districts with the capability to report uniform financial data (UFARS) on an annual basis, when the school year has been completed. This system has been a model for other states. Districts choose from either the state ESV administrative software or from several State Board approved software packages. UFARS defines standards for uniformity in reporting financial data. The approved vendors must be able to conform with the structure and content of these standards.

Desired Outcomes. In the future, the financial management component must be a network-based system to provide better communication between the state and school districts to ensure accurate funding and financial planning. Clearer data and regular information exchanges will help improve the use and allocation of resources by and between the state, districts, and schools. These different users must work collaboratively to define information needs and timelines. The financial management component also needs to be integrated with learner record and personnel payroll systems to ensure fiscal accountability, efficient aid payment, and program expenditures.

6. **Parental and Community Engagement.** The Minnesota Task Force on Information Technologies recommends that the State of Minnesota develop standards and models for using information technologies to involve parents and communities in enhancing and measuring student learning.

Current Condition. There is an increasing number of examples of how technology can enhance parent and community engagement. A few districts provide electronic mail to students' homes. Cable television provides for broadcasts of board meetings and listings of school events. Some districts utilize automated telephone call-back to verify a student's absence. Even though some of these exemplary practices exist, districts have no clear models or standards for use of technology to involve parents and the community

Desired Outcomes. Parental and community involvement is critical to education reform. Network technology can be utilized to provide new avenues for parental involvement. As more homes have computers, schools can utilize networks to communicate electronically with parents individually or in groups.

Priorities, models, and standards should be developed which help schools see how information technologies can be used to engage parents and communities. These should be developed in collaboration with other organizations that provide services to students. State and community service providers will need to plan and adopt shared data bases. The school should provide parents access to technology so they can support their children's learning and assessment. Electronic mail could provide a way for parents to communicate with

teachers about their children's progress and needs. Electronic access to media and resource centers can provide 24 hour availability for parents and students. The Internet could be used to provide information to parents and community members. These and other forms of information technologies can encourage parents and students to learn together outside of the classroom.

7. Professional Development. The Minnesota Task Force on Information Technologies recommends that the State of Minnesota designate funds and actively support professional development for all educators on how to use information technologies.

Current Condition. Professional development programs for teachers support the conventional views of schooling. Elementary and secondary schools lament the lack of information technology literacy among new teacher applicants. Traditionally, professional development for practicing teachers generally involves additional university courses or one-time training activities. There are few standards governing professional development on how to use information technologies to support student learning. Therefore, the quality of teacher training and skills related to these technologies varies considerably.

Desired Outcomes. Professional development must be provided to current and future teachers on how to successfully use information technologies to support curriculum, instruction, and learning. This professional development should focus on helping teachers use technology to support student achievement of the Minnesota Graduation Standards and Goals 2000. Achieving this requires collaboration among those who receive, influence, and provide professional development opportunities. This includes teachers, teacher educators, administrators, content experts, policymakers, and business people. A task force should be created to facilitate this collaboration.

The state and school districts are responsible for providing high quality professional development on how to use information technologies. Teachers and other school personnel are responsible for taking advantage of staff development once it is available on a consistent basis. Hiring and assessment processes should hold teachers accountable for developing and using information technologies skills.

8. Access and Connectivity. The Minnesota Task Force on Information Technologies recommends that the State of Minnesota create, fund, and provide access to one statewide information highway for all state and local public organizations.

Current Condition. The two main issues for access and connectivity are: (a) Do teachers and students have adequate access to current technology? and (b) Do existing accesses connect students and teachers to other people, resources, and information?

In most cases, teachers and students do not have adequate access to current technology. Information technologies need to connect teachers, students, and other school personnel with their peers within and outside of their school districts as well as with information sources such as libraries around the state and country. Minnesota has implemented the InforMNs project to connect all schools to the Internet.

Desired Outcomes. In the ideal situation, all schools would have networks that connect students and teachers within and among school districts. This would help teachers and students to share information and learn in collaboration with their peers throughout Minnesota as well as international networks such as the Internet. These networks should connect parents, students, teachers, and community members at school, home, and work. The Minnesota Information Access Council should include representatives from elementary and

secondary education so they can help plan Minnesota's statewide information technologies system.

9. **Leadership.** The Minnesota Task Force on Information Technologies recommends that the MDE provide leadership in the development, management, and continuous improvement of an information technologies system to support student learning.

Current Condition. The Task Force on Information Technologies has begun identifying critical issues, components, and standards for an information technologies system for elementary and secondary education. The MDE has reinitiated a leadership role to help districts implement technologies that support student learning, assessment, and record-keeping as well as financial management.

Desired Outcomes. Ongoing, cutting-edge leadership is crucial to creating an information technologies system that meets the current and future needs of students and teachers in Minnesota. Leadership will help ensure that systems are high quality and meet student needs. Lack of strong leadership has helped create the current lack of coordination and common vision for information technologies in Minnesota's schools.

The MDE should ensure that standards, guidelines, and strategies are provided to help districts implement information technologies. This clearinghouse function should provide research on the best practices for using information technologies to support all school functions. Increased elementary and secondary education representation on the Minnesota Telecommunications Council will help to ensure that all clearinghouse information is current and compatible with statewide goals and strategies.

The MDE should also involve representatives from a broad cross-section of public and private organizations in developing standards for telecommunications hardware and software to ensure that public and private systems are compatible. This information can be available electronically, depending on user need and capability.

The MDE should perform a biennial assessment of the status and quality of information technologies in Minnesota's schools. This will measure the quality of the current deployment of information technologies and provide information for future goals and strategies.

The MDE can provide the framework for district implementation of technology. This includes sharing information and research with district technology and media specialists. Developing and sharing this information could be accomplished by establishing a technology leadership committee. This committee would help representatives from state and local agencies, school districts, and businesses work together to develop standards and practices for the implementation of information technologies in Minnesota's schools.

10. **Funding.** The Minnesota Task Force on Information Technologies recommends that the State of Minnesota provide equitable funding to school districts for the acquisition, maintenance, and support of information technologies as well as the necessary staff development to allow teachers and other school staff to effectively and efficiently use the technologies to support learning.

Current Condition. Minnesota school districts are having a difficult time finding resources for the implementation of information technologies. The main source of such funds is the capital expenditure equipment revenue of $66 per pupil unit. In addition, districts can levy for interactive television (ITV). Beginning in FY 1996, the Governor's budget permits transfers from the general fund to the capital expenditure fund for equipment/technology purchases.

Desired Outcomes. The State of Minnesota should adopt a system for funding an information technologies infrastructure using the following principles:

- Cost should be shared by the state and local school districts,
- A large initial investment is provided to establish a basic level of information technologies in districts,
- Continued funding will be needed to maintain and upgrade hardware and software (at lower level than start up),
- Funds could come from sale of short term bonds and be repaid through connect charges and/or user fees,
- Funding should support a K-12 information technologies system that fits into Minnesota's overall information technologies infrastructure, not a "stand-alone" system.

To help local school districts purchase information technologies hardware and software, the state should:

- Provide an equalized aid and levy program so that all school districts have the necessary resources,
- Provide appropriate funding per pupil unit with a minimum revenue to connect all buildings. To be eligible for connectivity funding, the school district must have a technology plan, and buildings must have a minimum number of students or quality for sparsity aid, must continue being used for a given number of years, and must meet safety requirements.
- Revenue could be provided as an addition to the capital equipment or interactive television formulas, or as a new categorical aid,
- The funding level may start high as districts acquire hardware, software and connect buildings, and then decrease to a level needed for ongoing maintenance and continued upgrading on an annual basis, and
- The review and comment process for facilities construction should require that new buildings accommodate information technologies

Staff development is a critical component of an information technologies system. Schools must provide a significant ongoing investment to help staff develop the skills to use information technologies to effectively support learning and administration. In addition, staff development will need to be ongoing to keep teachers current with new technology.

APPENDIX

INFORMATION TECHNOLOGY HISTORY AND TRENDS

The following is a more detailed and comprehensive overview of the information technology trends discussed in Chapter One. This paper was written by Richard C. Hawley, a member of the Minnesota High Technology Council. It is targeted at readers with a high level of knowledge about information technologies.

ADVENT OF INFORMATION TECHNOLOGY

The introduction of microcomputers in the mid-1970s fostered a new era in information technology. Traditional mainframe computing and centralized processing were quickly challenged by the introduction of personal computers, desktop computing capabilities, modems, and the creation of local area networks (LANs). Correspondingly, the 1970s telephonic transmissions market developed new business features through a flourishing PBX and key system market. Internally, these telephone switches were managed by sophisticated "real time" operating software. Acquisitions and mergers of regional computer manufacturers by telephone equipment manufacturers demonstrated a vision for the future--integrated voice and data systems--which were introduced in 1982.

While the 1970s were a decade of significant technology-based product introduction, the 1980s brought many new economic trends. Performance increases created expanded market demand and opened new markets. Consequently, demand, which was driven by cost reduction, fueled further cost reduction and the cycle continued. The resultant economic environment nurtured the new technologies and spawned immense growth.

The 1980s also saw the proliferation of electronic devices, wide spread acceptance of consumer electronics and integration of digital information into a wide variety of products. Micro-processing enabled manufacturers to install integrated chips (ICs) into appliances, games, toys, and other consumer devices. This was also the first time consumers could afford to personally own a computer and modem. This led consumers to become aware of the implications of rapid changes in technology. The value of computer and communication equipment investments, shorter product life cycles, and technological obsolescence became factors for consumers. As a result, the complexities of computing increased the importance of training and maintenance.

The advent of advanced computing and telecommunications accelerated changes in information processing methodology demanded by new groups of consumers who previously had minimal involvement with computing and data processing. These consumer demands led to operating environments that were easier to use, new types of support services, new software applications, and continuous product changes. Hardware processing improvements occurred rapidly, and each improvement resulted in new product and application demands. One of the biggest demands was the ability to share information. It was no longer acceptable for one manufacturer's proprietary system to be unable to share information with another manufacturer's system. This led to a critical shift in the product development focus from hardware to software, open system architectures, new programming languages and tools, interoperability standards, and the development of new networks for local and wide area network communication. With more people interconnecting and more sophisticated applications being used, a networking market to handle

the increased traffic emerged and led to broad-band network technology. The growing demand for networking placed increased emphasis on fiber optics as the transmission media. The idea that all information would eventually be represented digitally gained acceptance. In addition to data processing, voice, video, and audio products began introducing and promoting digital operation and features.

The average consumer has also been impacted by affordable video, audio, and wireless communication technologies. It has become commonplace for consumers to own VCRs, audio compact discs, digital radio tuners, or appliances with integrated chip controllers. Cable television and computerized games have become a common form of entertainment. Camcorders and cassette recorders are used widely. Businesses use VCRs for training and have adopted voice mail systems, integrated voice and data systems, and digital telephone systems. Cellular phone systems have proliferated, and satellite dishes for television and microwave dishes for data transmission have become practical business delivery systems.

The 1990s brought new trends. The size of the computer and VCR market has created entire industries for the purpose of making software, video training, and entertainment products. The largest emerging software market is focused on educating and/or entertaining children, commonly known as "Kid's Edutainment." In information processing, the "Age of Visualization and Multimedia" has significantly impacted computer, video, and audio products. The CD-ROM market is an early example of this trend and further reinforces the movement towards universally capturing and managing information in a digital form. Advancing network architectures and powerful central processing chips have displaced mainframe operation. The convergence of voice, video, and data is evident in the growing broadcast quality, point-to-point video conferencing and video telephone market. Desktop video conferencing is being actively pursued by cable and telecommunications companies. Another trend is virtual reality, where physical senses can be stimulated by real world or simulated experiences captured or created in computerized systems. Perhaps most importantly, there is greater acceptance of information technology by the general public as is evidenced by the growing market and the interest in developing a national information superhighway and the use of the Internet.

FUTURE INFORMATION TECHNOLOGIES TRENDS

Cost Performance. The rapid advancement of information technologies has been the result of continued cost reduction and increased performance. For example, integrated circuit designs that moved millions of operations per second (MOPS) now move billions of operations per second (BOPS). Monitors and video graphic adapters once displaying only 256 different colors can now display 16.7 million. In addition, as costs have decreased, new ways to interface with the computer have emerged. Users are no longer restricted to keyboards, but have a variety of options such as tablets, infrared devices, voice recognition systems, touch screens, video interfaces, telephone integration, and electronic pens. Output devices have grown beyond traditional printers to include photo realistic printers, video, audio, speech, graphic, telephonic, and real-time environmental controllers. The cost reduction and increased performance phenomenon also extends into traditional fields such as telephone, television, business instruments, medical devices, optics, wireless communications, and consumer electronics.

Digitizing of Information. Digitizing information consists of adapting nature's analog signals such as audio, light, and radio waves to data or numbers that a computer can process, reformat, and display in life-like representations. Photographs and two-dimensional still images are examples of early computer printer outputs. Today, telephone systems are migrating to digital telephonic standards (ISDN), consumer electronics such as audio and video equipment are migrating to digital capture, and television broadcasters are committed to digital transmission for high definition television (HDTV). Cellular technology is also in the process of conversion to digital signaling. Real-time data acquisition techniques used in manufacturing have migrated from simple pressure and temperature measurements to visual inspection systems. Development of tactile sensory and olfactory systems appears to be on the horizon.

Voice, Data, and Video Convergence. The trend towards digitized information has sped up the convergence of voice, data, and video. Traditional analog systems had little commonality. Each was implemented with its own delivery system and became a separate industry unto itself. Television, telephone, radio, audio, and computer systems used different technologies for processing and delivery. Today, the common bond of digital processing and delivery is intermingling technologies and redefining markets and industries.

Convergence and integration will force major physical and technological renovations within traditional telecommunications companies that will require large infusions of capital. Telephone companies currently have neither the band width for video nor the computer capability to process data. Today's cable companies do not have the capacity to handle bi-directional communications or telephone features. Computer networks have delays and capacity problems in handling voice and video. Television broadcasters lack the means to receive and process information. Examples of the movement towards convergence of voice, data, and video are apparent in various market areas. Computer Telephone Integration (CTI) and Video on Demand (VOD) are two technologies impacting traditional telephone companies. Additionally, computers, besides being used for control and monitoring systems, play a major role in multimedia development. Nonlinear editing systems for video and audio are currently available, and desktop video conferencing and video telephone products are emerging. Storage media such as magnetic tape, hard disk drives, optical disks, and CD-ROMS are used for audio, imaging, data, and video storage and archiving.

In addition to the business implications of convergence, there will be significant user and regulatory impacts. Traditional delivery systems for telephone, television, radio, computer data, and others will merge and intermixed voice, data, and video technologies will be commonplace. Regulations based solely on one mode of communication or transmission will be obsolete.

Interactive Environments. Integration and performance advancements have made computerized systems capable of real world response and replication, creating interactivity. Interactive environments can: (a) enable television to react to input, projecting the user into the image, (b) change computer systems into delivery mechanisms for virtual worlds, and (c) allow for digital storage media to be used for mobile interactive experiences. For computer systems and digital networks, interactivity demands that large amounts of information be transmitted bi-directionally. Most traditional transmission systems lack the capacity to carry the volume of information required. Consequently, television, telephone, satellite, microwave, computer, and other traditional carriers will need to redesign and enhance their infrastructures.

Storage Systems. Progress in computing performance has been coupled with improvement in storage technology. Storage capacity and access/retrieval speed have been increasing. New media types such as CD-ROM, optical disks, and PCMCIA cards are being introduced. Internal random access memory (RAM) capacity and speed have been enhanced to handle video. New SCSI wide interfaces offer a four fold increase in capacity, while fiber channel and ATM offer increased bandwidth. In addition, portable media have been increasing in popularity. Recent product releases include 15 megabyte flash cards the size of matchbooks that can be used for digital cameras, pagers, and mobile devices.

Availability of Electronic Information. The proliferation of personal computers and improvements in storage capacity options have opened a major market for information providers. This is a significant trend for education as the plummeting costs of consumer electronics and computerized devices have allowed the general public to collect and produce their own digital information. Video clips, images, reference materials, interactive text, games, software, and manuals are available on CD-ROM. Internet is expanding on a daily basis, libraries are converting traditional texts and materials to electronic formats, and the availability of instructional videos and CD-ROMS is steadily increasing. Camcorders and audio cassette recorders allow users to record experiences and data. Letters can be composed in computerized word files through keyboarding or direct dictation. The availability of such a huge variety of materials, media, and methods of application can significantly alter the educational experience for the learner.

Standards and Interoperability. Telecommunications industries created standard practices and protocols to ensure the ability to share information, however, computer systems were traditionally plagued with barriers to data exchanges. Today, open national and international formats and protocols are being established for computer systems and networks. The advent of voice, data, and video integration will increase the development of new standards. Frameworks for standards development were developed by the International Standards Organization (ISO) which specified an open systems architecture with layers of interface. This layered approach enables independent software and hardware development and applications that are independent of operating and communication systems. Interoperability issues are crucial to the education system, especially with the evolution towards integrated digital environments.

Computing Architecture. In addition to performance gains from component advancements, computer architectures emphasize higher performance. Voice and video demand that high volumes of data be delivered and processed quickly, reliably, and without interruptions or delays. Therefore, computers are being restructured to handle demanding multi-media applications. Major suppliers such as Microsoft, IBM, and Apple are redesigning their operating systems to accommodate multi-media. New architectures allow for coordinated use of more than one CPU chip in techniques such as distributed and parallel processing. Programming languages and tools are being redesigned so that software can take maximum advantage of new hardware and operating systems. The advancement of "plug and play" concepts offer easier installation and maintenance. Architectures are also being revised to integrate new systems. "Buses" to move data between components, such as the PCI bus, offer substantial improvement in system management and memory portability. Led by Microsoft's endorsement of standard application interfaces (API), digital signal processing (DSP) technologies have been developed that can off-load CPUs from the intensive

analog/digital conversion and processing that is part of any video, audio, or communication functions. Digital signal processing technology promises to minimize hardware obsolescence through software upgrades.

Client/Server Architectures. Since the mid-1980s there has been discernible movement away from mainframe computers. The introduction of the personal computer and intelligent terminals has moved control to the desktop. Distributed and networked environments have evolved to today's client/server architectures. The movement toward previously installed applications is being assisted by software conversion tools and the adaptation of mainframe computers for client/server processing.

Compression and Decompression. Compression involves mathematically coding data to reduce the number of data elements. Decoding, or decompression techniques, can be either "lossy" or "lossless" with ratios of error ranging from 4:1 to 100:1. The productivity and cost reduction potential of compression has caused television broadcasters to convert their infrastructure from analog to digital. With all the emphasis on higher performance, increased computational power, and more data-intensive applications, data compression shows much promise.

Networking. The growing desire to share information has led to widespread growth of networking. Within this phenomenal growth are other significant trends which are driven by users' increased appetites for capacity, speed, reliability, flexibility, and productivity. One such trend in networking is the increasing demand for capacity or bandwidth. Bandwidth requirements have been doubly impacted by the increasing sophistication of applications and the proliferation of network users. Applications have migrated from simple text and data files to voice and data. Additionally, the sheer increase in the number of users has had a significant impact on bandwidth requirements. As an example of a bandwidth calculation, an original system with 100 users, each transmitting a 2,000 byte word file, would require capacity for 200,000 bytes to move the files simultaneously. With 2,000 users, the capacity required moves to 4,000,000 or 4 megabytes. This approximates the maximum usable capacity per second of a 10 megabyte ethernet network. Files including pictures could easily increase to 150,000 bytes, therefore the system demand from the original 100 users would rise to 15,000,000 bytes or 15 megabytes, causing users to wait about 4 seconds or overload the ethernet network. Typical telephone voice lines have a capacity of 56,000 bytes per second, but delays result in clipped voices. CD level audio requires 171,000 bytes per second. Realistic video quality requires 15 megabytes per second. For two-way interactive video with sound, the volume more than doubles.

Another significant trend in networking has been the change in topology and geography. Geographically, traditional transmissions were made to local printers or terminals. This spread to other desktops within a building, creating a local area network (LAN). Transmission outside the building, referred to as a wide area network (WAN), requires signals to be sent over greater distances. This led to new special equipment development. Distance and bandwidth expectations for wide area networks spurred fiber-optic and twisted pair copper wire research. Topologies evolved from star networks with a central hub connected to other special points for point to point networking. Unfortunately, star topologies were vulnerable to failures. Today's self-healing, fiber ring topologies and switchable connections are replacing star configurations.

Convergence of voice, data, and video has also had an impact on networks. While networks for each of these media have been revised, there is network technology emerging that is capable of handling combined media. Asynchronous Transfer Mode (ATM) technologies have been tested strenuously in recent years with considerable success. Not only have ATM designers eliminated transmission problems of video and voice across data networks, they have demonstrated data transfer rates in the gigabyte per second range. The introduction of the integrated network marks a new era in which the traditional separation and regulation by media type will no longer be valid.

Internet Trends. The appetite for sharing information and expanding geographical connections has led to a thriving interest in national and global networking. The concept of the "information super highway" is becoming more prevalent. The use of the Internet grows along with the use of dial-up services such as America On-Line and Compuserv. While the resources of the Internet are extensive, it was originally designed to be a data sharing network and is bandwidth limited. The extraordinary growth in the number of users is taxing its capacity. The federal government is coordinating resolution of many issues surrounding the Internet and its replacement, the National Information Infrastructure (NII). These issues include privacy, security, network management, universal access, and intellectual property rights. The federal government has made it clear that individual states will ultimately have the responsibility to build the infrastructure. Many states have funded and initiated construction of their infrastructures.

Wireless Telecommunications. Wireless technologies created the cellular phone and pager phenomenon of the last decade. Today, cellular modems are commonly used. Conversion of cellular signals to digital is underway and television broadcasts via digital satellites are being marketed. For data networking, radio and infrared frequencies can provide connectivity within buildings. Microwave dishes can be used to interconnect local area networks. Radio frequencies have been licensed for data services. These are only a forerunner of developments to come. Personal communication networks (PCNs) will allow mobile wireless communication anywhere in the world. For example, Motorola has proposed IRIDIUM, a personal communication network based on low level satellites.

Mobile Systems. Miniaturization, wireless communication, and portable power improvements are increasing the development and use of mobile systems. Miniaturization of electronics provides smaller, more portable computing devices. The use of lap top computers and personal digital assistants (PDAs) is increasing steadily. Wireless communications enable users to be interconnected even in remote areas or while in motion, yet these features would be rendered useless without power. Engineers have developed a variety of methods to improve battery life by reducing the operating voltage of the computer circuits, introducing new rechargeable battery chemistry, and implementing computer-controlled power management.

Recognition of Information Technologies. Recognition of information technologies and their importance is a recent trend. For many years, it was considered "stylish" to be technologically ignorant. Information technologies are now embraced as crucial to economic, financial, and physical well-being. The existence of this trend is supported by federal initiatives such as the National Information Infrastructure (NII) and the popularity of the Internet.

MEETING DATES, LOCATIONS, AND PRESENTATIONS

June 8, 1994: Room 112, State Capitol, St. Paul, Minnesota

Ms. Marla Davenport, Supervisor of Special Projects, TIES. Ms. Davenport explained the Internet's background and history. She also described the InforMNs Project, a joint effort between the Department of Education, MNET, TIES, the University of Minnesota, State Universities, and MEMO, designed to provide Internet access to all Minnesota schools.

Dr. M. James Benson, President, Dunwoody Institute. Dr. Benson emphasized the importance of "planning from the future." He stressed that organizations need to continuously respond to change, learn, and use innovation as a foundation for all planning and strategy.

Mr. Joseph Graba, Interim Executive Director, Higher Education Coordinating Board. Mr. Graba discussed the Minnesota Telecommunications Council that is establishing a statewide telecommunications network for post-secondary education. He said this network will use communications and information technologies to provide Minnesotans with access to expanded and enhanced learning opportunities and information resources without time or distance limitations. Mr. Graba also stressed that elementary and secondary education should be involved in the Council.

Mr. Dave Kittelson, Technology Specialist, Blue Earth Public Schools. Mr. Kittelson explained that Blue Earth uses primarily Apple II computer technology but is working to build a network in the high school that will connect students, classrooms, and the administrative offices. Future plans include networking the entire district and researching the feasibility and cost of connecting to Internet.

Mr. Jeff Holte, Technology and Media Coordinator, St. Louis Park Public Schools. Mr. Holte reported that the St. Louis Park School District built its information technology/communications infrastructure by: (a) making information technology a district priority, (b) providing leadership, and (c) involving the local community. He outlined the key components of this infrastructure as:

- Enhanced communications, including installation of telephones in each classroom.
- Planning for logical computer connections/information flow.
- Analysis of technology's impact on learning.
- Connecting school buildings for both cable television and data flow and transmission.
- Providing easy electronic data collection and distribution.
- Providing students and teachers with Internet access and getting each student access to a global electronic mail account.

Mr. Holte emphasized the importance of continuously moving toward increased and improved access to technology as a learning tool for students.

June 22, 1994: Room 107, State Capitol, St. Paul, Minnesota

Dr. Betsy Case, Director, Office of Grant Development, Minnesota Department of Education. Dr. Case provided a presentation on the Goals 2000: Educate America Act, which is intended to serve as the blueprint for educating children in the future. The Act consists of these eight goals:

- School readiness;
- School completion;
- Student achievement and citizenship;
- Teacher education and professional development;
- Mathematics and science;
- Adult literacy and lifelong learning;
- Safe, disciplined, and alcohol and drug-free schools; and
- Parental participation.

Dr. Case also discussed the technology aspects of Goals 2000. The MDE intends to develop a state technology plan designed to increase the use of technologies that enhance learning, provide staff development, and support the Goals 2000 objectives.

Dr. Robert Buresh, Office of Grants Development, Department of Education. Dr. Buresh presented the new Minnesota Graduation Standards being developed by the MDE. He explained that the focus of the Minnesota Graduation Standards is to ensure that every high school graduate in Minnesota is equipped with the knowledge and skills necessary to compete globally. Dr. Buresh then provided examples of the standards in various disciplines and described the process and timeline for implementing the graduation standards in Minnesota schools.

July 27, 1994: U.S. West Communications, Minneapolis, Minnesota

Ms. Lois Briesemeister, Strategic Account Manager, U.S. West Communications. Ms. Briesemeister briefly described the applications of telecommunications technology in education and other areas.

Mr. Jack Riese, Product Manager, Telecommunications Division, Department of Administration. Mr. Riese described MNET, the network deployed by the Department of Administration to deliver STARS communication services. Mr. Riese explained that U.S. West is the main vendor for MNET projects, including technology applications for Duluth Public Schools, ESV Region I in Moorhead, and higher education.

Mr. Joe Trimbach, Data Applications Consultant U.S. West Communications. Mr. Trimbach described the following telecommunications technologies that are currently used:

- *SMDS - Switched Multi-Megabit Data Services*. SMDS is a high speed telecommunications technology used for data transmission.
- *ATM - Asynchronized Transfer Mode*. ATM is a broad band, cell relay technology that can be used for transmission of voice, data, and video.
- *ISDN - Integrated Services Digital Network*. ISDN is a narrow band technology used for transmission of voice, video, and data.
- *Frame Relay* - Frame relay technology is commonly used to connect school districts by collapsing lines to a host site. Frame relay technology is used primarily for data transmission.

He explained how U.S. West forms "communities of interest" that encourage potential users to work cooperatively toward developing and deploying a technology. He said U.S. West has concentrated efforts to implement technology for public access to the "information highway" on:

- Rural and urban access.
- Advanced technical architectures.
- Regulatory reform.
- Business and government applications, including document imaging, video conferencing, interactive employee training, vaulting, and communications among various enterprises.
- Health care, in the expansion of communication and information-sharing between health care providers both state and nationwide.
- Consumer/residential services, including videophones, home banking, and home teaching.
- Education, including access to Internet, building administrative and instructional networks, facilitating distance learning, and providing multi-media delivery and collaboration.

Mr. Jack Pugaczewski, Member, Technical Staff, U.S. West Communications. Mr. Pugaczewski demonstrated the technical operation of an interactive video classroom and described in further detail how SMDS, ATM, ISDN, and frame relay technologies function.

August 16, 1994: IBM, Minneapolis, Minnesota

Ms. Valerie Pace, State External Programs Manager, IBM. Ms. Pace described several education partnership projects that are coordinated by IBM in Rochester, Minnesota:

- *Partners for Quality*. This project is designed to extend the quality concept to the educational system and involves IBM, the Minnesota Academic Excellence Foundation, and other organizations.
- *Math/Science*. This project is a collaborative effort between IBM, Mayo Clinics, Rochester Public Schools, and the Zumbro Education District to encourage students to explore mathematics and science.
- *Youth Apprenticeship*. This project is designed to integrate school and work. Students work in apprenticeship at IBM in a variety of technical positions while continuing their education.

Mr. Chris Gibson, State Education Manager (IBM Eduquest), IBM. Mr. Gibson explained that IBM has worked with administrators, teachers, students, and parents to identify the following factors for successful use of information systems:

- Communication;
- Access;
- Staff development and support;
- Classroom management;
- Integration of technology into the curriculum;
- Equipment access;
- Facilities/technical infrastructure; and
- Equity.

Mr. Chuck Odorizzi, Consultant, Educational Systems, IBM. Mr. Odorizzi helps school districts deploy administrative technology solutions. He said the following areas are studied when a school district implements a system:

- Evaluation of the administrative environment.
- Implementation choices.
- Building an infrastructure and wide area network.
- Choosing an architecture.
- Determining applications.

Ms. Pam Greenslade, Education Marketing Representative (IBM Eduquest), IBM. Ms. Greenslade provided examples of how instructional technology is used in the classroom and can be integrated into the curriculum to enhance teaching A video was presented on IBM instructional products that allow students to study interactively.

August 24, 1994: 500 North, State Office Building, St. Paul, Minnesota

The Task Force used this meeting to discuss current trends in information technologies.

September 15, 1994: National Computer Systems (NCS), Eden Prairie, Minnesota

Mr. Robert Bowen, President, NCS Education. Mr. Bowen explained that NCS is aligning its products and services to expand its involvement in Minnesota education. He emphasized the importance of providing technology tools to teachers to increase their efficiency and effectiveness in serving students.

Mr. Joe Mildenhall, Director, Education Technology, NCS. Mr. Mildenhall discussed the role of technology in education improvement, including:

- The educational system faces many challenges such as: (a) change, (b) increased accountability, (c) new technologies to support learning, and (d) ways to do more with less.
- Technology can be a significant productivity source by allowing information to be used as a catalyst for change and quality decisions.
- The future for information technologies indicates (a) greater capability for increased access, (b) decreased costs in information storage, (c) increased speed for access to information, and (d) increased connectivity.
- Technology increasingly impacts education as it continues to grow in importance and provide more resources for learning. Technology can also provide richer electronic information about students, increase the points of connection within the learning process, and extend learning beyond the traditional school walls.

Mr. Mildenhall also described an "integration vision" developed by NCS that aligns curriculum, measured instructional progress, accessibility to student information, enriched assessment, and effective financial management.

Mr. John Harrison, Vice President, Administrative Systems Development, NCS. Mr. Harrison described the NCS approach to the client/server systems architecture. Mr. Harrison emphasized that the current industry efforts are moving to open systems environments.

Ms. Cathy Romayne, ESD Product Consultant, NCS. Ms. Romayne provided a demonstration of the NCS MicroCIMS software, an instructional management/student information application. She emphasized that NCS is working to make products that address school district needs such as (a) data banks for aggregating information, (b) the ability to aggregate information from unlike systems, and (c) instructional products designed to develop and maintain information on student performance. This allows schools to correlate instruction with school and student needs.

Ms. Stephanie Burton, Vice President, MSD Business Development, NCS, and Mr. Philip Hudspeth, Director, MSD Business Development, NCS. Ms. Burton and Mr. Hudspeth presented on NCS performance assessment and imaging applications. Ms. Burton described the Performance Scoring Service offered by NCS out of its Measurement Services Division. Measurement Services has a new approach to the traditional process for large scale performance assessment scoring using image technology. This allows a testing program to integrate both multiple choice and performance items in a testing document and has resulted in improved quality in terms of reliability, process control, and flexibility. They showed a video demonstration of the Performance Scoring Service.

Mr. Al Stamy, Vice President, Educational Services Development, NCS. Mr. Stamy discussed other states efforts to develop and implement new technology systems for schools. He offered the following process for establishing an information technologies system:

1. Set the vision.
   - Identify the driving force for change.
   - Identify a strong project champion.
   - Establish a technology plan (goals, standards, maintainable products).

- Communicate with and develop staff toward the change process.

2. Establish implementation keys.
   - Secure funding plans.
   - Select technology partners.
   - Focus project management with measurable milestones.
   - Initiate pilot testing.
   - Conduct staff development.
   - Provide for follow-up support.
3. Consider social implications.
   - Privacy;
   - Equity;
   - Equal access; and
   - Impact of change on people.
4. Recommendations
   - Set the vision using technology as a leverage point--technology is not the vision in itself.
   - Set realistic goals and timelines.
   - Learn from set-backs and successes.
   - Achieve measurable improvement in education results.

September 28, 1994: Apple Computer, Inc., Bloomington, Minnesota

Ms. Joan Wallin, Educational Technology Consultant, Apple Computer, Inc. Ms. Wallin described the Apple Classroom of Tomorrow (ACOT), a program developed to study the effects of technology on teaching and learning. ACOT is learner centered, active, constructivist, and authentic. Demonstration sites yielded the following results:

- Students demonstrated a dynamic exploration and representation of information, experimentation, and problem solving.
- Students exhibited social awareness and confidence, independence, and effective communication.
- Students exhibited confidence in using computers and a willingness to share computer expertise.
- In over 200 programs where technology delivered basic skill instruction, students learned more in less time.
- Teachers participating in the ACOT formed a support network, shared instructional strategies, collaborated on teaching, and experienced engaged classroom interaction with their students.
- An ACOT model for staff development is based on a constructivist learning environment with situated experience, specific plans for classroom changes, and immediate and ongoing support.

Ms. Wallin offered the following as Apple's recommendations on information technologies:

- Design for the future. Develop strategies and funding that enables schools to continually take advantage of emerging technologies that support instructional goals.

- Foster flexible technology systems that promote authentic learning, encourage collaboration, provide relevant and engaging activities, encourage critical thinking and creativity, and increase the depth of understanding.
- Provide vision and leadership. Demonstrate how technology applies to learning throughout the curriculum. Model technological expectations at the state level.
- Integrate planning with site-based decision-making. Research shows that technology alone or instruction alone are not as powerful or productive as technology integrated with instruction.
- Support continuous staff development. Develop models that integrate instructional methodology with computer applications. Provide convenient access to technology expertise in each school district.
- Promote connectivity. Develop data standards and state policies that foster transfer of student information. Promote greater interaction between schools, homes, and community and provide access to all forms of information.
- Address equity. Provide teachers and students with access to technology at school and home and provide access to diverse information.
- Begin by ensuring that every teacher has a computer that is conveniently located, powerful, and networked.

Mr. Tim Cuddy, Consulting Engineer, Apple Computer, Inc. Mr. Cuddy demonstrated a Powerbook as an example of technological portability. He also discussed wireless networks and general network technology. Mr. Cuddy demonstrated a voice recognition system, various ways of transmitting messages and mail, and an information access server that allows a user to search for information along specific parameters.

Mr. Paul Pittman, Market Development Manager, Apple Computer, Inc. Mr. Pittman discussed Apple's mission to help people transform the ways they work, learn, and communicate. He reported that Apple is currently the world leader in the manufacture of personal computers and the market leader in education. Apple's philosophy is to transform education through (a) active and interdisciplinary learning, (b) cooperative work, (c) responsiveness to different learner styles, and (d) recognition of the teacher's central role in learning.

Mr. Paul Misugades, Account Executive, Apple Computer, Inc. Mr. Misugades demonstrated several types of curriculum solutions developed for learners of all ages.

Ms. Sue Collins, Education Relationships Manager, Apple Computer, Inc. Ms. Collins, Apple's government relations liaison, spoke briefly on several technology initiatives under consideration by the federal government.

September 29, 1994: University Club, St. Paul, Minnesota

Dr. Frank Snyder, President, Computer Curriculum Corporation Dr. Snyder reported that Computer Curriculum Corporation focuses on developing (a) multimedia core curriculum, (b) corresponding management systems, (c) technology communication systems, (d) teacher and administrator training, and (e) technical support. He showed video demonstrations of multi-media approaches to science and mathematics instruction. Dr. Snyder emphasized that in an information technologies system:

- Schools are technology-based both in terms of administrative functions and curriculum.
- Learners need personalized instruction, collaborative and exploratory learning, and learning resources.
- Teacher need help with planning, instruction, and feedback assessment.
- Administrative systems provide accountability, performance-based assessment, minimal record keeping, and student information on demand.
- Community-wide learning networks involve home, school, and business.
- Curriculum is thematic, interdisciplinary, focused on problem-based learning with real-world content, and encompasses both foundation and higher level skills.
- Assessment is embedded in the instructional technology, is continuous, and provides portfolio and alternative approaches to assessment.

Dr. Snyder also defined the following technology directions and trends:

- Technology is increasingly moving toward devices and systems that are portable, interoperable, scaleable, and transparent.
- Instructional technology is evolving to use: (a) multi-media formats, (b) skills development, (c) intelligent tutoring, (d) editable courseware, and (e) formats that can be configured across content areas.
- Communications, networking, and platforms are evolving rapidly.
- Software technologies and operating systems are evolving to use: (a) speech recognition devices, (b) text to speech conversion, (c) improved operating systems, (d) cross platform development and deployment, (e) object oriented foundations, (f) extendible standard architectures, and (g) client/server architectures.

October 13, 1994: KTCA-KTCI (Twin Cities) Public Television, St. Paul, Minnesota

Mr. Mark Lynch, Project Coordinator/New Ventures Researcher, Twin Cities Public Television. Mr. Lynch stated that public television is a community based service designed to provide information, education, and public services in addition to the entertainment generally provided by television. He said the following about information technologies:

- The variety of information technologies will continue to broaden and increase.
- Lifelong learning services will be available in a variety of media formats focused on meeting individual learner needs and schedules. The learner is increasingly gaining control of the learning process. If lifelong learning services are of high quality and value, their use will increase.
- Curriculum technologies can be accessed through a wide range of technologies.
- The design of an information technologies system must be learner driven. Vendors and providers are working in partnerships to distribute a variety of services to learners.

Ms. Paula Jeske, Manager, Video Services, Twin Cities Public Television. Ms. Jeske reported that Video Services provides: (a) in-house production, (b) video conferencing, and (c) program distribution. She said that history documentaries are heavily used in schools. Public Television is in the process of creating a series of history

videos with accompanying materials for teachers. Ms. Jeske also explained how media is being affected by laser disc, network, and on-line transmission capabilities. In addition, there is also an expansion of lifelong learning through satellite technology.

Mr. Richard Hudson, Executive Producer, Twin Cities Public Television. Mr. Hudson said that "Newton's Apple" is a science-based educational television series now in its 12th year of production. This show is watched by over 5,000,000 viewers and is the most widely used television program in middle school classrooms. The 3M Company is the corporate underwriter for the show providing about $1,000,000 per year. These funds help Twin Cities Public Television produce teaching guides that are distributed without charge to public school teachers. Mr. Hudson explained that "Newton's Apple" is also available on video disk. He demonstrated how the video disk can be searched for subjects and interact with classroom computers.

Ms. Sandy Welsh, Executive Vice President for Learning, Public Broadcasting Service. Ms. Welsh stated that:

- Public television is assisting with the implementation of the federal Goals 2000, including the Ready to Learn Service, an educational television service that helps day care providers and early childhood educators prepare children for school. In addition, Math Line provides high quality professional development training for mathematics instructors. Going the Distance partners PBS stations with local colleges to offer an associate of arts degree using distance learning courseware.
- Public television has almost finished installing a new satellite system that will provide the capability and capacity that allows transmission of dozens of simultaneous video feeds.

Ms. Welsh also stated that public television can provide expert help in identifying the needs and delivery services required by teachers and learners. Public television hopes to become as visible in education as it is in programming.

Mr. Jim Kutzner, Vice President, Operations and Engineering, Twin Cities Public Television. Mr. Kutzner described several projects that Twin Cities Public Television is using to develop partnerships as a way of expanding and diversifying services. Mr. Kutzner explained that Twin Cities Public Television views itself as a publisher and has developed a series of on-line services to provide information to the community. An example is Minnesota On Line, which is funded through partnerships among nonprofit and for-profit organizations and the Corporation for Public Broadcasting. Components of this service include KTCA On Line, MPR On Line, and Partner On Line. KTCA On Line, for example, provides Newton's Apple, Almanac, News Night, Alive TV, technical assistance, information on KTCA membership, sales, and other services.

Mr. Kutzner reported that KTCA and PBS are switching to digital operations. PBS is an industry leader that has encouraged exploration of both satellite and fiber technology. In closing, Mr. Kutzner emphasized the importance of providing gateways to the community for partnership and involvement.

Mr. Paul Dillenberger, Math Instructor, Franklin Middle School. Mr. Dillenberger is a group leader and user of the Math Line Project. Math Line is funded by Sci/Math^{MN} and designed to help teachers instruct students how to apply problem solving skills and mathematical reasoning to real life. Math Line enables teachers to communicate with each other while learning to apply technology. Mr. Dillenberger provided a demonstration of the Math Line on line program. Features of Math Line currently serving 516 teachers include:

- Learning groups, in which most of the learning for teachers takes place.
- A Math Line Resource Center, which includes a bulletin board for posting information.
- Twenty-four hour teacher access.
- Facilitators who organize smaller study groups and other activities.
- Teachers' ability to compare and develop instructional strategies.
- Math Line provides a risk-free environment that allows teachers to experiment without classroom scrutiny.
- Twenty-five videos currently in production.
- Continuous support so teachers can effectively use the system.

Dr. Iris McGinnis, Director of Assessment, Minnesota Department of Education. Dr. McGinnis explained that the new Minnesota Graduation Standards will establish a results-oriented system to certify students' skills as they move through the educational system. The graduation standards are also designed to shift teachers' traditional emphasis from input to output.

Dr. McGinnis stated that local school districts will need help using technology to implement the learning and records processes required by the graduation standard. Students' long term records are needed on networked computer systems instead of paper files. Dr. McGinnis then said the components of an information system for the graduation standard are:

- Students will be assigned an identification number for their entire educational career.
- Students will develop an individualized learning plan upon entering secondary school. This plan will be updated to reflect student successes and needs as they develop.
- Student records will be maintained electronically and be available to people who need to evaluate the information.
- Standards, models of assessment, and sample products will be transmitted electronically to teachers so that they will have a variety of methods for instruction and assessment. Not every child will take the same test. Instead, the standards will define what the student needs to achieve.

Dr. McGinnis explained that the Minnesota Graduation Standards need an on-line support system. The Office of Graduation Standards is working on defining the elements for student records and will be releasing a request for proposals to develop an information system that aligns with the components of the graduation standards. Dr. McGinnis also stressed that schools need communications and hardware capabilities to operate the system.

Mr. Nevin Nolder, Education Specialist, Office of Special Education, Department of Education. Mr. Nolder explained that the Legislature created a Special Education Task Force. One of its specific assignments is to develop a technology plan for special education. Components addressed in the Special Education Task Force report include:

- *Assistive Technology*. Assistive technology is defined as any item that is used to increase, maintain, and improve functions of individuals with disabilities, such as prosthetics, speech recognition technologies, hearing aids, and other devices.
- *General Technology*. There is movement toward "schools without walls.". Technologies such as Internet will become common. Access to communications is critical.
- *Administrative Systems*. Special Education has been on the cutting edge in gathering data at the administrative level to make payments and communicate with special education entities across the state. Examples of this are the Electronic Data Reporting System (EDRS) that allows districts to send fiscal information needed to generate special education payments, and Minnesota Quick.Link, which is essentially an E-Mail system that lets school districts to communicate with the Office of Special Education.
- *IEPs (Individualized Educational Plans)*. Technology allows for IEPs to be managed by the student so that they can be full participants in the educational process.

October 26, 1994: Earle Brown Continuing Education Center, St. Paul, Minnesota

Dr. Joe Nathan, Director, Center for School Change, University of Minnesota Mr. Nathan outlined some of his beliefs related to teaching and learning:

- When educators and parents work closely together, students learn more.
- The most effective way to predict parental involvement is to examine how the school promotes it.
- Administrators and teachers are not effectively trained to involve parents in the educational process.
- School size studies show that smaller high schools provide better environments for students and produce greater gains in student achievement. Several states are now beginning to create smaller schools.
- Active learning promotes student engagement and achievement.

Mr. Nathan also offered the following recommendations for changing today's schools and improving the educational experience:

- *Learning*. It is necessary to examine how learning occurs before attempting to deploy technology in the learning process.
- *School Organization*. Give schools greater flexibility in terms of limiting or expanding school size. Schools also need to rethink staffing patterns. Encourage experimentation and innovation.
- *Teacher Training*. Good teachers are dramatically underutilized. Those experienced in the educational system should be asked to participate in the education of new teachers and administrators.

- *Home Environment.* Constant social change and societal problems have great impact on schools and learning. Focus efforts on the problems existing outside of school as well as those in school.
- *Compensation.* Schools should be rewarded for demonstrating increased student achievement. The current bargaining system for staff compensation needs to be examined to allow this.

Ms. Nancy Henderson, Minnesota Branch Manager, School Administration Software, Inc. Ms. Henderson explained that her company serves 478 school districts in 12 states. It is the most widely used in-house, stand-alone software in Minnesota, serving over 70 districts. It is a state-approved alternative finance system. Ms. Henderson offered the following key attributes for a statewide information technologies system:

- Make use of technology already in place such as Internet.
- Build on district knowledge in the design of the system. Do not reinvent the wheel.
- The system should be open and allow for total integration of data. Districts need to be able to choose the system that is effective for them.
- Encourage districts to use available technology such as electronic transcripts and grade-books.
- The system needs ongoing support.
- The system needs to allow for a free market environment. Competition is the impetus for innovation.
- Required data must be defined and must be useful to districts.

Mr. James Van Tassel, Representative, SASI, Macro Educational Systems. Mr. Van Tassel outlined the following as crucial characteristics for deploying technology in education:

- Provide classroom teachers with easy access to student record systems.
- Technology must be accessible, self-training, and adaptable to a multi-vendor environment.
- Make sure district needs are clearly understood and then design the technology to meet the needs.
- Use and modify existing tools.

Mr. Steve Hallan, Director, East Central Minnesota Educational Cable Cooperative. Mr. Hallan provided a brief history of interactive television in northern Minnesota. He pointed out that interactive television has provided successful instruction. Mr. Hallan reported the following findings resulting from pilot projects conducted through the ECMECC.

- Interactive television needs to be truly interactive. Full motion, video, and audio are important. Student engagement halts when a student cannot ask questions and obtain answers.
- Resources are scarce. Interactive television organizations try to ensure quality and cost effective operation.
- The majority of students surveyed indicated they would participate in more interactive television courses.

Mr. Mark Beltz, Business Manager, Farmington Public Schools. Mr. Beltz explained that Farmington Public Schools, formerly a member of TIES, has moved to network the district and operate stand-alone systems. This network effort began by linking school buildings together with a simple phone line system. Farmington now uses a

local area/wide area network for administrative purposes. This has improved information sharing. The end goal is to give teachers technology that works for both curriculum and administrative purposes. Mr. Beltz identified the following as barriers Farmington encountered when implementing their system:

- Traditional geographic separateness.
- Students and secretaries are often the most computer literate people in the people district.
- Lack of support for concepts.
- Availability of equipment.
- Cost.
- Personnel.
- Lack of leadership.
- Lack of support at building level.

WORKING SESSIONS:

- November 22-23, 1994: Hyatt Regency, Minneapolis, Minnesota
- December 15, 1994: Earle Brown Continuing Education Center, St. Paul, Minnesota
- January 26, 1995: Minnesota Department of Education, St. Paul, Minnesota

MINNESOTA TASK FORCE ON INFORMATION TECHNOLOGIES MEMBER BIOGRAPHICAL PROFILES

Ms. Teresa L. Edwards. Ms. Edwards is currently the principal at the Pillsbury Math/Science/Technology Elementary School for Minneapolis Public Schools. She is a member of the Minnesota Elementary School Principals Association and was awarded the National Distinguished Principal Award for Minnesota in 1994. Ms. Edwards was also a Bush Fellow in 1994-95.

Mr. Joseph P. Graba. Mr. Graba is the Interim Executive Director for the Minnesota Higher Education Coordinating Board. Previous positions include Deputy Executive Director of the Minnesota Higher Education Coordinating Board, Deputy Commissioner of Education, State Director for the State Board of Vocational Technical Education, and three terms in the Minnesota House of Representatives. Mr. Graba is also the current chairman of the Higher Education Telecommunications Council.

Mr. Richard C. Hawley. Mr. Hawley is President and CEO of Introspect, Inc., a consulting firm in telecommunications and systems integration. Recent projects undertaken by Introspect, Inc. include medical imaging and desk top video conferencing product development, assistive technology consultation, computer/telephone integration, and future network design architectures for regional telephone systems. Mr. Hawley is a member of the Minnesota High Technology Council, EdNET, and Sci/Math^{MN}.

Ms. Amy J. Hjelmeland. Ms. Hjelmeland is the Interactive Television Coordinator and Technology Facilitator for the Freshwater Education District, Staples, which serves ten school districts in central Minnesota. Ms. Hjelmeland also works with community education, arts programming, violence prevention programs, secondary vocational issues, and curriculum development. She served as the Minnesota Interactive Television Network (MITN) President in 1994-95.

Mr. Jeff W. Holte. Mr. Holte is the Coordinator of Media and Technology for St. Louis Park Public Schools.

Dr. Kerry R. Jacobson. Dr. Jacobson is Superintendent of the Little Falls Community Schools.

Dr. Clark M. Kirkpatrick. Dr. Kirkpatrick is the Executive Director of TIES, a joint powers organization providing technology support and information services to over 50 member school districts and educational organizations across the state.

Ms. Barbara Lerschen. Ms. Lerschen is an independent consultant with Northstar Technical Resources and Shared Resource Management. She currently develops microcomputer-based applications for clients such as General Mills, FMC, Cargill, and Piper Jaffrey. Ms. Lerschen's technical experience also includes 17 years with Control Data and two years with Racotek. She has also worked as a mathematics and science teacher.

Ms. Christine Matuzek-Rivas. Ms. Matuzek-Rivas is the Director of Education and Community Affairs for the Minnesota AFL-CIO. She has served on a number of state advisory committees and councils, including the Education and Employment Transition Council and the Task Force on Technology Competence.

Dr. John W. Mercer. Dr. Mercer is currently Deputy Commissioner of Education and Chair of the Task Force on Information Technologies. He previously served for 11 years as the Executive Director of the State Council on Vocational and Technical Education. In addition, Dr. Mercer has worked as an education planner with the State Planning Agency, University of Minnesota, and Macalester College. Dr. Mercer also represents the MDE on several other key policy groups, including the Education and Employment Transitions Council, Higher Education Advisory Council, and the Minnesota Commission on National and Community Service.

Mr. Sheldon Sampson. Mr. Sampson is a technology coordinator and classroom instructor at Lakefield Senior High School in Lakefield, Minnesota. He also serves on the Board of Directors of the Minnesota Education Association.

Mr. George D. Scott. Mr. Scott is a teacher of technology and graphic arts at Central High School in St. Paul.

Mr. Noel E. Stratmoen. Mr. Stratmoen is the Manager of Facility Administration at Seagate Technology, a research and manufacturing facility in Bloomington, Minnesota. His duties include space coordination, asset management, records and documents management, and disaster recovery planning. A former industrial arts teacher, Mr. Stratmoen has served on the Northfield School Board for 14 years and is involved in numerous school, church, and community committees and task forces, including the Transportation Task Force, Finance Committee, and Personnel/Negotiations Committee for Northfield Public Schools.

Mr. Terrance M. Twite. Mr. Twite is the Executive Director of the Wasioja Education Technology Cooperative (WETC). Mr. Twite's duties include planning and developing specifications for fiber optic networks and equipment, telecommunications contract negotiations, curriculum coordination for using technology in the classroom, program development, and staff development.

Mr. Gregory A. Vandal. Mr. Vandal is the Superintendent at Sauk Rapids-Rice Public Schools and the former superintendent of schools in Eden Valley-Watkins Public Schools. He has also worked as a consultant on administrative and educational technologies and as a professor in the same field at St. Cloud State University.

MINNESOTA DEPARTMENT OF EDUCATION
INFORMATION TECHNOLOGIES RESOURCE TEAM
BIOGRAPHICAL PROFILES

Mr. Bill Asp. Mr. Asp has worked as Director of the Office of Libraries since 1975. He has served with several organizations relating to library and information services, including the Advisory Committee for the 1991 White House Conference on Library and Information Services, Chief Officers of State Library Agencies, the Minnesota Regional Network (MRNET), and the Continuing Library Education Network and Exchange.

Mr. Jeffrey Briggs. Mr. Briggs is a member of the MDE Financial Management Team. Mr. Briggs' experience includes seven years at METRO II as a Regional Accounting Coordinator and Finance Services Coordinator. His responsibilities at METRO II included training in applications and the use of microcomputers and mainframe systems, assisting in development of systems, and correcting data problems.

Mr. Leo G. Christenson. Mr. Christenson is the Director of the Office of Research and Planning for the MDE where he develops and manages research initiatives to measure the effectiveness of Minnesota's educational programs and services. His previous appointments include Director of the Office of Lifework Development for the MDE, and Executive Director for the State Council on Vocational Technical Education.

Mr. Mike Damyanovich. Mr. Damyanovich has served for 30 years as a classroom teacher and as a curriculum and technology specialist with Osseo Public Schools. He currently is working as a professional development coordinator and technology project supervisor with Sci/Math^{MN} in the MDE.

Ms. Denise Garcia. Ms. Garcia works in the Office of Service Design and Collaboration for the MDE. She is responsible for coordinating the Prevention and Intervention Funding for the Minnesota Communities Project, a collaborative offering of competitive grant funds from several sources.

Ms. Carol Hokenson. Ms. Hokenson is the Team Leader of the Data Management Team, Office of Information Technologies, MDE. This team manages the MDE's data collection activities in their various phases from review and analysis of collection requirements, data definition and capture, and data distribution.

Mr. J. Mark Manning. Mr. Manning is the Director of the Office of Information Technologies for MDE. Mr. Manning has extensive background in data management, school district reporting systems, and systems architectures for elementary and secondary education. He is currently involved in identifying critical issues for implementing technology in schools.

Ms. Mary Mehsikomer. Ms. Mehsikomer works for the Office of Information Technologies at the MDE. Ms. Mehsikomer has over 15 years experience in office administrative management, including budget development and management, committee administration, and information management services.

Mr. Gary Olsen. Mr. Olsen is a member of the Education Funding Team of the MDE. Mr. Olsen helps to develop funding mechanisms and is a user of student and financial data processed on statewide systems.

Acknowledgment: Mr. William F. Marx of the House Education Finance Division and Mr. Mark Misukanis of Senate Research participated as legislative liaisons to the Task Force on Information Technologies.

MINNESOTA INFORMATION TECHNOLOGIES TASK FORCE RESOURCE TEAM

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