# Creating

# Learning Communities:

# Practical, Universal Networking

# for Learning in Schools and Homes

**February 1996**

## A Report for School and Community

## Technology Planners

## and Policymakers

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Priest (1995) Results of Survey of Community Networking Activities that Included Schools
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# ***Sources and Acknowledgements***

This report is based on information distilled from a wide range of sources: the 670 print and electronic resources (referenced in Appendix B), a workshop/conference attended by experts in school, community and global networking (see Project Reports above), two online surveys of schools and community-wide networks, and follow-up online and telephone interviews with school technology coordinators, school administrators, commercial vendors, networking specialists from schools, community networks, businesses, universities and government agencies.

All of the above generously shared their experiences, strategies, techniques, criticisms, advice and vision about networking and its role in enhancing in-school and at-home, community-wide learning. We gratefully acknowledge their individual and collective input which has enabled us to base what follows on the realities faced by educational networking advocates who are working within today's cost-cutting school climate.

We are particularly grateful for input from developers of nonprofit grassroots community-wide networks and local educators and parents who share a common vision of school-home connectivity as integral to the development of learning communities. We applaud all educators willing to work with local community networks to achieve practical networking economies and the benefits of school-home connectivity. As such cooperation becomes more common, learning communities of the sort advocated in this report are likely to proliferate.

We wish to express our gratitude to the John D. and Catherine T. MacArthur Foundation for the generous support that has enabled the Educational Products Information Exchange (EPIE) Institute to carry out the work that has produced this report. We particularly appreciate the vision of Peter Gerber who encouraged us to undertake the work accomplished with the aid of the Foundation's support.

# SECTION I: Introduction

"We have access to grants, but we don't have access to communities" School Principal, Barry Vitcov, who is "...hoping to find money for an Internet account for the school before the end of the academic year, but he worries about the cost at a time when there are other concerns, like fixing the school's roof which leaks during downpours." (The New York Times, Jan. 29, 1996)

## *Introduction and Rationale*

This report appears at a time when most schools and their communities are operating under increasing fiscal constraints. This is underscored by a recent federal (GAO, 1995) report alerting the nation to the eroded physical condition of its public school infrastructure. However, this is also a time when national political and business leaders are urging that by 2000 all the nation's classrooms and libraries be networked to the National Information Infrastructure (NII).

Ensuring networked connectivity of schools and libraries to the NII via the Internet is seen as essential for preparing America's youth to share in the anticipated educational, economic and social benefits of life in the Information Age. Yet many schools and communities may feel that they are being asked to invest in a technology with unknown costs, and largely undemonstrated benefits. Others may feel that the goal, though laudable, is impractical, given the constrains under which a their schools are having to function.

This report is designed to be a useful tool for those school and community decisionmakers who may agree with the goal of networking, but who are concerned about the practicality of achieving it for their schools and communities. The most obvious of these concerns are related to technical, fiscal, and timetable decisions. But other, ultimately more important concerns relate to broader and deeper educational and social dimensions and decisions.

Among these concerns, there are two that are given particular emphasis in this report:

1. How can networking be effectively used to strengthen and increase (a) at-home learning for students, (b) parents' support of that learning and (c) teachers' support of parents involvement in their children's learning?

2. How can at-home access to these networked benefits and enhancements of at-home learning be accessible equitably to all students and parents within all schools in a community?

The report attempts to relate specific fiscal and technical decisions to such broader educational/social dimensions and decisions implicit in these two emphases.

We have tried to do this in ways that relate the networking of schools to local and global opportunities to improve communication and learning among teachers, parents and others who are major players within the overall "learning ecology" within which students learn (Niebuhr, 1993; Komoski, 1994).

Our goal is to help school and community decisionmakers develop practical, equitable and sustainable telecommunication networks capable of:

1. Enhancing learning for all learners by contributing to the development of local learning communities with school-wide, community-wide/world-wide connectivity;

2. Improving parent-teacher communication and cooperation via school-home e-mail and/or voice mail communication networking and supporting parents' interest in improving children's learning both at home and in school via homework help, student progress reports, home-school conferencing and access online learning resources;

3. Encouraging students to devote significant amounts of out-of-school time — at home or at networked community learning centers in libraries etc. — engaging in computer mediated communication activities such as information exploration, cooperative learning as well as through the use of curriculum-related instructional resources;

4. Involving the local community in positively supporting and strengthening all elements of a community's overall "learning ecology" (e.g., schools, libraries, families, peers, community centers, media, neighborhood organizations, youth groups, health, social and civic agencies, etc. (Niebuhr, 1993);

5. Responding to the changing needs of learners, teachers, parents and adapting to changing technologies and pedagogies;

6. Being supportive of — and being supported by — the local community as the infrastructure for an evolving learning community.

Answers to the many practical, technical, educational and fiscal questions to be dealt with to achieve the outcomes implicit in the above statements will seldom, if ever, be the same for any two schools and their communities. What is practical and affordable in one school community may be judged not feasible by another. What may be affordable initially, because of an available grant, gift, or business partnership, may prove otherwise once such funding has ended. Some schools and communities may be granted a "free launch" into cyberspace, but once launched, is the momentum sustainable?

The costs of sustaining the technology and ongoing staff development for networked schools with local and global connectivity are largely unknown. Unfortunately,they will remain so until more experience is gained and the results of that experience are accessible to schools and communities, via the very networking capabilities addressed in this report. Nevertheless, this report is intended to be a practical, useful work for those school technology planners and policy makers who agree that the networking of schools and homes can facilitate the building of learning communities in which equitable, universal access to electronic learning can be achieved.

Through school-home networking there are those who envision (1) students and their parents better understanding what curriculum goals students are to achieve, and (2) students learning how to access the resources they need to achieve both school's and their own personal goals. Others are questioning whether enough teachers are prepared to shift from traditional chalk-talk-textbook instruction to mentoring, monitoring, and verifying a student's understanding and progress as a result her/his exploring and constructing knowledge via inquiry-based learning? While some teachers may be ready for such a transition, others are reticent. Some of their reticence may be justified, in that effective instruction, no matter how it is mediated, always has educational value. Thus, in time, we feel that teachers and schools will find learner-appropriate uses of both instruction and exploration learning (see EPIE/CITS Model in Section IV of this report).

If and when the above-mentioned shift occurs in a particular school it will depend on many factors. Not the least of these is when and how teachers, school administrators and school boards begin focusing on what is going on around them in the overall learning ecology of the larger local and global community of which schools are but a part.

<u>The Dynamics of a Complex Undertaking</u>

At whatever level school and community decisionmakers proceed with networking, they are faced with a complex set of interrelated educational, technical and fiscal decisions that are both difficult and important. They are particularly difficult because of four interacting dynamics:

1. The dynamic of technological change, innovation and competing networking solutions;

2. The dynamic interaction between new technologies of networking and new approaches to teaching and learning, especially those emanating for research in cognitive science and a tension

between long-standing pedagogy of teacher-directed instruction and an emergent pedagogy of self-directed, knowledge construction and exploration learning;

3. The dynamic tension between the promise of the new networking technologies and the many practical and fiscal questions that must be answered with great specificity before that promise can be realized;

4. The dynamic growth of computers and connectivity in the homes of increasing numbers of students and the social tension resulting from the absence of this technology in the homes of those who cannot afford it. Proposed solutions to this at-home access disparity are addressed.

In light of these four dynamics, the report is designed to be a useful technical and educational resource of practical advice and information on school/community networking, as well as a guide to other relevant sources of help on a topic of great educational and social importance.

## ***Overview of the Following Sections***

Strategies, suggestions, technologies and recommendations to consider when addressing the four dynamics mentioned above are contained in Sections II-V, as follows:

SECTION II deals with the "**Do**'s and **Don't**s" of creating affordable in-school networks as well as school-home-local and global network connectivity.

It describes issues and options related to developing practical, affordable telecommunication networks that provide school-wide, community-wide and world-wide connectivity. It focuses on the "do's" and "don'ts," the "hows," "whys," and lessons that can help schools and their communities develop networks designed to enhance and extend learning opportunities. It emphasizes the importance of staff development and the need for teachers, students and parents to have ready access to information about relevant local, national and global resources. It also discusses the implications of newer technologies such as wireless and DVD (Digital Video Disc) on networking.

SECTION III focuses on how networking technologies may be effectively used to enhance student learning at home, and to improve parent-teacher communication and cooperation focused on improving children's learning at home and in school. It describes:

- The implications of the growing nationwide disparity between access to computers in the homes of many students and in schools;

- The capability of school-home networking to expand students' at-home learning time and opportunities, and to facilitate parents' involvement with their children's learning, homework and their communication with teachers;

- The challenge of extending expanded at-home learning opportunities to those students whose parents cannot afford a home computer.

SECTION IV examines more fully the purposes, promise, and benefits of networking and telecommunications described in the first three sections. While acknowledging that the overall process of education defies simple analysis, this section describes the directions in which networking technology is capable of taking teaching and learning on the threshold of a new century. This is done with reference to a multi-dimensional dynamic model of K-12 Schooling and Networking and factors related to learner effectiveness.

SECTION V describes practical steps schools and communities can take today with available networking technologies to develop an effective learning community and to strengthen all aspects of the overall learning ecology of school and community. In addition, practical strategies for achieving equitable access to computers, connectivity, and training for students and parents from low-income households are addressed.

# SECTION II: Achieving Practical Networking

*I am not saying that a World Encyclopedia will in itself solve any single one of the vast problems that must be solved if man is to escape from his present dangers and distresses and enter upon a more hopeful phase of history; what I am saying — and saying with their utmost of conviction — is this, that without a World Encyclopedia to hold men's minds together in something like a common interpretation of reality, there is no hope whatsoever of anything but an accidental and transitory alleviation of any of our world troubles. As mankind is, so it will remain, until it pulls its mind together. And if it does not pull its mind together then I do not see how it can help but decline.*

H.G. Wells, *World Brain*, 1938, pp. 24-25

When this study was originally conceived, we imagined creating a matrix of teaching objectives and comparing those objectives with networking technology. This goal was challenged in many ways:

• Some proponents of networking technology are actually advocates of technology-aided school reform. How does one assess a moving target where the objectives of curriculum are being challenged and changed by the technology itself?

• It became apparent that networking involved more than the conveyance of information — it involves communication, monitoring, and feedback. Out of this realization we expanded the scope of the project to include motivational effects of networks such as feedback for improved student self-esteem.

• Schooling has traditionally been under local and state control. This complicates matters because each state and, often, each school district defines its own curriculum objectives. Different objectives imply the need for different priorities among networking technologies and networked resources.

• Almost weekly there is yet another important technological development that pertains to networking. For example, we have been tracking the developments of very high storage CD-ROM discs. Called DVD (digital video disc), these discs can contain nearly 20 gigabytes of data, about 30 times the storage of current CD-ROM discs. How does one provide practical advice for K-12 schools when the relative costs of local versus distant archival of knowledge can change so dramatically?

• The costs of networking are also dependent on the Telecommunications Act of 1996 which was passed by Congress on February 1st, 1996. The bill provides for affordable telecommunications for K-12 schools. Yet there is no guidance in the bill as to what determines affordability. The decision is left to State utility commissions and the FCC. This results in cost uncertainties about school costs for telecommunications (see Rate Reduction tips below).

• Some well regarded observers of education and educational technology note that technologies that conform to how teachers teach in classrooms are accepted, while those that provide other promises are consistently rejected, decade after decade. For example, it is often stated that the blackboard and chalk has been one of the most pervasive technologies in schools. This raises the specter of digital network connections in classrooms going unused.

• In contrast, there are students and teachers building web pages in cyberspace, some electronic portfolios are already available for both employers and colleges to peruse, and some teachers are acceding their control of the classroom.

• There is not one network to consider but several. There are existing networks of people and practices. There are digital networks and there are telephone networks (both within school and from home to school). And, there are video networks — some for distance learning, some for cable programming, and some for locally, but centrally, concentrated resources such as VCR's. There are proponents of a single network for all these purposes pitted against the reality of network devices that only work on cables designed specifically for those devices.

• There are many players. Media specialists bring one point of view, librarians another, computer lab supervisors another, innovative teachers another, Internet surfers another, and several thousand software and content providers provide yet other points of view. School administrators determine the standards by which teachers are judged and how funds can be spent.

• Other respected observers note that the process of public schooling is bound by several complex roles including "conserving cultural values," encouraging creativity, acting as custodians, and credentialing each student. To these observers the relationship of networking technology to all of these tasks is not clear.

• Many teachers and students are eager for the excitement that exploring the Internet brings inside the walls of schools. Can learning always be fun?

• Roles of parents are in flux. Parental involvement in every day schooling has become technological more feasible. Will enough parents have the time and interest to make a difference in improving children's learning?

• The U.S. economy has entered a period of extremely high debt levels at the personal, municipal, state and federal levels. The federal government hands off more welfare and health care activities to states and localities, these demands will compete for scarce local funds. Yet, despite these concerns many schools are eying bond issues to pay for technology.

• Eventual costs of telecommunications are largely unknown. While the costs of low volume traffic such as e-mail will remain trivial, the costs of higher end applications such as video conferencing are yet to be understood. Also current congestion through many Internet providers is paid for by waiting for responses causing some to say WWW stands for "World Wide Wait." What can schools expect for response times?

• Most materials on the Internet are free of additional costs. But the development costs of high quality content, especially documentary quality videos, are very expensive. Schools do not know what charges they will eventually see for networked resources when quality materials, especially designed for teaching, are made available.

• Large uncertainties exist around issues of digital copyrights. Industry has been quite vocal about protecting copyright and this will restrict a school's ability to use these materials. Legislation is in preparation that looks especially onerous to users and educators' rights under "Fair Use" may be abridged. (Hearings on legislation are being held as this chapter is being edited.)

• In addition to many sources of uncertain costs and availability, the value of networking is also vague and uncertain. Already there are two camps forming: 1.) "Netniks" extoll the wonders of telecommunication based projects as sources of "authentic learning" while, 2.) "Stollniks" (after Clifford Stoll, author of *Silicon Snake Oil*) fret about the loss of real teachers and true hands-on learning experiences. As one of them put it, "Internet pictures of frogs are not real frogs (Brown, Unplug, 1995)."

• Many parents look to schools to provide highly structured, disciplined environments. Self-directed learning is low on their list of priorities.

• Many other parents do look to schools to provide opportunities for independence and creativity, and welcome technologies that encourage this.

• In an era where 47% of today's jobs require computer experience (McKinsey, 1995, p. 7) parents are encouraging students to gain this experience.

• But as noted in Section Three (Grunwald Associates, 1995) the purchase of a home computer to aid a child's learning is now the dominant driver of home computer purchases. As also noted, home purchases of computer software and Internet connectivity greatly exceed purchases made by schools. What role do public schools have in redressing inequities in access between families that can afford these tools and those that cannot? And what role do states have to address possible "pauper technology schools" — similar to the state crusades against pauper-schools such as occurred in Pennsylvania in 1834 and New Jersey in 1838 (Cubberley, 1920).

• Where does the time come from for teacher learning and adaptation? The recent National Education Commission on Time & Learning (Kane, 1994) found teachers being asked to do more in an environment already time deprived and "imprisoned" by time.

• There is actually too much information, too many stories for any one teacher to read. Magazines, journals and books recount stories of Internet projects, and networking examples. The Internet, itself, is increasingly populated by accounts of technology plans (e.g. http://www2.msstate.edu:80/~lsa1/nctp) or school case studies (e.g. http://www.ednet.apple.com or http://www.lloyd.com). Yet there is too little wisdom, perhaps because of the newness of the task before us. In reality many technology plans borrow from too few resources, fettered by a limited access to counsel or expertise.

• Where is the line between education and edutainment? As parents we witness how mesmerizing video games are to a child. In recent months several vendors have offered enhancements to MOO/MUD environments to extend them towards places of virtual reality where students can become virtual characters and interact with other students and fabricated features of the environment. Virtual online universities do exist (e.g. Athena University, http://www.athena.edu) and very serious teaching and learning takes place in these environments. What is the relationship of these virtual worlds to the world of the classroom, or to the "classroom" of living in a community?

• Where does the current technology for learning and collaboration lie in relation to our educational technology needs? The Web page, while graphically alluring and more intuitive than earlier Internet tools, is a morass of uneven, disjoint educational resources (Priest, 1995, Primer). Databases of quality and depth such as by Dialog, EPIC, and Homework Helper are only available via the Internet for a fee (often substantial). And collaborative tools such as joint-authoring softwares, web-based computer teleconferencing, threaded newsreaders, and listserve exchanges are still at an awkward stage of development where hours of interaction can produce little learning. Information "when needed, where needed, as needed" is still an elusive goal for the developers of groupware and collaborative tools. (Perhaps one of the most advanced so far is CSILE (in Means, 1995, p. 14).)

• There is the Myth of the Online Expert and other resource fallacies. Some fortunate students have been privileged to partake in networking experiences which have brought them in contact with scientists and other experts. In one study parents were reported to be envious of their child's access to famous authors (Teles, 1991, p. 69). We must recognize that such opportunities cannot be common to all students. Some accounts of learning scenarios (in Fulton, 1995, and elsewhere) promise unrealistic amounts of access to scarce resources. Nonetheless, we will have improved access to "secondary-experts" — librarians and teachers who specialize in particular knowledge areas and can be contacted via networks. And we certainly should continue to encourage scientists and others to selectively identify blossoming student talent that would benefit enormously from direct contact.

• And the Everest Syndrome (Gallo, 1994, p. 17 — "computers should be implemented into the school curriculum 'because they are there.'" Indeed, when Honey (1993, Case Studies) identified the allure of the Internet to teachers and students she used phrases such as "like an ocean," "exploration, discovery, murkiness, mystery" and "uncharted territory." The thrill and challenge of such quests beckon many to the Internet, but this exploratory call should not be equated with everyday matters of curriculum and learning.

• Some (e.g. Riel, 1995) depict significantly restructured schools where teachers become just one of many resources at the tips of student's fingers. The description of this new kind of school is simply vibrant. No longer is there just teacher, but there are four levels — learning guides, entry teacher, mentor teacher, and master teacher. Made possible by the Charter movement, the students benefit from Learning Centers built around themes, such as the "Ocean Center." Technological aids and tools are all about.

• Stepping back, how readily will any one school system transform itself into Riel's vision or something like it? Will the Charter school movement provide the necessary push? Or will Charter schools stumble as described in "Charter School's Hopes Collide With Reality (Avenoso, 1995)."

• Will the business community be the impetus? Will the National Information Infrastructure Advisory Committee, along with Messrs. Gore and Clinton provide a vision? Will Richard Riley's leadership for parental involvement and challenge grants to the states provide the platform for change? Will local superintendents and principals pave the way?

It is in this bewildering torrent of complexities that this report addresses practical school networking. A common theme in the literature is that there is no "one blueprint" for school networking. Indeed, even if everyone could agree on Ethernet vs token-ring, or CATV vs T-3 digital TV, the diversity of choices that relate to the specific character of the state, localities, and personalities produces a myriad of different choices for each school and each district.

There is no one right networking answer for all schools and communities. There are, however, a number of guidelines that help schools from making mistakes. We have distilled from the literature and from our surveys and research a snapshot of **do**'s and **don't**s to serve as basic guidelines for school and community technology planners.

Some of these suggestions are fundamental while others are relative. An illustration will help. A fundamental **do** is "standardize." Stick to one type of wire, one type of LAN card, one brand of LAN card, one type of PC, one brand of PC, etc. Resist buying different brands at different times because of changing prices or "close-out" sales. You standardize to reduce inefficiencies when you install equipment, when you maintain equipment, and when you upgrade parts of the system. The few dollars savings on a "deal" is not worth the hours of aggravation when a new "driver" is incompatible with an odd-ball PC. If you are going to encounter a conflict, you want the time to solve the conflict to apply to all of your equipment.

Another **do** is to run more than one wire type when you wire a school. But this **do** is more relative to your circumstances and relative to when you wire. In the distant future one wire will suffice for all wiring needs. This single wire will provide electrical power, telephone service, video service, and digital-network service. Today, however, each of these services have distinct and different wiring requirements. The cost of wiring is mostly the labor. Category 3 wire is 4 cents a foot, category 5 wire is 10 cents a foot, 1 fiber optic cable is 36 cents per foot, and 4 fiber optic cable is $1.02 a foot.

Technical aside: there are many technical guides cited in our bibliography. The prices above are from MilesTek (1995) which is not only a catalogue of wiring products but also contains wiring tips. The choice of wiring relates to the speed of the signal passing through the cable. Category 3 wire is fine for telephone and can often serve for digital data up to 10 Mbps (megabits per second). Category 5 wire is more common for data communications and can be used to about 100 Mbps. Fiber optic cable has an upward limit of 100 Gbps (gigabits per second) (Chapman, 1995, Personal Computer). CATV is often run using coaxial cable RG-59U. Digital data can also be run using RG58A/U or RG58C/U. Sometimes digital data is run over CATV, especially if there is CATV cable already in place. For affordable routers, terminations, and interfaces the common practice today is 10 Mbps using Category 5 wire. While fiber cable, itself, is relatively inexpensive, the hardware required to use its higher bandwidth is not. (SAMS publishers sell a guide *Understanding Fiber Optics* which contains 456 pages on all aspects of fiber optics.)

If you decide that you do want telephone, CATV, and data in the near future and the design of your school requires a high level of labor — say fifteen minutes per foot, at $45 per hour the labor-cost per foot is $11.

In comparison, even 4 fiber optic cable is about 10% of the labor cost. In such as case you would seriously consider running fiber for future use. So running 4 cables at one time is often practical. (You would leave the fiber unterminated as the cost of termination is significant and the technology will improve over time). If, however, you have easily accessible conduits and can leave readily accessible cords to pull fiber through in the future, then you might neglect fiber now. There is also the possibility that high speed transmission cable (such as fiber) will change in the next ten years, but this doesn't appear likely.

Also, one popular approach to wiring schools is with volunteer help. The temptation with volunteer help is to minimize all costs. This can mean that the coordinators are not thinking about multiple wiring needs. From a strict economic standpoint the labor cost is still the dominant cost regardless of how it is provided (volunteer wiring of schools simply is a contribution to the school in lieu of higher school taxes). Thus, rationally, the fullest complement of cables should be pulled. Nonetheless it is somewhat more difficult to pull multiple cables and this additional burden may seem to be to much to ask of volunteers. (Often the volunteers have a "notion" that they are connecting their school to the Internet, and the presence of other cables may feel superfluous.)

Thus the pulling of multiple wires is a relative issue. It depends on many factors particular to each site, decisions about different networking needs, and the source of labor.

Background on Networking

Networking choices for schools, for the many reasons outlined above, are not been made with very clear objectives. Rather, they are largely made by imitating the low-end networking that businesses install. This occurs for three reasons. Many schools work with a local networking company. Such companies have sprung up in every state and region. These companies spend their days networking businesses and have a good idea of what connectivity seems to satisfy their business customers. So the first reason schools put in a certain level of networking comes from the familiarity of these networking companies with "typical installations." (Some of these companies specialize in school networks and have a better sensitivity to school needs.) The second reason schools tend to put in a certain level of networking is a result of the current costs of equipment. A 10 Mbps Ethernet card costs around $30-$40. Anything else costs more. A 100 Mbps card costs a lot more. The same is true for the other components -- cabling, hubs, routers, servers, etc. The third reason is a little more idiosyncratic. Video teleconferencing via CuSeeMe (currently a slowly changing black and white picture that occupies about 1/8 of the screen) is seen as a benchmark for connectivity. If you can't establish one such session, you can't "show off" the network. Anything more doesn't seem important, yet.

Often there is already an existing MIS (Management Information System) network in the district office of a school district. This is most likely a Novell network running an Ethernet LAN (Local Area Network). The purpose of this network is administrative. It is actually the "business end of the school." In many schools there are labs running ILS's (Instructional Learning Systems) and these use their own proprietary networks (Sherry, EPIE Institute, 1990). There are also LAN's which permit schools to provide student computers which run networked software. And there are often small networks in libraries for the purposes of sharing CD-ROM resources.

In our review of K-12 networking we found very little information about how schools are combining and integrating these existing networks. We conducted a survey of members of the Consortium for School Networking, selected networking companies and were able to find very little about integration efforts. Since many of the existing networks run Novell Netware as their networking software we contacted a Novell SE (software engineer) who discussed levels of integration.

✎ Information passing along a digital network is comprised of data packets. A software program communicates to the network card via a driver and/or stack. The format of the packets is dependent on the "protocol." Novell has used IPX for a number of years. The Internet uses TCP/IP. There are other protocols, e.g., DEC uses LAT. There are three popular hardwares associated with networks: Ethernet, token-ring, and arcnet. Ethernet is the most popular.

Token-ring is by IBM and schools that want to standardize to IBM have stayed with token-ring. There are strengths and weaknesses of the three "architectures." Apple supports both Ethernet and localTalk. LocalTalk (also called AppleTalk) is popular because Macintoshes have been "network ready" for over ten years by supporting the LocalTalk protocol which requires no extra hardware to interconnect Macintoshes. Many of the first school networks were achieved using LocalTalk for the price of connectors. LocalTalk, however, is limited to 230.4 Kbps which is about 40 times slower than an Ethernet at 10 Mbps. (LocalTalk is somewhat slower than today's fastest modems at 28.8 Kbps.)

Schools may integrate the different physical networks. Both IPX and TCP/IP packets can run simultaneously on the same Ethernet network. Bridges can be used to go between different network architectures, e.g. a group of Macintoshes can be connected via LocalTalk to a bridge and then onto an Ethernet. For a school administrator to run, say Netscape under Windows, there must be a second stack for TCP/IP in addition to the IPX stack for Netware. Alternatively the administrator can change over from IPX to TCP/IP entirely using Netware IP. For UNIX systems, using Netware for NFS Services, both disk drives and printer transparency can be achieved. One third party vendor, FireFox, makes a product that runs both IPX and TCP/IP as a single stack (saving memory on the DOS machine).

More difficult to integrate are DOS (non-windows) based CD-ROM networks in libraries. McQueen (1990) reports on softwares that can be used to provide telnet access to CD-ROM networks. This permits students at other telnet capable terminals to access these resources either from within school or from home. The number of simultaneous users in this configuration, however, is very limited. As libraries upgrade to servers that can be placed on the Internet the technical problems of remote access become easier. Unfortunately there remain site license problems since vendors of CD-ROM's do not wish the entire Internet to access a disc licensed to one particular library. Today there is no effective way of determining the geographic location of someone on the Internet. While many domains can be matched with a geographical area, domains such as aol.com and compuserve.com can be anywhere in the world. Access must then be confined using registration, ID's and passwords. An alternative is to require that a user have an account on a gateway machine to the resource. This is commonly employed by OCLC for access to their FirstSearch databases. Everyone who has an account on the gateway machine (often a campus wide machine for students and faculty) is site licensed to access FirstSearch.

Copyright and license problems will be an increasingly important factor, and perhaps a major hurdle to affordable school networking (as discussed above).

Networking using TCP/IP can be done quite frugally. Since the protocol has been the subject of research and development both inside and outside of government and universities, there are many pieces of an Internet network available for free or as shareware.

The choice of server is important. UNIX servers are popular because many of the first TCP/IP connections were among UNIX machines. Unfortunately many report that UNIX systems are pesky in terms of administration. The UNIX shell was originally developed with the programmer in mind. As a result UNIX never penetrated into businesses and the same may be true for schools. Nonetheless, there is an excellent public domain UNIX operating system called Linux. Linux is available for both Intel based machines (the ones that often run DOS) and for most other popular machines. (One consultant recommends the Debian distribution of Linux over the Slackware version. The same consultant recommends Cyclades as a low-cost, multi-io card to run with the system.)

Companies including BBN (1995) and Lloyd (1995) have entered the market to provide Internet servers specially designed for schools. Further, Microsoft has announced they are working on a package of software tools to facilitate school and home-school connections based on their NT server (Microsoft, 1995). The software tools will be donated to schools to encourage them to adopt NT servers. Microsoft also donates NT server software to schools.

One of the features of the BBN server is a software component called FrontDoor™ which allows school staff to customize and administer the server without having to access the server's underlying UNIX operating system. "This makes it easy for library and school staff to manage the server — regardless of their technical expertise." (BBN, 1995, Boston Schools)

✎ Unlike other technologies such as photocopy machines, networks are comprised of many separable pieces. These pieces require a common language and infrastructure to interconnect them, usually TCP/IP and Ethernet, but the network can be comprised of many different machines and architectures, even within a school district. While the standardization argument above encourages schools to adopt uniform hardware and softwares across the district there are some good reasons to break with this rule:

1. Administrative systems, such as MIS's will continue to have network capabilities that cannot be attained via Internet tools. For example, client-server tools for accessing record databases may be only available under certain operating systems and servers.

2. Library systems, especially catalogue systems, may be only available under certain operating systems and servers.

3. For economic reasons parts of the network might be either:

A. Earlier DOS-based machines running DOS TCP/IP tools such as NCSA telnet, University of Kansas DosLynx (web browser, Boutell, 1995), University of Minnesota Minuet (graphical web browser, Boutell, 1995, Gonsalez, 1995), or KA9Q, Phil Karn,'s TCP/IP DOS telnet program (Horzepa, 1989, Karns, 1991, Snow, 1995)

B. Yet earlier machines that run public domain/shareware telecommunications software to appear as VT-100's and be connected via serial ports to a local terminal server (note: this is an excellent solution to utilizing early Macintosh machines and Apple II's both within schools and for connecting low-income, have-not, homes with schools) It provides these machines with text-based access to the Internet and their local disk drives can be used to store e-mail and other materials for students to work on with word processing tools that run on the particular machine. In particular, we have identified the Coker Terminal Server software which can connect these machines to an OS/2 server (OS/2 is an excellent multi-tasking operating system that can run on a low-cost 386 or better PC). The OS/2 server then connects the terminals to a Linux Server with Internet access. The terminal server software is priced (including educational discount) as follows:

| Number of Lines | Price (U.S. dollars) |
|---|---|
| 4 | $60 |
| 8 | $105 |
| 16 | $150 |
| 32 | $260 |

Thus it would cost $8 per VT-100 machine to provide an Internet lab of 32 machines. Availability Russell John Coker, rjc@snoopy.apana.org.au. (per e-mail, Priest, 1/7/96) A single copy of OS/2 for the server, at an educational discount, is $72. Linux is shareware.

4. Inclusion of a Community BBS system to enhance home-school connectivity. To date the features of a BBS software such as Major One by Galacticomm provides a better environment for community activities. These BBS's have been refined over a decade to provide features including forums and local chat. Nonetheless features of the Internet are able to capture some of the flavor of a BBS by using local newsgroups (and a news reader), IRC (chat), and interactive web pages (forums). Even major online services such as AOL (Internet World, 1995) are conducting surveys to understand how they can provide a more "local presence" to their users.

One major community BBS system, the National Public Telecomputing Network (NPTN, 1994) Free-Nets, has been described as "fraying" (Toronto Star, 1995). With 50,000 active users the Cleveland Free-Net's 75 public phone lines are "jammed day and night." "Those who do get through often just use it as a local-call access to Free-Nets in Buffalo or Tallahassee that are easier to use and have more features. And many have abandoned it in favor of the growing commercial on-line Internet services. (Toronto Star, 1995)"

Fundamentally we are witnessing a struggle between maintaining a sense of local community and the lure of "virtual communities" on the Internet. The LINCT Coalition (Komoski, 1995, LINCT) encourages local community building efforts around a local BBS. The LINCT program includes volunteerism and encourages low-income families to earn donated computers by learning to use them and by volunteering to help others in the community. An adaptation of the Time Dollar system (Burdick, 1994 and Cahn, 1994) called Community Service Credits is made an integral part of the BBS. For one hour of volunteer work anyone can earn 1 CSC Credit. LINCT is currently studying how its goals can be achieved using Internet based tools to simulate the look and feel of a local BBS.

As discussed further in Section Five, the features of BBS's are becoming more attainable using Internet tools. We anticipate that within the next couple of years the sense and feel of a BBS will be achieved using Internet machines, causing many BBS's to become variant Internet servers. We are witnessing this transformation with Galacticomm's Major One BBS. Thus our advice is for schools and communities to work with and link to **existing** BBS's. For new efforts we suggest working with Internet tools as described in Section Five.

5. High School or community-center Computer Shop activities that permit students to build "toaster nets" out of most any machines the shop can obtain. (Barry Kort describes the building of toaster nets — a collection of surplus machines tied together using public domain software — at the end of this Section.) Recalling high school car shops and A/V (audio-visual) clubs in schools, some schools are offering a place where students can learn to take computers apart and put them back together as part of a local network. With the availability of LINUX, the computer shop can take many common computers from IBM PC's to DEC workstations and put environments on them such as MOO (Multidimensional Object Orientations). A MOO permits the creation of a virtual place which can include features of a game, such as Dungeons and Dragons, or of a learning environment with virtual classrooms, virtual slide projectors, and places for students to assemble with online teachers. We suggest that one potential contribution of the U.S. Tech Corps could be to help establish and advise such Computer Shops in schools and community centers.

Authentic learning with computers involves the hands-on experience that a computer shop provides a student. It is this kind of experience that will produce the next generation of engineers that this country needs if it is to compete the global marketplace.

Working with donated computers and public domain softwares, students can learn to "hack." While the word hacker has gained some negative connotation through association with unauthorized computer use, in the computer world, being called a "computer hacker" is a compliment. The computer hacker goes beneath the surface of the computer and gets to know it at its various levels of software interfaces. The imagination of a hacker should be recognized as a tribute to the inquiring mind that is able to breach supposedly impenetrable software walls. (School administrators will be pleased to know that they can erect "firewalls" to sensitive records, preventing breaches. More anxious administrators can insist on keeping administrative record systems (and their networks) physically disconnected from other school networks and the Internet.)

Networking Models

Several studies have used "networking models" to help schools and policy-makers make decisions about different "levels" of networking. The seminal work was by Newman (1992, Models) at BBN. In his report Newman sketches out the various ways in which schools were providing connectivity including phone lines, local area networks, and various forms of Internet connectivity. While 1992 was not long ago, the ways schools can achieve Internet connectivity have changed dramatically. In the late 80's and early 90's it was common for schools to connect through a university. But in the last couple of years various Internet providers have offered affordable connections to both institutions and homes.

In 1994, Warner (1994) and others developed a most useful extension of Newman's work addressing the school decisionmaker. One section shows an overview of connection models features and benefits, and other sections show how to extend existing networks to enhanced networks.

Also in 1994, Rothstein (1995) took Newman's models and extracted five "cost models of K-12 Networking." These were:

- Single PC in each schools, with modems (14.4), dial-up model, district office with file server and 56 Kbps line to the Internet
- School with LAN and shared modem (14.4) to district office with file server, LAN, Router, and 56 Kbps line to the Internet
- School with LAN, Router, and 56 Kbps line to the district office, and district office with file server, LAN, router, and 56 Kbps line to the Internet
- School with LAN, file server, router and 56 Kbps line to the district office, and district office with file server, LAN, router and 1.5 Mbps (T-1) connection to the Internet
- School with LAN, file server, router and 1.5 Mbps (T-1) connection to the district office, and district office with file server, LAN, router, and 1.5 Mbps (T-1) connection to the Internet

Rothstein computed a low and high cost of establishing and maintaining each model for the all public schools expressed as a total and as a cost per student. For the last model the total U.S. one-time cost ranged from $51 billion to $113 billion, and the annual costs ranged from $4 billion to $10 billion.

In 1995, McKinsey used an alternative "model of infrastructure deployment." They describe 4 models:

- Single room school Lab with 25 computers, Ethernet LAN in the lab and 10 telephone lines
- The above plus a computer and modem per teacher
- Partial Classroom model where half the classrooms have 1 computer per 5 students, Ethernet LAN across and within all classrooms, and a T-1 connection (1.5 Mbps)
- Classroom model with all above plus in all classrooms 1 computer per 5 students

The total U.S. cost for the last model is $47 billion with an annual maintenance/operating cost of $14 billion.

McKinsey also presents the costs as a percentage of K-12 spending in a year. This is expressed as a percentage of "Public K-12 Spending in the Final Year." They take the deployment period (5 years for the first 3 models, and 10 years for the last), annualize the capital expenditures, and add the operating/maintenance expense in the last year. Since the operating expenses are highest in the last year of deployment, this figure represents a peak annual budget load. For the 4 models, this percentage is 1.5, 3.0, 3.4, and 3.9 respectively. Also, the average total cost of the fourth model, per school, is shown as

$555,000 with an average annual cost of $165,000, and the average total cost of the fourth model, per student, is shown as $965 with an average annual cost of $275.

## Missing from these Models

Implicit in these models is a series of machines that are connected to the Internet. What these models do not show is any relationship to other forms of teaching resources be they video tape, educational software program, or local access to DVD CD-ROM material.

There is the sense that whatever is provided via the network will come via telecommunications and from the outside.

We question this assumption for the following reasons:

➾ One of the "benefits" expressed about the Internet is that it is always changing — there is always new information. We question whether teachers want their curriculum materials to be "always changing" on them. While exploring the Internet can be a facet of education, teachers and learners will also require resources that are more like books — stable, organized, and reliably available.

➾ As mentioned above, we are on verge of a dramatic increase in the local storage of digital materials — the 9/18 gigabyte DVD CD-ROM. Ten of these disks (at an estimated production cost of $1.00 each) will contain most of the materials residing on the Internet that any teacher may wish to use. The players for these disks are priced around $500 in the first year of production. A $700 carousel player containing 100 such disks would provide access to 1,800 gigabytes of material. At 30K bytes per jpeg image, this could contain 1,600,000,000 images. If a teacher decided to selectively view 1/10th of all these images for 1 minute each the task would take 270,000 hours looking at images or or almost 200 years based on a standard school day.

There would be enough space for text material to keep students reading for centuries. Only as we might wish to provide full motion video does this archive start to look small. But even for all the video resources one school might require this mechanism may be the most cost-effective over the next decade.

➾ Steven Hodas and Gary Warren of NASA have demonstrated (Hodas & Warren, 1995) their HorizonNet system for lower-cost school and community networking in which they place a large caching disk on the Internet server. In the Yorktown Elementary School Demonstration the cache fulfilled 92% of the information requests by students without reaccessing the Internet. This greatly reduced the need for high-speed Internet access.

➾ If we combine the CD-ROM technology above with the NASA caching system the resulting load on the Internet by all U.S. schools and libraries would be almost nil. A DVD archive could be established to respond to the same URL codes constructed as Universal Resource Locators. Thus, instead of using megabytes of telecommunications resources to access NASA photographs, the photographs would be pulled from the DVD archive. Already there is software that scans popular sites and alerts users to updated materials. This same software would ensure that any recent additions to a site would be recognized and provided via the Internet. (Already very popular sites on the Internet must be "mirrored" because of congestion. DVD archives would simply extend the concept of "mirroring" to the district level.)

## EPIE Institute/CITS Networking Model of Resource Access

In developing the following resource access model we draw from the insights of Larry Cuban (1995) and Margaret Riel (1995) presented at the Office of Technology Assessment Technology Futures Workshop (Fulton, Futures, 1995).

Cuban observed that elementary school teaching is much different than high school teaching. He notes that in many ways high school teaching is modelled on college teaching. He further comments that people aren't running about asking why there are not computers in college classrooms!

The common pedagogy of high school, as of college, revolves about an ongoing exchange of knowledge, ideas and questions between teacher and students. The technologies that fit that culture are those that provide the teacher with the ability to illustrate, present, and explain content.

In contrast, elementary school activities tend to be more fluid and students often break into groups for various activities. Cuban, thus, suggests that the exploratory aspects of network computing will be assimilated in elementary schools and rejected in high schools. Depending on teaching styles of individual teachers, middle schools will tend one way or the other.

Consequently we see educational technology dividing into two broad categories:

> ➾ High-end presentation machines that can draw on networked educational software, CD-ROM, and the Internet in conducting teacher/class interactive presentations. The computer would have both high capacity CD-ROM player, access to a local area network and school CD-ROM/Video archive, access to the Internet, and high-quality projection capabilities (Color LCD projectors or large high definition monitors).

> ➾ Exploration machines. Ideally these should be high-end PC's, but, depending on a schools budget, these could be donated older machines with text web browsers, or the forthcoming HollowPC (new, low cost machines primarily intended for looking at materials on networks). These machines would have wordprocessing capabilities, etc., but no disk drives — all materials would be stored more economically and safely on the server. ("Oracle plans to ship its first Internet PC in March: Oracle Corp. is putting the finishing touches on its first Internet PC, which it says will ship in March, and is working with Acorn Computer Group on a second version. The new device will meet the $500 price goal, but will come without a monitor. Instead, consumers will use cable to hook it up to their television sets or PCs. The manufacturing cost, according to Oracle's VP of network computing, is under $200 — $100 for four megabytes of RAM, $30 for an ARM 7500 microprocessor, and the rest for the keyboard, mouse and network connections (Wall Street Journal, Jan. 11, 1996, p. B2).)

In most school districts (given Cuban's analysis) we would expect to find the high-end, presentation machines most frequently opted for by teachers in high school with exploration machines either outside the classroom — in convenient areas where students could access them and/or at home where they have the time to make use of them.

We would also find the exploration machines in the classrooms of elementary schools where students would be engaged in multiple activities using them, either alone or in groups. The teacher would move about more as a coach and guide as in the scenarios described by Margaret Riel (1995).

Further, we expect that facilities such as SmartSystem (Dukane, 1995) will flourish in proportion to the relative costs of providing resources, physically, in the classroom, via media server within the school or school district, and via the Internet. SmartSystem involves a high quality monitor in the classroom with a remote-control; the materials being called upon are located at a central room and the facilities include VCR tape machines, CD-ROM's, and other media players. In this era, the video material is still provided via coaxial cable using analog CATV. In the next decade we see those installations giving way to digital high-definition monitors and video digital data transport.

> ✎ While most of college/university teaching occurs as Cuban describes, there are various "distance learning" approaches that have succeeded. Some are conducted "asynchronously" using various computer teleconferencing softwares. Others use video links with audio return links. Another successful approach has been by Athena University (described above) where a "virtual classroom" is created using the MOO environment tool. MOO enhancements can provide the user with a "graphical appearing" classroom environment where a class room appears on the

screen and the members of the class "appear" on the computer screen. A related use of computers in a "teacher centric" classroom is a system by Discourse Technologies (Discourse, 1995). Students are given small LCD display keyboards at their desks and the teacher has a computer monitor that shows what each student is typing on a single line of the monitor — one line per student. The teacher can glance across the rows and know how active each student is and what they are "saying." [A video tape is available called "Teachers See the Difference Not the Technology."]

What is the relationship of these systems to both high school and college/university teaching? Will "virtual universities" put traditional universities out of business? The answer is not clear. We do know that many colleges and universities are scrambling to improve their "distance learning" capabilities.]

In Addition

We also see an increasing use of telephone networks both within schools and between schools and homes. In our review of practical networks — actually in use — we found many schools opting for telephone and voice-mail systems. In a U.S. Department of Education funded study, Priest (1973) found that lower income parents in Albuquerque, NM had as their highest goals for their high school children, better communication among teachers, students and themselves. In the Benefits Section (IV) of this report we examine three dimensions of the effectiveness of networks. While voice-telephone does not provide a conduit for learning resources, it rates highly along an inspirational (affective) dimension and a discipline/monitoring dimension (see, further, Section Four).

With voice-mail, teachers are better able to receive and send messages both within the school and outside. The literature is filled with disparaging remarks about the lack of telephones in classrooms, describing teachers waiting in line for pay telephones with students.

The potential trade offs and complementarities between voice-mail and e-mail systems is still unknown (an e-mail network provides better access to learning resources). While some parents have regular access to e-mail through their work or through online services, most do not. A recent Rand study (Anderson, 1995) recommends universal e-mail access. Telephones are a convenient device; requiring little time to access and use. In contrast, computers have start-up time, connection time, etc. While services such as ISDN promise connection times of less than a second, the rates by the Baby Bells have been too high for all but the most serious Internet user (e.g. USWest proposed flat rate ISDN residential service of $184/month, tap-info@essential.org, 12/27/95, see rates below).

Community Expanded Model

Figure A illustrates one of many possible community-expanded models. Within this model, the school networks are part of a larger set of networks serving the community. In this illustration, the base of the community server is in a local library. In other communities it could be an extension of the school server or an extension of an online service providing "local presence."

When we recognize that government services, including social services, are intimately entwined with families and schools, the possibilities for using a local community network to strengthen the community's overall "learning ecology" is enormous. Networking promises to bring parents, teachers, children, and social services together in responsive and responsible ways not before achievable (Niebuhr, 1994). Cook (1995), however, warns us of how the government services of Washington State have taken on a darker side as services become intrusive rather than helpful. Clearly technology cannot be simply applied without an underlying model of conduct that respects privacy, acts responsibly, and actually increases the well-being of the community.

One promising approach promoted by the LINCT Coalition (described above) rewards members of the community for helping others. When a community is comprised of active, involved, concerned citizens, the responsive, responsible community model becomes far more achievable.

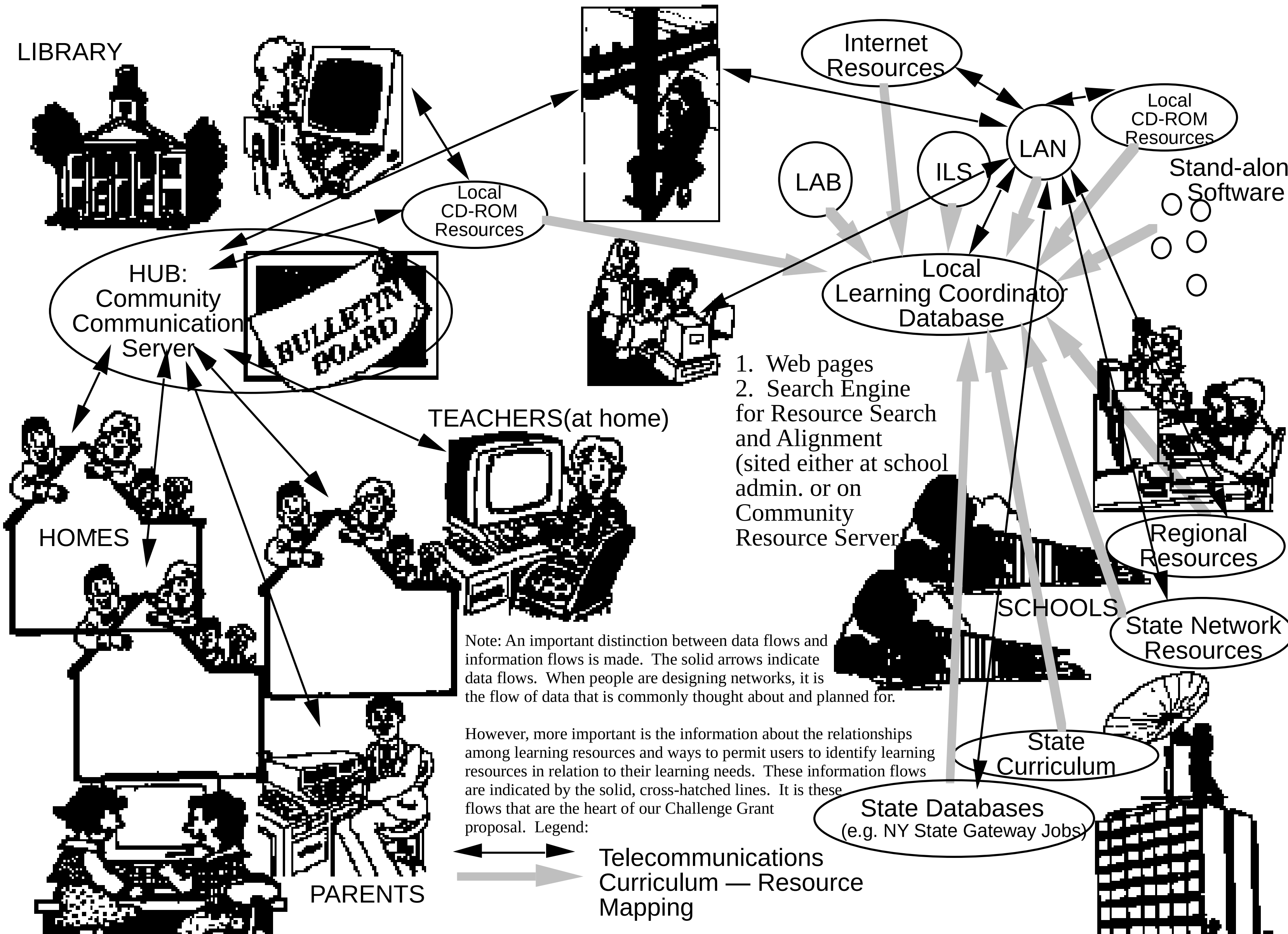


FIGURE A: GUIDING INFRASTRUCTURE MODEL

## **Do**'s and **Don't**s of School Networking — Tips

By this point it should be clear that the do's and don'ts relate to any number of different models of networking. Thus these guidelines imply value judgements as well as network configurations.

Some of the tips found in the literature are conflicting. For example, some practitioners have found e-mail to pen pals to provide a way of introducing students to the Internet. Others disparage pen pal e-mails as ineffectual and too unstructured to be helpful. Actually, there are elements of truth in both positions.

The tips are organized alphabetically by keyword. The bibliography of this report has nearly 4,000 keywords assigned to 670 references. [A future EPIE/CITS activity is to make these references available for web browsing by keyword.]

The tips fall into 6 categories and are labeled: ✿ *Project* ✉ *Hardware* ❋ *Software* ☚ *Administration* ⌘ *Environment* ✯ *Resources.* We provide these categories as a legend in the footer of this part of the report. Project (✿) related tips pertain to organizing and maintaining network conversations or communications. They are often "collaborative projects." Hardware (✉) and software (❋) tips address the mechanics of networking. Tips regarding how to organize people or what people need to be organized fall under Administration (☚). Tips relating to the atmosphere or ambience are labeled Environment(⌘). Finally, connections to learning resources are labeled Resources(✯).

✿ (Do have an) Active Curator (Bull, 1994, p. 241)

In the area of computer teleconferencing and forums, active participation depends on a facilitator or "curator."

"Research indicates that is not simply the organizational structure of the menu but the presence of an active curator that results in active use of instructional resources." "The curator can identify and bring resources to the forum and provide suggestions and ideas for ways of integrating these resources into the ongoing curriculum."

Lesson: In constructing any forum-like discussion for learning, be prepared to have an alert, talented individual massage content, prompt members (of the forum) for responses, and ensure that the discussion does not ramble.

✉❋ (Use) Adequate State-of-the-Art Hardware and Software (Addessio, 1994)

Many uses of the computer are more user-friendly as hardware has advanced and software has taken advantage of those advances, such as in graphical interfaces.

We provide two caveats. This statement came from a project where the Los Alamos National Laboratory put technology into the Los Alamos Middle School. In such projects a school may become the recipient of a level of technology that it would otherwise not be able to afford, thus providing an unrealistic, non-scaleable situation. Second, we note the advances, described above, in making older machines into exploration machines. (The exploration machines may be used to explore the CD-ROM carousel, the cached Internet materials, or the Internet directly, as described above.)

Lesson: It may seem that there is an endless progression of computer improvements and software advances. According to "Moore's Law," the density of computer chips quadruples every three years. This is expected to continue until the year 2000 (Kozma, 1995, p. 20). Meindl's projections are less optimistic, with the density of chips growing at 20 to 35 per cent through the year 2111 (Kozoma, 1995, p. 20).

Computers even today are overpowered for most of their uses such as e-mail or wordprocessing. Only in areas such as complex graphics and artificial intelligence are even today's machines inadequate.

If the price difference is relatively small, always buy the more "powerful" machine. Someone will eventually develop an application to push it to its limit. However, 32 bit machines with 8-12 megabytes of memory will meet many needs for a good while. Even in the past when "price was no object" there was seldom built a machine past 64 bits.

✎ A 32 bit machine means that the arithmetic registers and, usually, the bus (connections) to the processor are comprised of 32 parallel bits. The width of the registers determines the complexity of instructions that can be performed and the width of the bus determines the speed at which data bits can enter and leave the processor. The IBM XT was was an 8 bit processor with a 16 bit bus. The Apple II was an 8 bit processor and 8 bit bus. Most machines today are 32 bits except DEC's Alpha and some of the new game computers for kids (64 bits).

Lesson: Buy the most powerful machines you can afford unless you are certain their use will not require that power. Remember, even the earliest PC is more than adequate for word processing and as an exploration machine. (For example, this section is being written on a 16 bit Macintosh built in 1984. With Versaterm's Versatilities program (priced at $40 for educational buyers) this machine is connected to the Internet running telnet as the client. With telnet any text-based Internet tool from a server can be operated including a text web browser, [Synergy Software, 1995]. In conversation with Paul Reese (a pioneer with Macintoshes in the classroom, COSN List, 1/11/96) we learned that he is using Mac Plus computers running System 6.5 which will run Mac TCP providing the full range of Internet tools including Eudora mail and Mosaic web browser (there are many Macs that cannot be upgraded to System 7 out of memory limitations). Reese uses a TribeStar bridge to interconnect the LocalTalk network with an Ethernet network. He also uses LCIII on the LocalTalk part of the network which run Netscape. "The Tribestar was designed to break a localTalk network into 8 separate sections and therefore reduce packet collisions. It works very well doing that but has also worked nicely giving TCP to my older computers. It is a nice way to speed up a LocalTalk network without having to invest in Ethertalk cards and wiring." (Mac TCP is not shareware and many introductory kits provide a copy in the $20-$30 range.)

Comparable telnet capabilities can be achieved on even an 8 bit DOS machine by running Columbia Kermit (shareware) which provides the machine, again, with telnet capabilities using a $30 Ethernet card on the machine [da Cruz, 1995]. And full graphical web browsing can be achieved on the 8 bit DOS machine using Minuet (shareware) [Gonzales, 1995]).

✿ (Be sensitive to) Adjust the Pace (Kimball, 1995)

This pertains to an electronic conference or forum (as above).

When students participate in a conference at different frequencies, they can become lost if material appears to go by too fast. "One way to even out the 'rolling present' is to provide cues that let participants know which items are hot and active. You can put this information in an information file or in the first conference message, or you can send out periodic e-mail updates (p. 56)."

Lesson: Asynchronous communication (the ability for people to access an on-going discussion at different times) is useful but can lose members who get out of "synch." One activity of the facilitator is to help stragglers rejoin the discussion.

☛ (Gain) Administration Involvement (Lipman, 1994)

A lone, dedicated teacher can only do so much without a committed administration and a source of funds. School-wide systems must have the full backing of the school administration (and the school board).

Lesson:  Each school and school district is comprised of a unique set of actors.  While there may be consensus about the networking plan or changes needed in a current plan, there it may be necessary to shuffle staff or to hire someone from the outside to get things rolling.

⌘ (Provide) Ample Time (Peha, 1995)

As the National Education Commission on Time & Learning (Kane, 1994) emphatically notes, schools run short on time.  Yet networking projects require time for orientation and time to carry on.

Lesson:  Embark on a student networking project only if you can provide ample time for it to succeed.

⌘ Be Organized (Walker, 1995)

"Make a flow chart so students can see how the parts relate to the whole and so they can understand how their contributions fit in.  For example, in our weather project, students took daily instrument readings. Then, using spreadsheets, they created forecasts to produce long range studies...(p. 32)"

Lesson:  The Internet is an interesting place to explore but as the teacher tries to put an Internet project in the context of the curriculum, the relationship of the Internet activities to a workplan is essential.

⌘ Be Realistic (Walker, 1995)

"In planning an effective Internet project, it's important to keep your feet on the ground.  That is why we chose Grade 6 meteorology as the basis for our project.  It offered the potential to do real hands-on field scientific observation.  Yet, it did not require expensive instruments. (p. 32)"

Lesson:  It is one thing to find data on the Internet and another to incorporate it into a project that requires that students accomplish tasks to learn something.

✿ Brainstorm Your Project (Walker, 1995)

Lesson: In running an Internet-based project engage others in the school such as the librarian and a vice principal to think through the project, break it into manageable sub tasks, and provide a showcase (a "Weather Wall" for the library) for the results (p. 32).

✉ Build New Schools with Networking in Mind (Bryne, 1990)

Lesson:  While existing schools can be very difficult to wire or provide electrical power for computers, there is no excuse for a new building to lack adequate conduits, wall plates, and electrical outlets.  (And as discussed above, run cable for telephone, CATV, category 5 wiring, and fiber for the future).

✉ Cable Plant Standardization (West Ottawa, 1991)

New buildings are not the only places to concentrate cable standardization efforts.  "Standard raceways of cable trays in the halls and conduits to each room must be installed during the construction to facilitate installation, maintenance and evolution of the communications cable plant in the schools."  "Cabling designed to carry voice, data and video communications must be installed to every room.  Additionally, four strands of fiber optic cable will be installed to each room for future use.(p. 9)"

"Currently fiber optics provides a cost effective solution for building-to-building communications and backbone installations in larger facilities.  For this reason, the fiber to the room in each school won't be used except in a few select cases but it will be available for the future as the cost of the electronics continues to come down.  In the larger facilities, such as the high school and the middle school, fiber will be used in the backbone networks in those buildings. (p. 9)"

Lesson: As shown above, the labor component of cabling is the dominant cost. Wire for the future.

✯ (Use) CD-ROM's for Research (Guerette, 1994)

As suggested elsewhere, CD-ROM's as learning resources will be a vital way for schools to provide students with tools for research. In this reference "New Brunswick Leads in Network Technology," the district has implemented advanced uses of CD-ROM's.

Lesson: Reduce reliance on telecommunications and improve stability of resources by using CD-ROM based resources.

⌘ (Use) CD-ROM to Maintain Acceptable Use (EPIE/CITS)

The new DVD CD-ROM not only has the capacity to hold all school-relevant text and image resources from the Internet but it also passes through an editorial stage where content is carefully chosen.

Lesson: Our first amendment for free speech is likely to make the Internet contain more materials than individual parents or school systems will want to provide access to. While there are software approaches to "blocking" specific information, these approaches are difficult to implement. The DVD will provide the ability to chose content, provide stability in retrieval, and reduce telecommunication costs.

✉ (Use) Central Pool of Modems for Home Connections (California Guide, 1994)

The California Guide is one of the most comprehensive compendiums of information for K-12 networking.

Lesson: Maintaining dial-up connections is expensive and requires effort. The California Guide recommends placing dial-up connections for home access in a central pool. (As an alternative the school might consider buying a block of accounts from an Internet Provider.)

⌘ (Recognize that) Change Takes Time (Carlitz, 1994)

Section IV describes how much of teacher training is, in actuality, a process of changing modes of instruction. From the perspective of introducing networking, this process change takes time.

Lesson: Introducing networking has more to do with changing how teachers teach, than it has to do with learning to use a technology. It is for this reason that studies find the dominant "costs" of introducing a network relate to "professional development" rather than the costs of the physical network. Whether these should be called "costs" is discussed in Section IV.

☛ (Networking is actually) Changing Teacher Practice (Means, 1995)

One of the most comprehensive reports about the relationship between technology and change is *Technology's Role in Education Reform* sponsored the Office of Educational Research and Improvement (OERI).

"Placing technology in classrooms does not ensure that it will get used appropriately, or even that it will get used at all. Many of use have visited classrooms with one or two computers in the back covered with a plastic cover that is rarely removed. The reformer's vision of project-center classrooms with students using technology tools makes extensive demands on teachers. Teachers are expected to orchestrate a classroom in which students pursue different questions, work at different speeds, use different materials, and work in flexible groups. Students will be working with original data sources, often pushing beyond the limits of the teacher's knowledge, and learning to work together to produce products that demonstrate what they have learned. All of this must be carefully planned and supported by a teacher in such a way that the students take ownership of their projects and feel responsible for their own learning, while at the same time ensuring that the essential content in local, state, or national curriculum standards in multiple areas are met and that students will perform well on whatever high-stakes assessments are to be given. There is no doubt that the reform agenda calls for fundamental changes in teaching practices on the part of most teachers. In some ways, the introduction of technology only adds another level of complication to what is already a daunting task. How does a school get all or almost all of its teachers on board, particularly when many of those teachers have little experience with technology? (p. 66)"

Lesson: There are two basic ways people are proceeding, in accord with the EPIE/CITS model described above. If networking tools are simple extensions of the traditional practice of teaching, little change is asked of the teacher and the technology will be adopted as each teacher sees its utility for traditional classroom teaching. In contrast, if the exploratory model is emphasized, significant changes in teacher practices must occur. This will require such a fundamental change in the practice of teaching that chaos and uncertainty may fill many teacher's lives to accommodate the change.

✎ The above reform report lists five precursors for "success" in achieving technology-based education reform at a schoolwide perspective (Means, 1995, pp. 165-166):

➾ Time devoted to developing a schoolwide vision. A consensus around instructional goals, and a shared philosophy concerning the kinds of technology-supported activities that would support those goals. Such consensus takes time to achieve, and although it requires instructional leadership, it also requires the active involvement of teachers. Site-based management and grant opportunities appeared to serve as catalysts for such discussions.

➾ Adequate technology access for all students. To the extent that there are only a few computers in regular classrooms or computers are clustered in a few labs in one part of the school, most teachers have little opportunity to integrate technology into their instruction and indeed feel little responsibility for doing so.

➾ Time for teachers to learn to use technology and to incorporate it into their own curricular goals. Particularly after the first initial hurdles, learning to use a new piece of hardware or software in a mechanical sense is a fairly short-term activity and can be accomplished through the typical in-service session. Thinking about how technology can support one's own instructional goals, however, and learning how to orchestrate a class in which students are doing challenging projects, portions of which are technology based, take much longer. These kinds of learning need to occur over time, preferably with opportunities to observe models, to practice, and to receive feedback on one's section.

➾ Easily accessible technical support. Most schools have a few teachers who are comfortable with technology and able to do much of their own troubleshooting. But most teachers have limited experience in this area, even if they are comfortable using a technology they have not completely mastered in front of their students, these teachers will not be willing to plan around technology use if there is a good chance they will encounter technical problems that they cannot get fixed for days or weeks.

➾ Rewards and recognition for exemplary technology-supported activities. Like the rest of us, teachers are influenced by the reward structure around them when it comes to deciding where to place their energies. Not surprisingly, school leadership that values technology and education reform activities was associated with more widespread and sustained emphasis in these areas.

The same report also associates "success" within schools to (pp. 166-168):

➾ Good curricular content. Although in some cases the availability of new technology inspired a project (e.g., the production of multimedia materials about local leaders), in all cases the most fully developed projects had strong curriculum content and many components that were not technology based.

➾ A structure within which teachers can innovate. Many of the early technology enthusiasts dreamed of a "teacher-proof" system embodying sound principles of teaching and learning and engaging students directly without the interference of a teacher whose knowledge base might be incomplete or whose pedagogy might be faulty. Studies of classroom implementations of technology have demonstrated that this goal was not only unrealistic but wrong-headed. Teachers can subvert practically any kind of instructional material to their own goals and ways of teaching. Thus, in newer conceptions, the teacher is an essential part of the instructional application of technology.

➾ Opportunity for teachers to collaborate with peers. Just as the difficulty of what we are asking teachers to do in moving to project-centered instruction implies an advantage for building on existing curriculum structure, it also suggests that the support teachers can get from collaboration with their peers will be important.

➾ Teachers and students already comfortable with project-based learning. Bringing technology into a classroom and implementing student-centered projects is much easier if the teacher and students are not trying to learn about a new technology at the same time they are struggling with new roles and new structures for organizing classroom activities.

➾ Use of technology across subject matters and classrooms. There is a certain amount of "overhead" that goes with learning to use any new technology. Students need to acquire keyboarding skills and learn how to get into programs and files and to store their work in appropriate ways. Passwords and Internet search skills require a certain amount of knowledge that has nothing to do with most curricula and is unlikely to carry directly over into adult settings for any but perhaps senior high school students because of rapid changes in technology. Given this reality, the more classes and grades over which this "technology overhead" can be spread, the better. Teachers in schools that use technology throughout the school find it easier to use technology because they do not have to teach all the technology skills themselves. Moreover, when technology is used across a broad range of classes, many more students find enjoyable uses and feel confident about their ability to learn new technology applications. [EPIE/CITS comment: Many arguments are made for introducing technology in schools to provide vocational skills. The author of this item clearly believes that technology is changing at such a rate that only imminent graduates will benefit from this exposure.]

⌘✯ (Integrate a) Community BBS (Priest & Komoski, 1995)

As the expanded EPIE/CITS model suggests, schools are but one facet of the resource and communication base for students and parents.

Across the country are many community networking projects. Some of these are funded by the Corporation for Public Broadcasting and their CWEIS program; others are funded under the Department of Commerce's TIIAP program; many others are self-funded (see, for example, discussion of NPTN above). A study of 80 community projects that included schools in their list of activities (Priest, 1995, Community Networking Survey) showed that very few were successfully integrating their activities with public schools. This is be partly because the community networking movement has preceded the use of networking within and for schools.

✎ Fifteen of the eighty community networks responded to our community survey. We asked respondents to describe how schools were involved in their projects, cost-effective steps to keep the costs down or make the process work better, relationships to outside partners and grant resources, the role of training, and what advice the respondent had "in making school/home and school networking happen in the next five years." (Many projects didn't even have e-mail, indicating that networks were not yet in place in at many sites.)

Many of the respondents were receiving funding from sources such as TIIAP but expected activities to continue beyond the funding duration. Charlotte's Web of North Carolina has been one of the more successful community networks in involving the schools. "The school system hired a trainer with part of their NTIA grant money. They will retain her with school funds. this trainer is running workshops for teachers, creating training "masters" at each school site to manage the training needs for each school. The training has been done in a series of week-long workshops the teachers and media specialists attended during the summer. (for public training, we do twice a month HTML training and once a month unix file manager training. Each unix session is two hours long with the class limited to 10. Each HTML session is limited to 10 and lasts an hour. (lines 295-302)"

For school involvement, "The school systems had developed its own World Wide Web pages accessible through Charlotte's Web (see http://www.charweb.org/project/cms). These pages contain information about the schools for the community at large and teachers: calendars, background reports, a 'Parent Center,' lesson plans, access to the curriculum Research Center's library catalog, etc. (lines 1632-1644)"

Advice from Charlotte's Web is "Be willing to start small and scale up. Whatever you do -- DO something. Don't wait for final approval of a technology plan, a budget or PTA support. Just get started and build from there. Plan carefully but know you must be willing to change the plans radically. The technology is evolving rapidly; better equipment is becoming cheaper all the time. Be willing to address sensitive content issues up front -- bring them up and get parental and administrative support in the beginning. (lines 321-330)" In summary, "a community network is a distributed network - the work of building it is shared by many institutions, agencies and individuals. A special breed of volunteers seem to be attracted to this type of project and are willing to contribute their time and talents...'It takes a whole village to raise a child' ... the school's can't do the job alone. (line 1721)"

In contrast, The Iowa State University of Science and Technology (also TIIAP recipients) is developing information materials. Schools in Iowa are connected either by private providers (often Iowa Network Services, a cooperative of local independent phone companies) or through the State of Iowa's Communications Network (a state-developed fiber optic communications backbone for education and public development). "We are providing an information resource to educators and public planners. At this stage we are not providing an educational program. We have recently received $50,000 to begin building community analysis modules to be linked with the information resource, providing education on demand to individuals and groups that want to engage in public analysis activities on a local basis. This development is just barely getting underway. (lines 510-515)"

Efforts in Los Angeles are held back by access to the same systems. "The main deterrent to more active participation is the fact that relatively few members of the school community have LA Free-Net accounts and only a few classrooms have an Internet connection. From home, only those students and staff who have computers and modems can participate. (Lines 760-765). Within those confines, "each participant school has a menu area designed by and administered by staff members of the school itself. Characteristically there are menu areas for the Administration, for curriculum, for parents/community, and for students. Each of these menu areas contain at least one interactive discussion area for public dialog as well as for announcements. (lines 753-758)"

At the Greater Columbus, Ohio, Free-Net there are several school related projects. 1.) "Each school system has an area where it posts public information such as telephone numbers, activities, schedules, general descriptions, newsletters, etc. In a few districts, teachers post things about their specific classes. 2. Several teachers use the Free-Net to sponsor special, electronic projects for their students, and 3.) There are several joint curriculum based projects with a couple of specific schools aimed at integrating technology into an interdisciplinary curriculum. (lines 987-997)" Their suggestion for the next five years, "The schools should try to form consortia across district and municipal lines to handle a central modem pool and centralized services for students in a municipal system. Otherwise, everyone will need to make parallel investments in equipment and staff that are very inefficient. There are economies of scale and scope in creating shared systems. (lines 1084-1088)"

At a library based effort in Lexington, VA, another TIIAP funded effort is only beginning. Their response is like a number of groups contacted in that they have identified target audiences (in this case libraries, schools and local government) but specific plans or activities have not begun. At a Green Valley High School effort in NV, teachers and students use Internet connections and the school district's FirstClass Internet program — but dial-up access from homes is not available and they hope to receive another grant for that (lines 1334-1338). A Greater Knoxville Community Network (KNET) is also only beginning. "As KNET develops, we envision Knox County Schools publishing up-to-date information and announcements within the menu items for citizens to easily access. Some mentoring between teachers and University of Tennessee staff is already occurring. (line 2005)"

Project COnNECT, Denver, CO Free-Net, had plans for 3 educational components, "1.) mathenet - an online tutorial for students to post questions and receive replies from student/teacher volunteers, 2.) electronic study groups - students throughout the state would engage in online workgroups to discuss calculus, geometry, and 3.) school health - establish an online site of adolescent health info, with nursing students responding to students' questions." Yet "the first two of these planned projects were never created due to lack of involvement of the education partners. The third, school health, is in the process of being established. (lines 1482-1497)." Instead, "a more general and modest math and science online resource was established using the gopher/Free-Port platform of Denver Free-Net and the www capabilities of Boulder Community Network. Contained within are curricular plans, online projects, e-mail service, and numerous related usenet discussion groups. A local discussion group was also created for rural CO teachers to share their experiences using technology in the classroom. (lines 1499-1504)" Costs were reduced by using both the Denver Free-Net and the ACLIN state library system for public access. The overall project is CPB supported and continuation is uncertain after the grant ends.

At a Santa Clara, CA project one school is involved (K5) and the participants are networked by e-mail and through the Internet. "School administration, teachers, parents and students have formed a group concerned with promoting computer literacy and access to Internet information, particularly for those parents/students who otherwise would have difficulty with online access. The project was largely parent-driven, with the active assistance of teachers who instruct in computers. The program is entirely extracurricular." "An integral part of the project is participation in Even Start, a federal grant family literacy program that serves families at risk. Donated equipment and low-cost non-profit network fees put these families online so that they can communicate by e-mail with their teachers, with school administration, and with each other. (lines 1798-1889)" For cost savings the effort recommends employing VT-100 terminals with modems in place of computers (donated or very low cost), use of a non-profit community based Internet service provider, and use of volunteers as trainers & shareware/freeware software as available.

✿ (Use) Computer as a Communication Tool, Not as CAI (Teles, 1991)

In early application of computers the focus was on Computer Assisted Instruction (CAI). With networks, educators are learning that the communication link can make up for the lack of intelligence of the computer as a machine.

Lesson: Computers are not very smart. People are smarter. Use computers to get people to achieve learning by interacting with other people.

✉❋ (Use) Computer Shops (Priest, Interim Report, 1995)

Computer shops provide students with the opportunity to understand both the hardware and software of computers and communications.

Lesson: Inquiring students need the opportunity to go beyond just running programs. Some of these students will become future engineers and scientists.

✿✉❋☛⌘✯ (Provide) Computers to Take Home (Means, 1995)

"According to estimates given by both the principal and the technology coordinator, fewer than 1% of the students enrolled at Nathaniel Elementary School have access to computers at home. To enable their students to compete with students from more affluent homes in future education and work settings, Nathaniel staff felt that they needed to try to provide these students with in-home as well as at-school technology experience. Nathaniel Elementary decided to purchase 78 Macintosh Classics for use in a special parent/student take-home computer program. The take-home program provides families with computers on a 4-week loan basis. Participation in the program is self-selected. (p. 65)" [EPIE/CITS comment: While "buddy system" loaning of computers has been popular the problem with these programs is the child must return the machine. In contrast LINCT (Komoski & Priest, 1995) recommends providing children and their families with an opportunity to earn a donated computer by learning to use it and earning their training by doing volunteer work in the community.]

Lesson: Home is where the time is. Especially, low income families are unable to provide their children with the same advantages that higher income families are providing. It is part of the mission of public institutions, especially public schools, to help provide computers to homes.

✿✉❋☛⌘✯ (Provide) Computers for Teachers to Take Home (Means, 1995)

"One strategy for getting teachers involved with technology that has been used in many places is to *give teachers computers for their personal use*. (p. 68)"

Lesson: Home is where the time is. Programs giving teachers computers for home use give teachers a better idea of what can be done with the equipment and get them accustomed to using the equipment as a tool for their own productivity.

✿ (Use) Conferencing that is Project Oriented (Levin, 1989)

"As an alternative initial activity to "computer pals", let me recommend that you join one of the "project" oriented activities currently ongoing on the network. Read through the $IDEAS postings for the past month or so and select the one that is most interesting. Its much easier to start out by joining in with an ongoing activity, and then once you've gotten a feel for how these networks work, suggesting new ideas for activities. (line 128)"

Lesson: A task oriented discussion has better longevity and more appeal than more idle networking chit-chat.

✉❋ (Use) Consultant in Establishing a Network (Graham, 1995, Rothstein, 1995)

"Even a few hours with an experienced, professional consultant can be significant in ensuring that the network is installed properly. (Rothstein, p. 24)"

Lesson: Expert advice can be accessed by working with Vendors and/or by hiring a consultant. For example, even something simple such as wiring requires adherence to fire codes and the use of non-flammable cables through fire walls. As another example, each connection in a network is a potential source of reflections. Improperly made connections, of, say, the incorrect impedance BNC connector can cause problems that even sophisticated equipment finds difficult to locate.

✉ (Consider) Converting School Intercom System into a Network (Hodas, undated)

Many schools were wired for school intercoms. While their cables were never intended for data communications, they can be tested for their potential to carry a local area network or to provide, at least, telephone service. While the speeds attainable may not be over 2-300 Kbps, this is adequate for Macintosh LocalTalk. [Note: Also look for existing telephone wires for the same purpose, see results of CoSN survey below]

Lesson: Many Internet and networking applications do not require very high data rates. If funds are very scarce, consider starting with existing wiring, be it old telephone lines, CATV cables, or intercom lines. But be careful, investing in low-speed technology may be wasteful. Consider Macintoshes that can be used both for LocalTalk now and Ethernet later. Look into serial port LAN network software that doesn't require more than a small license fee and serial cable boosters that increase the range that data can travel on older lines. (Perhaps the thoughtful combination of existing wiring and a newer "backbone" line would suffice. The existing wiring reduces the labor going to the many classrooms but the higher speed backbone provides the connection to the server.)

☛ (Consider) Coordinating Academic and Administration Networks (Carlitz, 1994, section IV-8)

"Obviously there needs to be a level of interoperability between these two systems so that teachers can provide administrative data and can access this data as needed. On the other hand there is a need for system security in administrative systems which may go beyond that required for academic systems. (line 921)"

Lesson: Plan early on how an academic network will connect with not only administrative networks, but library networks and community networks as well.

✉ (Use) Correctly Placed Servers (Gargano, 1994)

This advice comes from one of the Internet RFC's (Request for Comment) documents. RFC's are an entire catalogue of information about the Internet. (The location of these is referenced in the bibliography) This document, *K-12 Internetworking Guidelines*, should be in any networking administrator's top twenty Internet documents.

"Networking servers will be located where they can be managed and supported, and also provide access paths with adequate bandwidth. A system of hierarchical servers should be created in larger school districts, with automatic transfer of common information from a central system to the secondary systems each night, or at appropriate intervals. Local servers will allow each school to provide on-line information particular to its programs and community. This model optimizes use of network bandwidth as well. (p. 6)"

Lesson: While an entire school district can run with one single, main server, this may not make sense either in terms of distributing the network load or in establishing more local servers that provide information more relevant to the local users.

✉ (Use) Cost-effective and Manageable School Interconnections (Gargano, 1994)

"School interconnect topologies (links) must be both cost effective and manageable. Communication between schools, district offices, county offices of education, and the State Department of Education must be reliable and of sufficient capacity to support the primary applications as well as allow development of new applications. Capacity is measured both by total data traffic volume and by response time when information is requested over the network. Reliability is measured by the percentage of time that the network is able to transport data. Reliability should be well over 99.7%. Capacity should be such that no more than 10% of the communications bandwidth is used during a typical work day. This is intended to leave adequate capacity for good response time to short term communication demands. (p. 6)"

Lesson: There are professionals whose entire job is to project network load demand and design for capacity and reliability. To the school board that is contemplating "running some wires" we remind these planners that an integrated network, especially for a school district of any size, is a professional technical undertaking.

⌘ Create an Ambience (Kimball, 1995)

This is another tip in reference to conducting an online conference. "Even though your conference members or list may be part of a larger network with its own culture, you can give your virtual group its own flavor. Think about how the first message or topic will set the tone; about how you model message formatting; and about how you respond to comments. How can you help the group create a mental map of the environment so that members develop appropriate expectations? (p. 55)"

Lesson: Most conferences do not take care of themselves. Facilitation is important.

✉ (Use) Custodians to Help Build Network (Graham in Priest, 1995, Seaford, NY)

Many schools have wired and installed equipment using their own school custodians. These people know the buildings intimately, know existing conduits and crawlspaces, and come at no added expense to the budget.

Lesson: Think about spreading the wiring and installation process over enough time that custodians can work it into their schedules. With the right spirit they can become an active part of the new enterprise, giving them recognition they don't otherwise receive. Make sure they receive training. This may simply involve their working with a networking technician for one day to learn how to create a reliable network. Make sure they can call the technician back (or by phone) for problems that may arise.

✉❋ (Use) Dedicated, Qualified Staff for Networking (Addessio, 1994)

Network installations of some size require two categories of staffing. These staff categories are called the NIC (Network Information Center) and NOC (Network Operations Center). The NIC staff person(s) should be able to answer questions ranging from "why does this e-mail bounce back to me?" to "how do I put this scanned picture on the school web page?" The NOC staff person(s) is required to maintain the network and respond to questions such as "I was looking up a student record and got a message 'Internal Server fault, request requeued.'"

In a small school these two jobs may be assigned to one person, at first, perhaps, to the technology coordinator and later to a trouble shooter and an information specialist.

For a town of about 30,000 people, an administrator can plan on hiring one NIC and one NOC type of person to handle networks throughout the schools. At about $35,000 salary and an overhead of 100%, budget $35K x 2 x 2, or $140,000 per year.

For the nation, this cost is about $1.3 billion to handle the technical support for the nation's schools.

Lesson: Plan ahead to keep a network running and to provide the technical support teachers and students require. There is no way to avoid these costs, and provided well, the services will assure that the investment in networks and teacher professional development bring the full benefits of networking to the school.

✿ (Be sure to) Define Roles in Networking Projects (Kimball, 1995)

"Once the purpose [of the project] is clear, you can begin to ask: Are the participants peer learners? Team members? Neighbors? Is the moderator expected to provide expert knowledge? Support and encouragement? A guide to other resources? (p. 55)"

Lesson: Facilitating online networking projects by providing clear roles for participants will improve the results.

✿ (Be sure to use) Designed Online Educational Activities (Teles, 1991)

"The design of the online environment is a key issue. Online instructors need to design the educational activities and learners need to know in detail what they are expected to do online (Fredman, 1989; Harasim, 1990; Riel, 1990; Rogers, 1989; Teles, 1991)." "Timeline considerations must be taken into account: short projects with well-defined end-points have been successful (Fredman, 1989, p. 6)."

Lesson: Structure is essential in assuring learning. While "wandering the Internet" is sometimes insightful, the educational use of the Internet requires design and structure.

✉ (Use) Disk Caching of Internet Materials (Hodas and Warren, 1995)

NASA plays an important role in aiding K-12 use of the Internet. One of the more useful Internet sites with many links to other resources is http://quest.arc.nasa.gov/OER/.

As described above, one important way to reduce Internet bandwidth needs is to "cache" recent Internet requests. Caching as many recognize is a technique used on today's PC's to speed disk access. A portion of the machines fast memory, often 2 to 4 megabytes, is reserved to hold recent disk accesses. This greatly enhances machine speed since it is generally more likely that the most recently used disk materials will be reaccessed.

The same principle is true with the Internet. The NASA HorizonNet project found that students' access of the Internet was repetitive at any given time. For example, if one student downloaded an image of sun-spot activities, other students tended to download the same image. In one elementary school, 92% of all Internet requests could be handled from the cache.

Lesson: Request that your Internet server be Internet cache enabled. Don't assume that because Internet usage is often not charged per item, that conserving bandwidth doesn't reduce costs. Indeed, when Internet access is reduced by 90%, this means that an Internet bandwidth of 1/10 the size can be purchased, saving the difference between, say, a dedicated T-1 line and more cost-effective Frame Relay connections. This can mean thousands of dollars per Internet connection per year. Also, as material is placed on the Internet on a per item basis (a trend beginning with various news databases), a cached item will save a school in access charges by many times.

✉ (Install a) District Wide Telephone System (West Ottawa, 1991)

"To make communications as efficient, cost effective and easy to use a single standardized phone system should be installed district wide. Each building will have a full function PBX (phone system. Where buildings are on common property a system may be shared by more than one building ... " "Using the fiber network, all phone systems will be connected to a central system and share a common voice mail system at that location. All calls between schools will be across the fiber network. Long distance calling will be consolidated to gain discounts based on volume access... (p. 11)"

✎ The strategic plan for the West Ottawa School District is one of the most comprehensive and integrated plans reviewed. The following objectives show the careful thought behind the plan:

➾ Maximize the non-print resources available to every classroom

The recent proliferation of materials available in non-print format — videotapes, videodiscs, educational broadcast programming, computer software, electronic encyclopedias, etc. — combined with the desire of teachers and students to make use of these resources leads us to investigate cost-effective means to bring them into every classroom

➾ Put information management tools directly into the hands of students and teachers

If computers and related technologies are "down-the-hall" or in another building or shared with many people, they are less likely to be used. Regular access is one of the first keys to successful use.

➾ Encourage more active involvement in learning by students

The most powerful feature of technology is its ability to put the control of the pace, selection and use of information into the hands of the student.

➾ Enable students to participate in the process of producing materials generated by technological tools

Word processing, desktop publishing, video presentations, interactive displays — these represent common means of presenting information in the world around us and our students are eager to try them. We need to provide alternatives to paper and pencil for student presentations.

➾ Increase the frequency of use of the tools of technology

An overriding consideration is that the technology implemented must be easy to use. A second consideration is to find the right tool for the right task. Just because something can be done on a computer, for example, does not mean it is time-effective or cost-effective to do so.

➾ Ensure equity of access for all grade levels and all service areas to the resources and tools of technology

Although it might be very difficult to deliver the many technologies suggested in this proposal, simultaneously, the distribution of equipment and services should quickly become as equal as possible — across grade levels and geographically throughout the District. [EPIE/CITS Note: From the standpoint of equity we encourage equal access, however, as the EPIE/CITS model suggests, utilization of networked technology is likely to be higher in the lower grades.]

➾ Improved teacher-student-parent communication

Through improved phone and data services, it becomes possible to increase the quantity and quality of communication. This is especially true when face-to-face meetings are difficult: the ability to inquire about homework assignments in the evening, for example.

➾ Improve internal staff communication

The use of voice mail, electronic mail, and electronic bulletin boards give the educational professionals options which can reduce annoying interruptions during class time, reduce traditional mail, and eliminate "phone tag."

➾ Increase staff efficiency

Time that is devoted to any teacher task that can be done more quickly or easily through the use of technology, can be reallocated to students and instruction. Reduction in time spent reporting attendance, preparing lesson plans, record-keeping, and preparing report cards will all be possible through the use of appropriate technology.

➾ Improve staff support in the areas of training, curriculum decisions, management of hardware and software, and troubleshooting and maintenance.

If efforts to support staff with training or outside help does not accompany the installation of new technologies, then the expected results for improved instruction, improved communication, or work efficiency will not occur. The kind of training necessary varies with the complexity of the application. A flexible, but carefully monitored, training program may best suit teachers' needs. In many cases, expert help is required. This expert help may need to be on staff if the situation warrants. (West Ottawa, 1991, p 5-8)

Lesson: As other parts of this report discusses, the use of telephone may actually be more important for many tasks associated with schooling, than digital networks. Schools should carefully prioritize their communications needs and ensure that telephone systems including voice-mail and many other possible features are considered.

✉ (Install a) District Wide Video Network Using CATV (West Ottawa, 1991)

"To maximize the district's ability to distribute video information sources within the schools and across the district, a district wide video network should be built. Within each school a distribution system should be installed to be able to broadcast video information from at least six sources located in the media center. At this time the network should be based on Cable TV (CATV) technology to each room. Each room should contain a TV that supports the building network connection and an in-room video source connection. To start with, the sources in the school should be video tape, laser disc, C-TEC CATV, video bulletin board and the district video network. (p. 10)"

The media resources described include laser-disc, VCR, and live production. In anticipation of the Toshiba/Sony/Philips high storage CD-ROM we suggest that all schools plan to install a DVD CD-ROM 100 disk carousel player.

Schools will also wish to consider systems such as Dukane's SmartSystem (Dukane, 1995) which provides automated access to the media center materials using easily used remote controls in the classroom.

Schools will wish to consider multi-purpose monitors that can serve as both CATV monitors and computer monitors. Monitors are becoming the most expensive item in a computer and/or video display system. Avoid purchasing two of these per classroom, when one will suffice. And remember, as teachers increasingly use such a monitor for teaching, there are poor economies in purchasing too cheap a monitor. The monitor should be bright enough to be easily viewed throughout a class even on a bright day.

Lesson: As discussed elsewhere, the economics of the location of media players is still uncertain. The Internet should be seen as yet one more media source with its attendant costs and uncertainties. There is a growing trend to avoid moving media players around in schools and to concentrate them in media centers, distributing the content via CATV (or via either CATV or digital network for DVD's)

✉ (using) Donated Equipment (Snow, 1995; Komoski & Priest, 1995)

Perhaps no subject raises more debate among educational technology experts than the use of older PC equipment. Many in schools have seen donated equipment sit in storage for lack of appropriate software. And many newer pieces of educational software require machines manufactured in the last few years due to memory requirements, monitor requirements, and operating system requirements.

Nonetheless, the use of "dumber machines" appears to have come full circle. As more content and facility is available via the network, the computer can be less powerful, again.

Also, these machines should be viewed callously. Most schools will not have the requisite talent to make a non-operable one work or to fix one that breaks. So treat them as dispensable. When one breaks, replace it with another. Give the broken one to one of a dozen organizations across the country that can swap parts and fix it (see, e.g., German, 1995). Alternatively, if you have a successful computer shop, give it to them. It makes an ideal puzzle for the inquisitive student. There is "nothing better than natural puzzles."

Lesson: Many earlier machines can be made into both text and graphical web browsers with software described above. The VT-100 (addressable cursor terminal) has become a defacto standard for the computer world and every computer ever manufactured, including the earlier CP/M machines are capable of emulating a VT-100. (The Santa Clara, CA case study reviewed above recommended obtaining actual VT-100 terminals for community networking. These terminals are so populous that they are given away at most amateur radio "swap-fests.")

While it may take the glitz of Netscape running on a $2000 Windows-based machine to attract a student to web pages, many learn to shut off images as a way of getting to the textual information, quicker. When scientific photographs are the center of a web-based project, a graphical browser is absolutely necessary. However, if the decision is between providing a student with a text-based computer for home use, or no computer at all — opt for the text-based computer. It makes a fine exploration machine and, because it won't run Myst and other diverting games, it may actually propel the student to more exploratory learning than a high-end machine.

> ✎ Earlier machines need not be viewed as only VT-100 emulators. Geoworks, a graphical based Windows look alike, runs on the original IBM XT. LINCT provides Geoworks with shareware software for word processing, spreadsheets, and telecommunications to low income households who earn their donated computer by learning to use it. These tools are excellent starting points for families that would otherwise have no tools from which to learn.

✉ (Use) Drawings and Specification (Lipman, 1994)

"Once ... decisions have been made, involve a network designer and have a diagram drawn. It is best to have a formal diagram with specifications done before you put out your bids. (p. 10)"

Lesson: The more clear and specific a specification, the lower bidders will bid. A hazy specification causes bidders to include costs for unknowns.

✉❋ (Take advantage of) Education Discounts (Crawford, 1992; from Edupage in Chronicle of Higher Education, Feb. 9, 1996, p. A21)

Many vendors, especially software vendors, provide exceptional low educational pricing. Some vendors do this because they realize that schools find it more difficult to justify costs; others do it because they wish to introduce prospective customers to their products while they are students.

"Librarians, Unite -- for Buying Power: College librarians are banding together to purchase electronic resources for their institutions. 'We've found that this sort of group purchasing power has really enabled us to leverage the dollars that we have and to get resources we couldn't have otherwise,' says an associate librarian at the University of Texas at Austin, which buys publications through the TexShare consortium. The group buying arrangement is also advantageous for publishers, who don't need to spend as much on marketing: 'As a group, we'll pay the vendor more money than they can realistically get by slogging it out school by school.' says the executive director of OhioLINK, which includes more than 40 colleges and universities. The president of Britannica Online figures that more than half of the 233 institutions using his product are doing so under consortium-based licenses. (Edupage)"

Lesson: Always ask what the educational discount is for any products or services you procure. Form or join buying cooperatives in your state. Team up with libraries. The OhioLINK,see discussion below under (Use) Online Databases, exemplifies how bulk or consortium buying can reduce costs.

✿ (Encourage) E-mail (Caruso, 1995; Anderson, 1995, RAND)

"Based on Rand's study of on-line communities (like Latino Net in San Francisco and the Blacksburg Electronic Village in Virginia), and what it discovered about how citizens use E-mail today, the report concluded that 'use of electronic mail is valuable for individuals, for communities, for the practice and spread of democracy, and for the general development of a viable information infrastructure.' (Caruso, p. D5)"

Students, teachers, and parents can use e-mail to tighten the loop in communications (see Section IV). E-mail also fosters improved writing, especially in peer-to-peer environments.

Lesson: While the use of "electronic pen pals" is not high on most networking educator's lists of learning tools, e-mail is useful in communicating amongst teachers, students, and parents.

✿ E-mail Encourages Writing (Kuttner, 1995)

In *The Revival of a Lost Art*, Kuttner describes how e-mail "In a fine reversal, e-mail is the revenge of print on video. It is producing, of all things, a generation of writers." Kuttner, a journalist, recounts how kids increasingly stay in touch with each other through e-mail, and how kids at college stay more in touch with their families. "E-mail not only lends itself to a lot of correspondence but also to quick response, hence to whimsey, and also, remarkably enough, to candid revelation. (p. 19)"

Lesson: In an era of the video, writing is making a comeback.

✉ (Use) Ethernet (California Guide, 1994)

To many, Ethernet is synonomous with networking. It has become the Kleenex of the networking world. While IBM can still tell you good reasons to use token-ring, most schools aren't listening.

Lesson: When a predominant technology form emerges, prices drop and features increase. Not only do schools prefer Ethernet, but they prefer 10BaseT to 10Base2 wiring because the hubs provide more informative diagnostic information (even though the range of 10BaseT is only 300 feet compared to 10Base2 at 1200 feet.)

✎ While this report is not a guide to the technology, it is recognized that certain terms need defining. In a basic network a cable (for 10BaseT this is 2 sets of 2 twisted wires) connect from a card in the computer — an Ethernet card — to a device at the other end using a plug that looks like a telephone plug, only wider — an RJ 45. In an Ethernet the wires fan out from points of concentration like a "star." The wires must go to a device that boosts the signal every 300 feet. The device that both permits multiple Ethernet wires to come together and boosts the signal is a "hub." The hub can be smart or dumb. Smart hubs provide diagnostic information when there are problems. The Ethernet signals are passed from hub to hub to a server. The server has an Ethernet card in it, just like each of the computers on the network. If the server passes signals onto other destinations, such as the Internet, it is called a "router." If the only function of the server is to pass signals onto another network, it is only referred to as a router, not a server. If signals from a different kind of network need to be connected to the Ethernet, the device at the union is called a "bridge." The speed of the Ethernet is commonly 10 Mbps (megabits per second). Connections to other buildings or to the Internet are done at different standard speeds. Common speeds are 56 Kbps (dedicated phone line), 128 Kbps (ISDN adjusted phone line), 1.5 Mbps (a T-1 line), and 44.7 Mbps (a T-3 line). Higher speeds are available through services like ATM, SONET, etc. Frame Relay is a service of the telephone company that provides more flexible speeds as required. ISDN is a switched service, while the other connections are dedicated to connecting one point in the network to another. Since the Internet acts as one large switched service, the use of dedicated lines do not interfere with the ability to send data from one machine to another. Internet switching is unlike the dedicated telephone switch. The dedicated telephone switch maintains a continuous connection from sender to receiver. In contrast, digital data is grouped in packets and the packets are routed to their destination by a store and forward process. Sometimes packets arrive out of order, and the receiving machine must ensure they are resequenced correctly. Because of this characteristic and the fact that packets take varying times to arrive at their destination, attempts to use the Internet for telephone service provides a choppy sound and delays in hearing the speaker. Services such as audio and video require buffering to avoid choppiness. In one-way audio and video, this buffering can provide clear reception to the listener. Today's Internet does not have the capacity nor the speed to support very many video connections. The cost and availability of full motion picture video by Internet, in the near future, is largely unknown.

✿ (perform) Evaluation of a Project as it Unfolds (Walker, 1995)

"...keep your project well-tuned. Keep your eyes open. Listen to your feelings. Find creative ways to bring out the best in one another. Be alert to encourage independent thinking as it cautiously emerges. Real talent must not be wasted. Be brave. Let your students astonish you with the depth of their insight, with the beauty of their art work, with the intensity of their writing. Don't neglect your Internet partners as you delight in your school's love of learning. (p. 35)"

Lesson: Project-based Internet interactions require careful nurturing.

✉ (Use) Existing CATV Cable to Carry Digital (Sun, 1995; Mundt, 1993; LANCity, various; Zenith, 1995)

Some towns are in the fortunate position to have been wired with CATV throughout the schools and municipal buildings. Many cable company franchise contracts required these installations, sometimes called INET's, as part of the public service requirement of the contract.

Until recently, the cost of using cable TV lines for data was very high — around $7000 per connection. While this cost could be justified in some cases, it was not a universal solution. In the spring of 1995 LANCity became a price leader in the field and introduced a $600 cable modem. Using one of the existing video channels on the cable, the cable modem can establish a 10Mbps Ethernet link over the line.

Further, the other channels of the CATV system can be used for analog video signals between media centers and classrooms, as well as programming from the various educational programs carried on cable.

Mundt studied the implementation of a Zenith cable modem system in the Glenview, IL school system. They found that existing lines were not always in good condition, but with help from the cable company they made repairs and established the network.

Lesson: If your school, and, or district already is wired for CATV, seriously consider installing a network using cable modems. Since over 90% of the cost of wiring is labor, an existing cable network could speed deployment considerably.

✉ (Use) Fast Modems ( Crawford, 1992)

While even 2400 bps modems are adequate for many text-based activities, the prices of high speed modems have plummeted. Currently, state-of-the-art 28.8 Kbps modems are still distinctly more expensive than

14.4 Kbps modems — a price difference of 3 times. For dial-up ports there is no question but to use brand name 28.8 Kbps modems.

Within schools the trend is moving fast away from modems and towards using Ethernet (Graham, 1995). Schools that attempt to get their Internet connectivity from providers such as AOL are faced with both hourly charges and telephone message unit charges. Graham strongly recommends that schools abandon achieving Internet connectivity via modem.

ISDN service is finally commonly available which permits connections to the Internet at speeds up to 128 Kbps. ISDN pricing varies widely depending on the tariff filed and approved for the local carrier. The "Basic Rate" tariffs as of January, 1995 are:

| | Installation | Per Month | Per Minute |
|---|---|---|---|
| NYNEX | $124 | $38 | $.085 |
| Pacific Bell | $125 | $20 | $.01 |
| US West | Free | $60 | Free |
| France | $119 | $35 | $.19 |
| Germany | $79 | $36 | $.14 |
| U.K. | $600 | $42 | $.19 |
| Belgium | $171 | $30 | $.06 |

Note: US West recently attempted to raise their monthly fee to $184
*Source: Xyplex, undated [1995]*

We include some foreign countries to illustrate how disparate the rates are in different locations. US West has indicated their rates are too low and have attempted to have them raised. Certainly the prospect of being connected to the Internet 24 hours a day at 128 Kbps for a flat rate of $60/mo. is very attractive. In contrast, a connection at $.02/minute for a month is $864 plus the monthly charge. The Taxpayer's Assets Project of Washington, DC have pressed for the telcos to lower their ISDN rates (Love, 1995). ISDN Internet Providers (David Berger, in Carver, 1995) say ISDN connections are made in less than a second so a connection need only be made while data is being transferred. This makes per minute charges more attractive since time spent reading a screen is not done while connected (provided the software disconnects and reconnects as required).

The above charges are for the connection from a house or school to the Internet provider. The Internet provider also charges for access to the Internet. As an example of these charges, PSI rates are as follows:

| Monthly Charge | Hourly (beyond monthly coverage) |
|---|---|
| $9.99 (for 9 hrs./mo) | $1.50 |
| $29.95 (for 29 hrs./mo) | $1.50<br>Note: the 29 hrs is for prime time, 8 AM-11 PM<br>Prices Current as of 1/11/96 |

Compuserve recently announced (Press Release, February 6, 1996) a flat rate for ISDN connection to the Internet of $6 per hour. This is distinctly higher than the PSI rate and raises questions about what ISDN Internet connection rates will actually be over the next decade.

ISDN connections at home are problematic if the ISDN line is the only phone line. An ISDN line is incompatible with all existing telephones, answer machines, and many features such as call waiting. Boxes are available to connect these standard devices to an ISDN line but at several hundred dollars per box. ISDN probably makes more sense for home offices and individuals who plan to make very serious use of the Internet.

The utility of ISDN has been the current debate on a list called isdn@essential.org (organized by Jamie Love, Taxpayers Assets Project). At press time we have this further comment about ISDN (dave@dexmn.com, January 19, 1995).

"I have been reading this news list for about six months now, and as a user of ISDN (I have two lines) I believe that the major problem at least in Minneapolis St. Paul, is not the price, but the reliability.

We have found it a real bear to get working, and an almost daily frustration to keep it running. In fact we are seriously thinking of going to 56K leased lines, and radio connections, in spite of the fact that they will cost more, and in theory be slower just because they are dependable.

Yes we have worked with our vendors, (telebit a reputable company who makes our routers cannot solve the problem) and I believe that most of the problem is with uswest.

Do other people have similiar experience? (dave@dexmn.com, ISDN List, Jan. 19, 1996"

In response to this question another member of the list described how every area of the country is "zoned" by color as to their suitability for ISDN service. Thus, before committing to ISDN, ask whether your area has existing lines that support ISDN. In areas that have the right installed lines, ISDN is reported as very reliable.

Lesson: Schools are migrating away from modem use to Ethernet connections. From the home, if the student plans to leave images on in their web browser or plans to participate in newer virtual reality environments (VRML, see for example, Greening, 1995) then purchase a 28.8 Kbps modem. Otherwise 14.4 Kbps modems have become very cheap (less than $40) and will meet most other needs. An older, or donated, machine with a 2400 bps modem is still adequate for e-mail, chat, and some text-based browsing of the Internet.

ISDN should be considered by schools as an alternative to other modes of connecting to the Internet. Especially if Internet caching and DVD CD-ROM's maintain local archives of, say, 99% of everything accessed by a school, an ISDN connection may be extremely cost-effective. But don't rush out an buy ISDN yet. As the above account suggests, the telephone companies are encountering troubles. (Remember: the telephone company is attempting to take the same grade telephone line they run to a house, and make it run at 128 Kbps, rather than 28.8 Kbps. They can only do that by: 1.) placing signal conditioners around every three miles, and 2.) making sure there are no faults, poor splices, etc., with the existing line.)

⌘ (Use) Flexible Classroom Activities (forNews, 1995)

"An important part of each forum is a set of activities that are designed for teachers to carry out in their classrooms. Classroom activities offer opportunities for teachers to experiment with, observe, and reflect on how their students work on and talk about mathematical issues. Project staff have found that while the character of the conversation among the facilitator and participants is important, the quality of the classroom activities teachers are asked to carry out are important too. The most important characteristic is flexibility — teachers need to be able to interpret and implement the classroom activities in ways that make sense for their students and classrooms. Teachers participating in the Forums teach a wide range of environments, so activities need to be adaptable to a variety of circumstances. (line 322)"

Lesson:  Forums must remain flexible to adapt to needs of classrooms.

☛ (Use) Flexible Technology Plan (McKanna, 1994)

"The Technology plan written today will probably start changing tomorrow. The district needs to be flexible and revisit the issues annually making sure no wrong turns have been made on the information highway. (p. 12)"

For example in the final days of writing this report, three significant new references were added with today's date. For example, advances with the HollowPC (described above) have been announced weekly during this period.

Whether it is the HollowPC, the DVD CD-ROM, or advances in Virtual Reality teaching environments, the landscape changes continually during these times.

Lesson: Keep track of changes, stay in touch with organizations that will alert you to important changes, and adjust your technology plan annually.

✿ (Use) Forums (Teles, 1991)

"Some of the 19 SITP [a Simon Fraser University Forum system] were active through Phase 1, while others lasted only a few weeks. In five of the most active conferences the moderators had previous online experience. These conferences were: SITP.ETC, SITP-Prose, SITP-Write, Law-Forum, and Wired.Writers. Ask-An-Expert was also very active throughout pPhase 1. The variety of topics addressed and the open access to both SITP and non-SITP schools helped to ensure their continued interest and activity (p. 28)" [Note: this document, like many in the bibliography is an ERIC reproduction; the reference page is the page of the original document, not the ERIC assigned page number.]

Lesson: Active, moderated conferences, forums, or lists can engage learning.

✉ (Use) Frame Relay (California Guide, 1994)

For background on Frame Relay see Apple, 1995, Frame Relay; Bigelow, 1995; Carlitz, 1994, Stages; Carlitz, 1995, Construction Set; Collins, 1995, Construction Set; Gargano, 1994; Schulyer, 1994; and Xyplex, undated.

Frame Relay is becoming a more popular way for schools, and other organizations, to establish a Wide Area Network (WAN). It is also a cost-effective way for schools to connect to the Internet. Prior to Frame Relay, schools, libraries, community networks, municipalities, etc., had to lease connections to the Internet, the price of which depended on the distance from the school to the nearest "Point of Presence" (POP) on the Internet. With Frame Relay, pricing is independent of distance and schools can commit to a lower speed service than they may occasionally need. The concept of a CIR, a "Committed Information Rate," means that the school is guaranteed the ability to transmit at that rate, say 28 Kbps, no matter how much traffic there is on the Frame Relay network. However, if no one else is using available circuits the school has the ability to "burst" above the 28 K to 56K (the limit of the dedicated line from the school to the nearest telephone CO (Central Office).

Some claim it is possible to contract for a CIR of zero and still be able to operate. The school would risk delays in Internet response but the cost of the arrangement would be distinctly lower than one with a CIR of 28, 56 or whatever.

✎ Frame Relay is similar to an earlier technology called X.25 packet transmission. Unlike X.25, however, the CIR is a new introduction and unlike X.25, error correction is performed only at the destination. This puts less overhead on Frame Relay compared to X.25, since the X.25 protocol included error detection during transmission.

✎ Data Transmission

Rates:

| | | |
|---|---|---|
| Fiber (limit) | 100 | Gbps |
| ATM | 155 | Mbps |
| 100BaseT | 100 | Mbps |
| FDDI | 100 | Mbps |
| T-3 line | 45 | Mbps |
| Token Ring | 16 | Mbps |
| Ethernet | 10 | Mbps |
| T-1 line | 1.5 | Mbps |
| Frame Relay | Variable, up to a burst limit | |
| 56K line | .56 | Mbps |
| 28.8 Kbps | .29 | Mbps |
| 14.4 Kbps | .14 | Mbps |
| 2400 bps | .024 | Mbps |

Legend:
Fiber (optical strand of glass)
ATM (Asynchronous Transfer Mode)
100BaseT (a 100 Mbps form of Ethernet)
FDDI (Fiber Distributed Data Interface)
T-3 (telephone designation for a trunk line)
T-1 (telephone designation for a trunk line)
56K line (common leased telephone line)

(In online forums) Go with the Flow (Kimball, 1995)

"There is no right answer to what should be happening in a virtual group — there may be times when you are more or less active. The key is to use the information about what's happening to learn, so that you can be a more purposeful facilitator. (p. 56)"

Lesson: Facilitation is paying attention to what is happening in your group, as distinct from what you wanted or expected would happen.

(In online forums) Identify Purpose (Kimball, 1995)

"The most important thing an online conference needs is an explicit purpose. Will members exchange information? Generate new ideas? Learn and explore? (p. 55)"

Lesson: A group can have many purposes — and its purpose may evolve and change over time.

Identify Technology Applicable to all Curricular Areas (West Ottawa, 1991)

"Every review of a curricular area should include a study of the resources available through technology. In some cases this is simply a preview of materials (education software, for example), but in other cases this study could reveal alternative teaching methods that become possible through the application of a technology (computer simulations, interactive videodisc, CD-ROM, for example.) This is an emerging area. (p. 14)"

The EPIE Institute maintains a teacher-searchable databse on CD-ROM that contains information and rated review citations on over 17,000 currently marketed education software products. The products cover all curriculum areas and all hardware platforms, plus CD-ROM and multimedia applications, etc. While states like Texas and Tennesse ensure that teachers in all schools have access to this information for selecting and integrating appropriate software into the curriculum, most teachers and educational technology coordinators in the country are unaware that in all likelihood there are many software and CD-ROM packages available to meet most curriculum, teaching and learning needs.

Lesson: There should be regular curricular reviews that consider review of media and technology. It is critical that this review take the lead in expanding on the K-12 Computer Curriculum to include other technologies and their impact on all curricular areas.

☛ (establish an) Implementation Team (Carlitz, 1994, Urban Setting)

"The means of achieving ... integration is the development of implementation teams. The teams should involve teachers and administrators who know how to guide activities through the school bureaucracy, and people with the technical expertise necessary to make needed decisions in this area and guide detailed implementation. (IV-4)

Lesson: A continued educational focus assures that project activities are comprehensible to teachers in the school district, and that technical experts are viewed as facilitators in the educational process.

✉❋ (Use) In-House Expertise (Priest Interview with Graham, 1995; Graham 1995)

Graham describes the situation where an architectural firm bid $1 million on a school networking design. Graham thought it was too high, worked with local vendors to develop specifications, and arrived at a cost of $250 thousand. After negotiations the architectural firm agreed to $350 thousand — a figure that is 1/3rd the original bid.

Graham was originally a remedial reading specialist. He helped network the Seaford, NY schools by training internal staff to do wiring and hooking up computers on a very low budget. He has subsequently become Director of Technology for a much larger school system on Long Island, NY, in recognition of his accomplishments.

How many Ken Grahams are there in the country? We don't know, but if you have one, you can save big money by avoiding "just putting the project out to bid." (see further the RFQ discussion below)

Lesson: Encourage in-house people and people with technical expertise in the country to dig in and work together on networking. These people will save the district money and provide continuous advice as technology and curricula change.

✉ Integrate Existing Systems (Gargano, 1994)

"Existing computers and terminals in schools and district office should be integrated as much as possible into the communication system. This installed base represents a large investment, albeit in many cases a somewhat dated set of equipment. Wholesale replacement of that base could be a large additional burden on funding resources. (line 368)"

Lesson: Many physical networks can carry multiple protocols, e.g. Novell IPX with Internet TCP/IP. Many systems can, at least, behave like VT-100 terminals, providing the means to give existing users access to "shell account" Internet access.

✎ There are two ways in which most people access the Internet: 1.) a "shell account" which the user "logs into" and which runs Internet applications such as Lynx (web browser), and 2.) a direct TCP/IP connection where the machine in front of the user is the machine "on the Internet." A machine is considered to be "on the Internet" if there is an IP address (Internet Protocol address) associated with the machine.

> ✎ These addresses take on two appearances: 1.) as a set of names separated by "dots" (periods), and 2.) as a set of digits separated by "dots". For example, a K-12 school in Florida named Pasco has an Internet address: pasco.k12.fl.us . If I ask NSLOOKUP what the IP address is, it tells me: 199.164.64.7. I can contact this machine using either form of the address. If I use the name-based address, the associated numeric IP address must be looked up by a "Name Server." It is a Name Server that NSLOOKUP uses to report the IP address. If I ask WHOIS (telnet to WHOIS.INTERNIC.NET and type WHOIS) about k12.fl.us it reports: Florida K-12 Schools (K12-FL-US-DOM), Florida Information Resource Network, 325 W. Gaines St. Rm B1-14, Tallahassee, FL 32399-0400. Administrative Contact: Stursa, Scott (SS286) stursa@MAIL.FIRN.EDU (904) 487-8672; Technical Contact, Zone Contact: Houle, Art (AH) houlea@MAIL.FIRN.EDU, 904-487-0911. As you can see K12-FL-US is a recognized domain in the domain registry at Internic. Internic is run by a 3rd party to register domains, assign addresses, and provide these addresses upon request. The registry contains contact information about most registered domains.]

Machines **on** the Internet have more "flexibility" than machines that are connected through a shell account. Netscape will only run on a machine with an IP address, so shell account users must use other browsers such as Lynx. Graphics may or may not be available through a shell account. Services such as AOL provide graphical access not only to their own online services, but to the Internet as well. If the graphic is not available from within the shell account the user is often able to view the graphic by asking that the image be stored on the shell account machine, transferring the image to the user's machine, and then using an image viewer. [Most Internet users would not call this "surfing the Internet" even though the final information is the same. Also, while many students quickly master such procedures, this process can bring some users to a confused standstill.]

IP addresses do not have to be permanently assigned to a user. Many Internet Providers give the user an IP address at the time they connect. This "roving" IP address will be returned to a pool of reuseable addresses when this user disconnects. Connections to roving IP addresses can be made via dial-up telephone access (SLIP and PPP) or via connections made via a network. Usually, however, most network machines have fixed IP addresses. One of the tasks of setting up a network is to establish a sensible numbering scheme for machines.

☛ Integrate Network with Curriculum (Carlitz, 1994, Urban Setting)

"... experimentation should [not] be open-ended and undefined in terms of goals. Rather there should be a close integration with the curriculum of any experimental efforts. (IV-3)"

Lesson: Integration is the key to whether innovations are used only occasionally or employed regularly in the classroom.

☛ (Encourage) Internal Competition for Resources (Carlitz, 1994, Urban Setting)

"The mechanism in [the Common Knowledge Project] for encouraging an integration with the curriculum has been the RFP process [see RFP below]. This internal competition for resources has additional benefits. As technology is deployed, it is placed in sites where teachers are committed to using it. This maximizes the efficiency of technology expenditures while rewarding individual initiative and encouraging effective site-based management. (IV-5)"

Lesson: The RFP process is a well known procedure for encouraging progress. Be careful in establishing the size of awards — awards too small will frustrate project personnel while setting awards too high will result in too few awards, turning away good ideas.

✿✮ (Use the) Internet (Kurshan, 1995; many others)

"... the Internet can be a magical way to learn. Imagine a place where children around the world can meet and ask questions of one another without leaving their homes or classrooms. Founded by Odd de Presno, an educator from Norway, KIDLINK now support a regular newsletter distributed across multiple networks, an online conference, KIDCAFE, moderated by students and a Worldwide Computer Art Exhibition. With over 23,000 kids responding to questions from 64 countries, it has clearly generated intense excitement and interest around the world. (p. 56)

Lesson: As Section IV details more thoroughly, there are many educators finding great benefits in accessing the Internet. In the first part of Section IV this report looks at the **purposes** of networking to better understand what networking, when, will be **beneficial**.

✉ (Use) ISDN (Levitt, 1995)

"If you think the ISDN standard of the mid-1980's can't fulfill your current networking needs, perhaps it's time you took another look. The market for integrated services digital network end-user products is taking off. ISDN is emerging as the best alternative to the plethora of slower modem standards, antiquated 56-Kbit-per-second leased lines, and switched 56-Kbps dial-up lines for making point-to-point network connections.

For anyone seriously considering ISDN, this review article by Levitt is nicely detailed and full of implementation details.

A PC ISDN card is priced just under $600 (DataFire) and has built in network termination, eliminating a separate device sometimes required to use ISDN.

An Ethernet to ISDN router/bridge costs just under $1700 (Ascend). This price should drop as ISDN becomes more popular.

Levitt encountered both limitations to 64 Kbps and incompatibilities with security "handshake" protocols but these problems appear to be only a matter of vendors making some adjustments and providing software upgrades.

Perhaps the most disturbing aspect of ISDN is the lack of compression standardization. Compression is not part of the ISDN standard and is provided by the manufacturer of the hardware. Without compression standardization it is necessary that identical protocols be used at both ends of the line to achieve compression. Since compression of 3:1 is common in data transmissions, a 28.8 Kbps looks like 86 Kbps when compared with ISDN at 128 Kbps with no compression.

Lesson: The quick connecting and disconnecting of ISDN lines (less than a second) can greatly reduce connect charges. Before committing to hardware make sure the compression capabilities at both ends match. Without compression a 28.8 Kbps modem with compression starts looking comparable.

☚ (Use) Leadership for Technology Implementation (Means, 1995)

"Although districts played an important role in shaping or supporting reforms at most of our sites and three of the innovations certainly never would have existed without district leadership, the most important leadership in almost every case was at the school level. (p. 115)"

Lesson: "Schools developed cadres of teachers active in designing and implementing innovations. The school principal appeared to be pivotal in inspiring and coordinating these activities in roughly half of the sites. In other cases, a technology or project coordinator emerged from the teacher ranks to play this role. (p. 115)"

✿ (Use) Learning Circles (Levin, 1995; Riel, 1993)

Learning Circles were developed by Margaret Riel as part of the AT&T Learning Network. "Learning Circles are virtual communities that have no fixed location or time zones. In part a Learning Circle is group conversation carried over electronic mail in slow motion. But what happens online is only half the story. The other half is what takes place in the classroom as a direct result of either the sending or receiving of information. The virtual and real classrooms are inseparable. (Riel, line 10)"

Levin illustrated a theory of "network-based learning environments" illustrating the theory with Learning Circles and related environments:

> ➾ Structure -- "one common dimension across the guidelines reviewed here is the notion that a social structure is important for supporting network interactions." In the case of Learning Circles there were "eight geographically diverse classrooms with a shared curriculum focus joined together for a semester. (Levin, line 61)"
>
> ➾ Process -- "Network activity is episodic, unfolding over time through a series of different phases. The exact list of steps or stages listed in the guidelines varies, but there is generally some sort of initiation phase, a phase in which the educational activity is carried out, and then some sort of wrap-up phase." In the case of Learning Circles Riel lists 5 steps, "forming the Learning Circle, planning the Learning Circle projects, exchanging work on the projects, creating the publication, and evaluating the process. (Levin, line 97)"
>
> ➾ Mediation -- "One key commonality among the guidelines is the importance of active, effective moderators to initiate and sustain the interaction on educational networks." In the case of Learning Circles, "Riel developed Learning Circle Coordinators to guide each Learning Circle. (Levin, line 135)"
>
> ➾ Community-building -- "Several of the guidelines focus on the steps involved in building a sense of community among the participants." In the case of Learning Circles, the Circles "start by exchanging 'Welcome Back' among all the participating sites of a Circle. (Levin, line 161)"
>
> ➾ Institutional Support -- "Several of the guidelines point to the need to embed educational network interaction within an institutional structure that will support and sustain the interaction over time." In the case of Learning Circles, "Riel has constructed Learning Circles within the institutional structure of the AT&T Learning Network (Levin, line 198)"

☚ (Include) Line Item for Repair (McKanna, 1994)

Lesson: A budget is complete only if it includes maintenance costs for equipment and wiring.

☚ Link Networks to Curriculum (Proctor, 1994)

"Mason (1989, p. 25) suggest that educators do not use networks very often and when they do, they often do not know how to use the technology for teaching purposes. "Connecting schools via e-mail, or accessing educational databases without strong foundations in the curriculum, can prove to be a technical hassle with very little educational benefit. The identification of what types of teaching and learning electronic communication is best suited for, what areas of the curriculum it best serves, and how best to integrate it with other educational media — these are the kinds of questions which must be answered before networking will be adopted by a significant number of educationalists. (p. 19)"

Lesson: As this tip and others suggest, network based-projects must be designed to meet curricular objectives.

✿⌘ Look at Problems Positively (Walker, 1995)

"Don't get discouraged. In the course of any project there are bound to be obstacles. Think positively. (p. 34)"

Lesson: Time, funding, resources are scarce and will detract from network-based projects unless dedication and resilience are applied.

☛ Materials to Support Parent Support of Teachers (Bielefeldt, 1994)

This tip is from an article by an ISTE editor on "untapped resources." (Like many materials cited in this study, the article is available via the Internet. This one is at the ISTE gopher, see the bibliography for the address.)

"Technology has penetrated the home much more than schools. This technology might be more available to support educators if organizations like ISTE [International Society for Technology in Education] could support parents in know how to use it. That support could involve:

- ➾ Making available materials that will help families directly support educators who want to use technology in the classroom.
- ➾ Welcoming parents into the organization as members.
- ➾ Sponsoring a new special-interest group [SIG] for parents. (lines 640-659)"

Lesson: Some parents become so involved with their children's education that they "home school." Other parents hardly know what their child does in school. As mentioned above, teacher/student/parent communication is a high priority (Priest, 1973). Explore how parents can be involved in their children's education, building on information contained in Section III of this report.

<u>Parental Involvement and Networking</u>: At present, the most advanced and fully featured networks for parental involvement are telephone-based networks.

Here are features and references:

- ➾ Telephone Absence Notification (Homework Hotline 1995; SIM-phony, 1995)
- ➾ Telephone Attendance Status (Parlant, 1995;SIM-phony, 1995)
- ➾ Telephone Electronic Mail Links (Parlant, 1995)
- ➾ Telephone Emergency Notification (Homework Hotline, 1995, SIM-phony, 1995)
- ➾ Telephone Group Messages (Parlant, 1995)
- ➾ Telephone Home Call Out, also called "Out-dial notification" and "outbound dialing) (Bauch, 1995;Homework Hotline, 1995,Parlant, 1995, SIM-phony, 1995)
  (Instead of the parent calling into the school, the system is triggered by an event, and calls the parent)
- ➾ Telephone Homework (SIM-phony, 1995)
- ➾ Telephone Homework Hotline (Sivin-Kachala and Bialo, 1992)
- ➾ Telephone Homework Infoline (Robinson-Wilson, 1995)
- ➾ Telephone in Classrooms (Hart, 1995; McKanna, 1994)
- ➾ Telephone Leadership Strategies (Homework Hotline, 1995)

"A Leadership Strategies Kit, designed for either principals or site-based management teams, provides suggested blueprint for implementation, training and community building around the Homework Hotline (p. 20)"

- ➾ Telephone Parent to Teacher Messaging (Parlant, 1995)
  (Parlant provides for both telephone and e-mail integration)
- ➾ Telephone Parent Voting (Robinson-Wilson, 1995)
- ➾ Telephone School BBS (Parlant, 1995;SIM-phony, 1995)
- ➾ Telephone Student Voting (Robinson-Wilson, 1995)
- ➾ Telephone System Wide Common Voice Boxes (Parlant, 1995)
- ➾ Telephone Teacher Resource (SIM-phony, 1995)
- ➾ Telephone Transportation Hotline (SIM-phony, 1995)
- ➾ Telephone School Usage Reports (Parlant, 1995)
- ➾ Telephone Voice Mail (AT&T, 1995; Bauch, 1995; Hart, 1995, Hixson, 1995; Homework Hotline, 1995; McKanna, 1995, New York Times, 1995, Parlant, 1995, SIM-phony, 1995)
- ➾ Telephone Voice Mail to Stimulate Parent Incall Messages (Bauch, 1995)
- ➾ Telephone Voice Memo (SIM-phony, 1995)
- ➾ Telephone Voice Reminders (Bauch, 1995)

Jerry Bauch (1995), a professor at Vanderbilt and a consultant to Homework Hotline, provides strong evidence of the success and usefulness of telephone networks. Bauch introduced the "Transparent School Model" in 1987 and since that time the technology has improved significantly: "There are two primary functions. First, a teacher can record a message for parents that summarizes the school day. The 60-90 second message give highlights of curriculum, concepts, special events and home learning expectations. Good messages also include suggestions to parents on managing and supporting study and homework. Parents can call and listen to the message. They are then prepared to greet their child with an understanding of their learning experience for that day. Parents are also "empowered" to manage the out-of-school learning experiences for their children. (Bauch, Parent Involvement Report, Vol. 4, No. 2, 1994, p. 1)"

"The second function of the model is "outcalling," where the technology system can store recorded messages and make automated phone calls to parents. Schools use outcalling for many purposes including: routine reminders, weather and emergency notification, targeted information to certain groups (e.g. play dress rehearsal notification), attendance notification, and stimulating parent use of "incall" messages ('Your child is beginning to slip in academic performance. Please call the hotline for teacher messages every day next week, and let's have a conference next Friday.') (Bauch, Parent Involvement Report, Vol. 4, No. 2, 1994, p. 1)"

While many are discussing and developing the possibilities of using online school-home networking, the point made here is that telephone networking is feasible and in substantial use, **today**.

Further:

"When done correctly, the model usually produces an increase in communication of at least 800%, and at least half of the parents call every day to hear teacher messages (Bauch, Parent Involvement Report, Vol. 4, No. 2, 1994, p. 1)"

In no other aspect of school networking are there claims of an eight fold increase in anything.

A Web Based Alternatives:

Tom Murphy, president of Imperial Systems, Holbrook, NY has extended web page functionality to provide access to teacher messages. On February 1st, 1996, a web-based pilot for parental involvement will be available at http://www.imperial-software.com.

The current implementation requires a SQL (pronounced sequel) database, a server (currently Microsoft's NT), teacher software provided by Imperial, and an SQL database/web page interface which makes database information available from a web page.

The system will run on most servers such as OS/2 and Windows, but not, currently, UNIX. Murphy uses Borland's Interbase SQL, but any ANSI standard SQL server could be used.

✎ Murphy originally planned to build a voice mail system like the ones described above. However, the cost of entry was too high. Servers that support voice messaging are more expensive and software that reads text from databases was also found to be expensive. In contrast, the above system could be assembled with a few man-months of effort. The teacher-client software was developed in Visual Basic. Taking data elements out of a SQL database and presenting them in HTML format is not trivial, but straight forward.

Imperial will give, at no cost, the teacher client and the software required to web enable the SQL database. However, many teachers use one of many student record keeping softwares. The free version of the software requires that the teacher enter both information about student performance and homework assignments manually (or by cutting an pasting from notes). A forthcoming version, price unspecified, of the software will have features more like Parlant's ability to read many standard record keeping formats and provide web links to that information.

✎ The largest unknown is the extent to which parents will access web pages versus use the telephone. Two years ago, without the ease of web access, the answer would have been "are you crazy?" Today, we judge that a web based system will be effective, but for only 10% of the parent population — those that own computers with a web browser (or access to one) and, of those, those who use networks enough to connect to the school web page. In a recent discussion, Komoski, Priest and Murphy discussed the relationship to the Suffolk Cooperative (Long Island, NY) library Services program that provides free Internet shell accounts (see above discussion on shell accounts) which include Lynx web browsing. Murphy was programming the web software using "table" access — a feature missing from Lynx. As a result, he plans to provide tabular data using HTML Level 1 so that these users are not excluded. (Telephone conversation, January 12, 1995)

Ideally, both telephone and web access should be available concurrently. We expect Parlant, which already has e-mail enabled their system, to move toward web pages, and, conversely, Imperial may move toward telephone interactivity.

Also, school technology coordinators must be alert to the capabilities that companies, such as Imperial, provide to extending web-based systems. Under "Online Computer Teleconferencing" (below) several web based teleconferencing systems are presented. These are general purpose ways in which "participants" can "post" and read notes (or messages), respectively, to and from a "web page." The Imperial web-enhancement is one kind of computer teleconferencing. Thus the Imperial system should be compared with other, general purpose teleconferencing tools. What makes the Imperial system potentially more appealing to schools is the feature "in the offing" that relate to integrating web browsing with commonly used teacher/student record systems.

✿ (Make use of) Mathematics Learning Forums (CCT, 1995 in Levin, 1995)

Levin notes that the CCT (Center for Children's Technology) developed a course called Mathematics Learning Forums which had many of the elements (described above under Learning Circles) related to his "theory of forums.

- ➾ Structure — "..eight-week long classes conducted over networks."
- ➾ Mediation — "...provided faculty facilitators..."
- ➾ Institutional Support — "... built the educational network activity of Mathematics Learning Forums into the institutional support of a College of Education, using the existing structure of a course to provide institutional support."

Lesson: In creating learning forums pay attention to structure, process, mediation, community building, and institutional support.

✉ (Install) Network Outlets Every 150 to 200 Square Feet (California Guide, 1994)

Lesson: It is no longer advisable to put only "one drop" per classroom.

☛ (Hire a) Network Operator (Lipman, 1994)

"A network operator needs to be specified. This person should know what to do when the system goes "down." The operator needs to be able to locate any wiring questions and get the system up and running as soon as possible. (p. 12)"

Lesson: Networks are multi-part machines. While modern electronics is remarkably more fault free than in earlier periods, parts of the network will give trouble. Some of the faults will be sudden and clear, others, such as poor data transmission due to faulty installation, will come and go, mysteriously, until the underlying fault is remedied.

⌘ (Do) Not Use a BBS for Teacher Discussions About Technology Options (Riel, 1990 in Means, 1995)

"Riel has found that the use of bulletin boards is very time-consuming and that it is sometimes inefficient for teachers to negotiate their way through them in search of applicable and appropriate ideas or conversations. (p. 21)"

Lesson: Tinker "observes that many teachers do not have time for 'mining' the Internet and that 'the issue of free resources is reminiscent of the days in which free software accompanied microcomputers. 'Most educators have discovered that free software is rarely useful in the classroom' (1993 p. 6, in Gallo, 1995, p. 19)"

Tinker's comments can be extended to Riel's observations about teacher's use of BBS's. Teachers do not have time to mine BBS's to learn about yet other things they don't have time to do.

> ✎ As identified in Section IV on Models and Benefits, one of the major benefits to the Internet is to provide an interesting place to explore. But many teachers are not explorers and asking some teachers to use the Internet, as many currently use it, is too unstructured and unrelated to teaching needs and curriculum goals. The many tips related to conducting Internet-based forums talk about how structure can be brought to these activities. Yet despite the best intentions, forum discussions can become divergent and participants can lose interest.

✉ (Do) Not Use Close Out Equipment (Crawford, 1992)

Using lower cost, close-outs works against maintaining standard equipment in your network. Close-outs may be fine for home use or for providing equipment for the computer shop.

Lesson: Resist using equipment close-outs or small quantities of donated equipment in the main part of your network. Do consider these, however, for home or computer shop use — places where lack of standardization does not carry carry a substantial overhead.

✉ (Do) Not Use Dial Access to the Internet (Graham, undated, ~1994)

Many schools get started by providing accounts such as to AOL only to find that the hourly charges run up enormous bills.

Even when considering Internet Providers with flat monthly fees, most schools must pay commercial telephone rates for local calls. Again, enormous line charges can be incurred.

Lesson: Weigh carefully the costs of dial-up access to the Internet against establishing a network. Running a network has many hidden costs (training, NOC's, NIC's, etc.) but those costs can be spread across many applications and uses. In the end, it is your school's priorities and usage patterns that will determine what services are most cost-effective.

✿ (Do) Not Use E-mail with Pen Pals (Rogers, 1990; Levin, 1989)

Lesson: Kuttner (above) commends e-mail as a way of bringing back writing, but experts who have worked with students find that structured projects provide much greater opportunity for learning.

✉ (Do) Not Use ISDN for School Internet Connections (Rothstein, 1995)

"On the other hand, there are a number of drawbacks in using ISDN. First of all, it requires special ISDN terminating equipment in the school. This equipment is not included in many of the RBOC's and cable companies' packages and will cost schools approximately $400 (two NT1 items @ $200 each)." "Further, ISDN is not scaleable beyond a certain point. The bandwidth of the line is determined by the number of ISDN lines running into the school. Many schools will receive three ISDN lines, which when multiplexed, give 384 Kbps (3 lines @ 128 Kbps per line). This is the maximum number of ISDN lines that can be multiplexed, so that the school is confided to a ceiling of 384 Kbps. For schools that plan to use these ISDN lines to connect to the Internet, or some other high-speed WAN, the bandwidth limitations may be unacceptable. Schools that make use of graphical clients (e.g. Mosaic) and video (e.g. CU-SeeMe) will require infrastructure performing at a rate of megabits per second, which is not possible with basic, narrowband ISDN. (p. 23)"

Choosing Internet connectivity, as discussed earlier, depends on the expected bandwidth "consumption." While we expect disk caching and DVD CD-ROM's to meet much school demand for bandwidth, video conferencing and other bandwidth intensive applications do demand more bandwidth than ISDN lines can provide. Frame Relay may be a good alternative since the CIR can be renegotiated once usage are clearer. Nonetheless, Frame Relay is not available "at the curb" and, thus, commitments must be made for dedicated connections between the school district and the nearest Internet "point of presence."

Lesson: There is no substitute for thinking out the kinds of applications you see your specific school employing and calculating the costs of various connection options. And keep in mind that Internet costs are still uncertain. While certain costs will continue to drop with advances in technology, access charges for materials on the Internet will become more prevalent. Think of the Internet as another media source and work out an overall media provision strategy.

✿ Nourish Online Conversations (Kimball, 1995)

"Even if there are a lot of active participants in a virtual group, it's important to keep adding new material to keep the group fresh and growing — both qualitatively and quantitatively. (p. 55)"

Lesson: Online conversations are like any other conversation. Without substance and commitment they will whither.

✿ (Use) Online Computer Teleconferencing (Teles, 1991)

Computer teleconferencing has a long history. Mason (1989) with the British Open University wrote a comprehensive review on teleconferencing. The following teleconferencing systems have been used in various teaching/learning situations:

- AKCS
- Caucus
- Com
- Confer
- CoSy
- DEC Notes
- EIS2
- Lotus Notes
- Participate
- Portacom
- VAX Notes

Beyond these specially designed softwares, web extensions have been developed for teleconferencing. These include:

- WIT (CERN, http://www.w3.org/pub/WWW/WIT) (public domain, early effort)
- HyperNews (based on HyperMail, http://union.ncsa.uiuc.edu/ HyperNews) (public domain)
  also at wsk.eit.com/wsk/dist/doc/admin/hypermail/hypermail.html
  see also, prism.prs.K12.jn.us:70/0/WWW/OII/disc1/mintons/index.html (K12 use)
  see also, http://www.gii-awards.com/cgi-bin/HyperNews/get/HyperDocs/community.html
- Georgia Tech (http://www.cba.uga.edu/groupware) (public domain, requires Netscape)
- Webboard (http://www.best.com/~duke/webboard/ (commercial)
  see also, http://hub.terc.edu/terc/teach/discussions.html (Teaching research use)
  see also, http://www.hamptons.com (Community BBS use)
- Web Crossing (http://webx.lundeen.com/ (commercial)
- Interactive/IP (http://www.ifi.uio.no/~terjen/interaction/ (commercial, Macintosh, free beta version to non-commercial sites)
- Metanet Webcaucus (http://www.tmn.com:8001/cauweb1.html) (commercial)
  See also, http://www.tmn.com
  Note: an extension of Caucus (above)
- Proxima Inc.'s Podium (http://www.proxima.com/Podium/ (commercial, requires Netscape)
- Pathfinder by Time Warner (http://pathfinder.com) (unclear if this may be licensed)

> ✎ Some of these web extensions are public domain; others are commercial. Some of these extensions can be run with a text browser; others require a graphical browser such as Netscape.

Four other widespread forms of teleconferencing include:

➾ UseNet Newsgroups (over 10,000 discussions conducted worldwide using threaded newsreaders, feeds, and archives)

➾ BBS Forums (Galacticomm, PC Board, TBBS, etc.)

➾ FredMail (see, e.g., Kurshan, 1994)

➾ Listserve's (thousands of discussions, for a comprehensive list of lists send mail to listserv@vm1.nodak.edu, and place in the body of the message LIST GLOBAL, a list within a subject can be received, e.g., by LIST GLOBAL/Business)

✎ The structure and format of computer teleconferencing is an entire field of study. Many teleconferences achieve some level of hierarchy. For example, a threaded newsreader considers the original message at the "top" and subsequent "posts" to the original message below the top message. A reply to a message other than the original message becomes yet another "branch."

Many computer teleconferencing softwares considered topic labeling and sub-topic branching to be so integral to the teleconferencing process that they incorporate the concepts of "parent topic" and "child topic." Any message from the participant had to either start a new topic, respond to a child topic, or, yet, branch from one of the existing topics. "Participate" was robust in this regard. The University of Georgia web-based teleconferencing software maintains these features (and thus may not be navigated with a text based browser because of certain page design choices). Another feature of a robust teleconference system is a means to track whether a particular user has read a message. In Participate the unread messages appear in a user "inbox" with a line indicating the relationship of the message to the topic thread.

Many Internet users access Newsgroups via a Newsreader (built into Netscape) or available as a separate program. Many such newsreaders track which messages have been read during a session, but do not keep track of messages read between sessions.

Universities such as the New York Institute of Technology built their distance learning courses around computer teleconferencing. It was an ideal way to maintain asynchronous discussions with a class that did not meet at the same time.

Lesson: It is the computer-teleconference that is the heart of much interactive learning on the Internet. As the structures of the conferences become complex, using hierarchies, the user can become lost. Interactive, hierarchical web pages are a simple extension of earlier technologies. Simple listserve technologies are bulk mail systems where one message to the list appears as e-mail to everyone on a list. Frustration is high among participants of these lists since the time required to find useful information is high. Nonetheless, such lists do form "virtual communities of interest" and some of much of the time spent is in experiencing that sense of community.

✯ (Use) Online Databases (Teles, 1991)

Teles documents the uses of online databases by students. Access to online databases was found to be a useful resource for students. Many "newcomers" to the Internet think only of "web pages" as resources (see Priest, 1995, Primer). While web pages with a powerful web crawler like the new DEC Alta Vista (http://www.altavista.digital.com) can turn up some curious information, almost all of academic reference materials are not on web pages.

A premier source of online databases is Knight-Ridder Dialog. Dialog, BRS, and SDC have maintained the most comprehensive set of academic databases for over twenty years. Nearly every abstracting service publication is available through one or more of these services. For business information there are online services such as Dow Jones.

In the last decade, OCLC (the organization that keeps track of what books each library in the country has) began an online database service in response to higher education schools' need for less expensive access to online databases (called EPIC or FirstSearch). Also, companies such as Silver Platter started putting some of the abstracts such as ERIC on CD-ROM so libraries could provide access without online charges.

Some states such as Ohio have established state-wide library access to online databases (see, e.g. Kohl, 1993 description of OhioLINK).

Access to useful databases, is, as a consequence of all these distribution mechanisms, uneven and sometimes costly. Colleges pay large site licenses to OCLC to permit all their students to access FirstSearch. A CD-ROM disc of a periodicals index costs around $1000/year and is limited to patrons of the library.

When networking people attempt to get, say, home access to a CD-ROM database they run into technical difficulties (discussed above) and licensing difficulties as contracts restrict the use of the database materials. Some Dialog databases cost $200-$300 per hour, putting them out of reach of all but the most serious business customers.

Yet it is many of these databases that students actually need access to via networks to get quality information. Fortunately, two of the more popular databases — ERIC (education) and MEDLINE (medicine) are produced by the federal government and the costs of CD-ROM's and online access are substantially lower than other databases. But, for example, Medline at $18 per hour is still a significant cost. If a student idly roams about it for a couple of hours, someone must pay the $36 bill.

Teles found that access to Grolier's encyclopedia and ERIC were very popular online databases for students (Teles, 1992).

A recent addition to the Internet is by Infonautics Corporation, creator of the Homework Helper online research service for students. In February, 1996, they announced the introduction of The Electronic Library on the Internet at http://www.elibrary.com. The library "aggregates more than 150 full-text newspapers, 900 full-text magazines, two international newswires, two thousdand classic books, hundreds of maps, thousands of photographs as well as major works of literature and art." (Press Release, 1996). The charge is $9.95/month for unlimited access.

The offer by Infonautics illustrates the kind of low-cost service that is currently possible on the Internet for resource materials. Note that the service offers more periodicals than one popular CD-ROM source called Infotrac but the coverage does not include magazines such as *Newsweek* or *Fortune*. The newspaper coverage is surprisingly good for this cost of service, but does not include major newspapers such as *The New York Times*, *Wall Street Journal* or the *Boston Globe*. It does, however, include the *LA Times* and the *Magill's Survey of Cinema*. The book coverage is mostly out-of-copyright pieces such as the *King James Bible*, but does include *Compton's Encyclopedia*, *THE WORLD ALMANAC*, and *Webster's NewWorld Dictionary*. By online search standards, the search capabilities are limited, but there is always a trade-off between good (and difficult) search capabilities and less precise (but easier) capabilities.

Also, American Online continues to expand their coverage — "comprehensive reference desk provides consumers and students with fast and easy access to information. AOL offers more than 80 sources on virtually every subject imaginable. (Press Release, Feb. 5, 1996)" New partners to the initiative include the Grolier Multimedia Encyclopedia, the Macmillan Information SuperLibrary (reference books), and INSO Corp.'s Columbia Encylopedia, Dictionary of Cultural Literacy, and Wall Street Words (definition of investment terms.) Current rates for AOL access is $2.50 per hour.

✎ As illustrated and discussed, some online databases and references remain very expensive via the Internet while others (e.g. Infonautics) are at very low prices. What is the teacher or administrator to make of all this? The answer is a matter of the comprehensiveness, depth and quality of the information. For example, for coverage of commerce and business, the *Wall Street Journal* (WSJ) maintains a level of comprehensiveness, depth and quality that very few other resources even compare to. Dow Jones, owner of the WSJ, doesn't even share their full text version of their publication with the leading online database vendor, Dialog.

The result is that the low-cost online database resources lack the "educational protein" of some of their cousins. A student can "thrash about" at an online search site for hours when a simple visit to the Reader's Guide or to Sociological Abstracts would have put the student onto key articles in minutes. But those resources are online only at higher costs.

Perhaps the student is learning something, in an exploratory way, by using a "second-best" resource, but the student is not learning to use the best research tools this country has to offer.

Lesson: The Internet will provide spotty coverage of useful online databases that schools can afford. When such databases are accessed via the Internet there are almost always online charges. Whether services such as by Infonautics or AOL will be able to provide access to databases such as ERIC, MEDLINE or the higher value databases such as offered by Dialog, at low, monthly costs is unknown.

In contrast, CD-ROM's with network licenses are likely to be the most cost-effective way for schools to provide database access to those databases not available through services such as Infonautics. Whether CD-ROM's will be more cost-effective for materials than those materials available through services such as Infonautics depends on how CD-ROM publishers respond to Internet competition, how many accounts a school might pay for to provide Internet access, and the ability for CD-ROM networks to provide for multiple use of the same CD-ROM. In establishing those site licenses, schools should opt for licenses that permit students to access the CD-ROM databases from home.

❋ (Use) Portable Eudora (Addessio, 1994)

There is a feature of Eudora that permits using Macintoshes by more than one student for e-mail. "The e-mail software was not installed on any of the systems in the computer lab. Each user was given a diskette that contained Eudora, the e-mail utility, and a unique settings file that identified them as the user. With the diskette, users would retrieve and archive mail, and they could move freely between systems while preserving the privacy of their e-mail. (p. 8)"

Lesson: E-mail systems that store messages and forward them based on user ID rather than machine ID are useful for students who do not have dedicated network machines.

☛ (Work for) Principal Involvement for Change (Weir, 1992)

Weir's *Electronic Communities of Learning: Fact or Fiction* draws from her years of experience with Seymour Papert at MIT and at TERC. This "must read" report is an excellent resource on educational change. In addition to appreciating the role of principals in bringing about change, Weir's discussion on whether the teacher or the student "controls learning" is revealing.

Lesson: Successful introduction of networking into the curriculum requires not only the involvement of the principal, but the principal's leadership as well.

☛ (Provide) Professional Development and Support (Solomon, 1995)

Lesson: Participants in the DOE National Technology Plan discussion (see bibliography) continually emphasized the need for Professional Development of teachers for technology to be successfully used.

☛ (Involve) Professional During Planning Stage (Lipman, 1995)

Lesson: "Get a professional involved in the planning stages. If cabling can be done during new building construction, it is much more cost effective. (p. 12)"

☛ (Involve) Professional to Oversee Contractor (Lipman, 1995)

Lesson: "Hire a professional to work with contractors and oversee the networking from start to finish. (p. 12)"

☛ (Use) Promotion Techniques to Aid Success (Robertson, 1995)

Introducing technology is about change. And change can be aided by promotional activities. Robertson lists these:

➾ Hold Executive Briefings
Show board members, community leaders, teachers, facility planners, finance directors, and the superintendent the latest technology. Ask hardware vendors to send representatives their latest products.

➾ Coordinate Tours to Other High-Tech Schools
Visit schools within a 5-mile radius to learn about equipment being used there

➾ Hold "Computer Day" for Parents
Invite parents for a hands-on computer day. Provide child care and after computer instruction. Teach them to use the software their children use daily. Plan enough instruction on word processing to allow them to create and print out a brief letter to their child.

➾ Have Students Evaluate Software
Choose a class to evaluate each new piece of software, a CD-ROM resource, or an Internet Resource. Better yet, develop a "techie tribe" that always, when new software arrives, fills out the registration card, boots it up, and explores its capabilities. Let the students demonstrate it to their teacher and the technology coordinator.

➾ Hold Contests Regularly
Carmen Sandiego Day - Broderbund has a catalog of Carmen Sandiego shirts, folders, context suggestions, stickers, and prizes.
Create Word Processing Contest - Promote keyboarding, word processing, and writing skills by integrating them into a contest.
Computer Art Contest - Students enter computer generated art work.
Internet Scavenger Hunts - Have students pick topics of interest and use Internet tools to find information. Have students compare information found on the Internet to other sources, such as going to the library.

➾ Seek Publicity
Write articles for local newspapers, magazines and chamber of commerce newsletters. Call the local newspaper every time you plan a networking contest or project.

➾ Develop a Media Center with a Trained Technician

Train the technician to use software and suggest networking projects. Have software catalogues, computer magazines, and Internet resource guides available (see e.g. Williams, 1995)

➾ Send Out a Newsletter

A regular, professional looking publication to the community is a great way to spread the word about your projects.

➾ Seek Outside Funds

Write grant proposals and ask local businesses to support the computer and network you want, what needs it satisfies and how much it costs. Enter any contest that offers equipment or software as prizes. Hold fund-raisers.

➾ Maximize Technology Use

Create mobile-laptop or multimedia stations, a video production studio, cable TV station, telecomputing station or satellite learning center. Allow students to checkout laptops, VCR's, video cameras, and classroom computers. Have your Computer Shop hold an annual fair where parents can see what was accomplished and members of the community can drop off computer equipment for the Shop.

➾ Reward those who Come for Training

Give tickets at the end of the session, have a drawing. Give away software, coupons for dinner at local restaurants, two T-bone steaks, candy, key chains, and paid vacations. (A paid vacation consists of one hour of freedom for the teacher while someone else teaches his/her class.

➾ Enlist Help

Help networking staff by selecting and training a computer contact teacher at each school.

➾ Train Students to be Troubleshooters

Teach them to set up and break down a computer, to understand networking monitoring tools and be able to locate a network fault. At the end of the year, recognize them with certificates of appreciation.

[Note: Above list was adapted to include network related activities]

✿ Provide Feedback (Kimball, 1995)

"Encourage those writers who contribute good messages by sending them private thank-you notes via e-mail, and by acknowledging them publicly in the conference or list. (p. 55)"

Lesson: Online environments lack many of the cues we are used to in face-to-face communication. Have your teachers and students learn to use symbols in their e-mail to communicate cues such as :) — "I'm smiling" (it's on its side!). A conference without personal and public notes of appreciation may collapse for the lack of rewards and recognition.

☛ Provide Resources for Teachers (Carlitz, 1994, Urban Settings)

"It clearly makes sense to provide resources for pioneers. While it might seem like a frill for some districts to encourage teachers within their system to experiment with new approaches to education, the cost of this exercise is minimal compared to the expenses that can be incurred by false starts and dead-end approaches to change. (IV-2)"

Lesson: The pioneering teachers in any school district are a valuable resource — one to be cultivated and used as a means of exploring new paradigms and models.

☛ Provide Staff Development (Massachusetts Software Council, 1994)

The *Switched-On Classroom* provides those school districts that are beginning to develop technology plans with a set of resources and instructions about how to involve "stakeholders" in the process.

The guide lists 10 areas of training and staff development (see Section 8):

- ➾ Introductory training
- ➾ Computer ethics instruction
- ➾ Technology-specific training
- ➾ Subject/grade level training
- ➾ Software courses
- ➾ Curriculum writing courses
- ➾ Distance learning instruction
- ➾ Classroom management strategies
- ➾ Technology as an assessment tool
- ➾ Process training

"Staff development implies more than training — it also refers to professional growth. Teachers must not only know how to use various technologies, but also must clearly understand how technology changes the learning process. (p. 8-1)"

Lesson: Staff development implies more than training.

⌘ (Use a) Public RFP (Chapman, 1995, Austin)

"The City of Austin released a Request for Proposals (RFP) seeking a private partner for a new city-wide information network based on fiber-optic media ... and includes the principles of universal access, an open system, interoperability, abundant bandwidth, true competition among service providers, etc., all in contrast to the cable TV model or the monopoly model of the telephone company."

There were critics that said the City's proposal was so outrageous and unworkable that no companies would respond. "So we're pleased to announce that the City of Austin got about a dozen proposals ... including proposals from major telecom companies like AT&T, MCI, Scientific Atlanta, GTE, and others (lines 47 - 54)."

Lesson: Traditional telecommunications providers may provide unimaginative solutions unless schools and cities ask for more.

✉ (ask for) Rate Reductions Based on the 1996 Telecommunications Act (Priest, Universal Service, 1995)

The Snowe-Rockefeller Amendment of 1995 added to the Telecommunications Act of 1996 a provision for affordable rates for schools:

> Section 254 -- Universal Service
> (B) Educational providers and libraries.-- All telecommunications carriers serving a geographic area shall, upon a bona fide request for any of its services that are within the definition of universal service under subsection (c)(3), provide such services to elementary schools, secondary schools, and libraries for educational purposes at rates less than the amounts charged for similar services to other parties. The discount shall be an amount that the Commission, with respect to interstate services, and the States, with respect to

> intrastate services, determine is appropriate and necessary to ensure affordable access to and use of such services by such entities.

However, this money does not come out of the "pockets" of the telecommunications companies, but rather from the total amount allocated for universal services as stipulated further in the Act:

> A telecommunications carrier providing service under this paragraph shall--
> (i.) have an amount equal to the amount of the discount treated as an offset to its obligation to contribute to the mechanisms to preserve and advance universal service, or
> (ii) notwithstanding the provisions of subsection (e) of this section, receive reimbursement utilizing the support mechanism to preserve and advance universal service.

Within a state it is the role of the Public Utility Commission (PUC) to determine what the amount of the discount will be. The PUC could decide that the costs to schools for telecommunications will be zero dollars, but, whatever they chose, those monies then must come from other universal services provided within the state such as rural subsidies and "lifeline" services. However, the State PUC can also raise the overall payment by telecommunications companies into the universal services "pot." Further, it can be expected that the total revenues of all telecommunications activities will increase as telecommunications becomes an increasingly larger part of all activities — business and personal. And as the total revenues increase, the monies available from the universal services payments would correspondingly increase, providing the additional funds to offset the school subsidies.

For schools to receive the rate reduction requires that the PUC implement this reduction. To ensure that the PUC does this and to ensure that the reduction is sizeable, it is the role of all interested in K-12 education to "lobby" the PUC for this reduction. The same is true for library rate reductions.

In determining the rate reduction, the PUC may wish to consider "means testing." In other words, it may wish to provide higher rate reductions for poorer school systems. Elsewhere in this report we discuss the problems of the "have's" and "have-nots." This is yet another opportunity to provide for the have-nots — in a way that provides increased learning benefits to the poor.

The Telecommunications Act does not, unfortunately, address the disparities among states when considering school subsidies for intrastate telecommunications. Since use of the Internet involves both intrastate and interstate telecommunications, the Federal Communications Commission (FCC) will decide what subsidies will be applied to the interstate portion of the charges. The FCC may wish to consider "means testing" for these subsidies, and thus subsidize either poorer states and/or states with more rural populations (and thus higher intrastate telecommunications costs). Since universal services decisions by the FCC will fall under the control of a "joint federal-state board," the education (and library) communities will want to influence this board in providing for higher rate reductions.

✿ (In online groups) Recap by Weaving (Kimball, 1995)

"Weaving is a networking term that refers to the process of summarizing and synthesizing multiple responses in a virtual group. The weaving item or response tells people where they've been, where they are, and where they might want to go next. (p. 56)"

Lesson: Weaving gives all members, however long they've been participating, a chance to start fresh or take off in a new direction.

☛ (Use of) Reflective Dialog for Professional Development (Spitzer, 1994 in Levin, 1995)

Lesson: Teachers and Staff need special attention using reflective dialogs when receiving professional development over networks.

☛ (Provide) Release Time (Graham in Priest, 1995)

Lesson: Professional Development involves providing release time for teachers by using substitute teachers.

☛ (Use an) RFQ not an RFP (Crowe, 1994)

Several tips have addressed the savings that can be achieved by schools that can provide careful specification of the network and other aspects of a school information infrastructure.

Lesson: An RFQ (request for quotation) can be issued when requirements are well specified.

⌘ Reconstruct The Role of School Within Larger Community (Hodas, undated, Culture)

"In Medocino, California, for example, an area devastated by declines in the traditional fishing and timber industries, the local high school has taken the lead role in developing a community-wide information infrastructure designed to encourage a fundamental shift in the local economic base away from natural resource dependency and toward information work. While initially dependent on NASA's K-12 Internet program for connectivity, the school district has moved to create partnerships with local providers to both secure its own telecommunications needs and be able to resell excess capacity to community businesses brought online by the school's own adult education programs. The school is moving toward a project-based approach that relies on Internet access in every classroom to devise an updated version of vocational education (Many of their students will not go on to four-year colleges) that meets both state requirements and the wishes of the Mendocino staff to work with their students in a radically different environment. (lines 872-899)"

Lesson: A hard pressed community has embraced technology both as a means of schooling and as a skill to be learned.

✉ Run Fiber (McKanna, 1994)

"The cost of labor is the highest portion of the installation. Having to rewire the buildings at some time in the future would result in paying the labor charges twice. The district installed fiber optic cables capable of carrying data at gigabit speeds in all buildings." (p. 5)

Lesson: As demonstrated in the discussion at the beginning of this Section, cabling labor can easily cost 90% of the entire wiring project. While fiber technologies will improve significantly in future years, the actual fiber cable will change little over that time. Install fiber optic cable today. For long, inter-building runs use it. Within buildings, however, use Category 5 (or equivalent) cabling for use today.

✿ Search the Internet First (Peha, 1995)

"Search the Internet yourself before asking students to. As one teacher said, 'Know what to look for in advance, so you and your students will not be disappointed.' (p. 21)"

Lesson: A scavenger hunt for something not on the Internet may be a waste of time and incentive. Remember that most useful academic online databases are not accessible by the Internet without providing an online account at a search facility. Materials that are out of copyright are most likely to be found on the Internet. So plan on finding Shakespeare and not finding authors within the last 100 years. There are exceptions. Some publishers permit authors to put a chapter on the Internet as a "teaser" to encourage sales. News releases, especially those where the publisher pays for the release, such as PRNewswire, are more likely to be on the Internet than stories sold to publishers, such as those by Associated Press or Reuters.

✿ (In Internet projects) Set Clear Goals

"Students will learn if they can see that they are involved in doing something real. To learn science, let them really be scientists. They had specific tasks to perform and data to analyze. (p. 31)"

Lesson: Clearly establish tasks and goals for Internet-based projects.

✿ (Use) Short Projects (Teles, 1991)

Lesson: Short projects have more easily identified beginnings and endings, providing the student with a whole learning experience.

⌘ Show, Don't Tell Students (Walker, 1995)

"Using library visit times and moments from planning periods, we showed small groups of students the basics of using Ottawa's Free-net, Usenet newsgroups, and resources retrievable by gopher. (p. 32)"

Lesson: Showing students results in active learning.

☛ (Use) Small Implementation Steps in Introducing Technology (McKanna, 1994)

"Take one building or technology at a time. Allow the staff and students time to absorb the changes. (p. 12)"

Lesson: Grow teachers, staff, and students as the technology grows.

☛ (Use) Specific RFP (Lipman, 1994; McKanna, 1994)

If you don't have the confidence to issue at RFQ (see above) then "...be specific in your RFPs. If district staff or architects don't have the necessary skills to write detailed specifications then find someone who can write them. All too often, specific details are left out leaving much to chance in the end. (p. 11)"

Lesson: It is easier to hold a contractor accountable with a thoroughly detailed specification than one which has left much to the imagination. Remember, assembling new technology is part of a discovery process that requires study and preparation.

☛ (Use) Standard Naming Conventions in the Network (McKanna, 1994)

"Standardize on naming conventions. One of the very first tasks of a large district is to establish a standardized naming convention for users as well as devices both for ease of use and for security. For example, have all student IDs begin with an "S," all teachers with a "T," administrators with an "A" and clerical staff with a "C." This immediately provides the first level of security for any large network. (p. 11).

Lesson: Standard Naming Conventions are part of the larger standardization process that can reduce costs and ease operation.

✉ Standardization on Equipment (McKanna, 1994)

Lesson: "With the limited dollars available in education, it is much less expensive to maintain standardized equipment right down to the bulbs in the overhead projectors. Service is easier, replacement faster and diagnosis of problems less time consuming. (p. 11)"

☛ Start Small If Necessary (Walker, 1995)

If your school doesn't have a network you can still start Internet-based projects. In the case of an Ottawa, Canada site, the school could access the Internet through the Ottawa Free-net, saving on provider charges. A single machine was connected via phone line and students prepared e-mail material on other machines — using the one Internet machine to send and receive e-mail.

Lesson: Using e-mail, even simple arrangements with older equipment can provide satisfactory projects. While dial-up access is not recommended for networking an entire school, it is a way of introducing students and other teachers to potential uses.

✎ It is possible to access almost every resource on the Internet via e-mail. Web pages, gopher resources, and even newsgroups can be accessed via e-mail. There are addresses on the Internet where an e-mail request is sent and the receiving machine processes the request and sends back the desired information. Nonetheless, this method of access requires patience and imagination. Also, it often takes an administrator or teacher seeing Netscape, perhaps with Acrobat and RealAudio, to get excited about the Internet. Indeed, there are many documents on the Internet in PDF format which require an Acrobat reader (some of these documents are networking resources and are labeled PDF in the bibliography of this report). There is a version of Acrobat that runs under DOS (not requiring Windows) and using that reader and e-mail, one can obtain any of the listed PDF files in the bibliography and read them. Since PDF files can be several hundred thousand bytes large it can take many minutes for the document to appear via the Internet unless the user has a very high speed connection. Therefore it is common to store PDF files locally if they are used for reference.

✎ About fifteen years ago the postscript format for representing text and drawings was developed. To this day it remains the most universal method of describing documents. On the Internet there are both Postscript files and PDF files. PDF is a compressed form of Postscript. To view Postscript files there are shareware readers for Windows and Macintosh platforms (see Aladdin, 1995). To view PDF files there is Adobe's Acrobat (see Adobe, 1995).

RealAudio is one of a few ways to receive audio recordings via the Internet. For example, National Public Radio's "All Things Considered" is available over the Internet (visit http://www.prognet.com). This kind of Internet use is really quite useful. An index of NPR's readings is provided via Netscape and a particular segment can be chosen and listened to. (Of course what makes this possible are "contributors like you" and tax dollars that support NPR. The recent rescue of federal funds for public radio attests to the value that many place on NPR and PBS.)

☚ State Size for Contracting Power (Kohl, 1993)

Some states have found that they can achieve economies by contracting for access to online database materials. Ohio has done this in the case of OhioLINK.

Lesson: This suggests that school districts should cooperate with state agencies in determining database needs and purchase state-wide licenses for materials. As an example, as noted above the EPIE Institute provides a database of over 17,000 educational software products on CD-ROM. States that have purchased membership in EPIE's State Consortium for Improving Software Selection (SCISS) can receive and distribute CD-ROM's to libraries and schools for an "at-cost" fee beyond an annual license fee. The Commonwealth of Massachusetts is providing the database to schools, parents, and students through MCET (Massachusetts Corporation for Educational Telecommunications) via a web page; Texas provides the database via WAIS on their state-wide network called TENET.

✿ (for online conferences) Support (and Recruit) New Members (Kimball, 1995)

Since online conferences are often continuing discussions, a new member can be confused or lost. "Although new members can stimulate a virtual group, they may have problems figuring out how to enter a fast-moving discussion. One way for them to introduce themselves is to create items that anyone can respond to, even those who don't think of themselves as experts on the topic. Send a message to newcomers encouraging them to respond to those items. (p. 56)"

Lesson: Online conferences should be facilitated to welcome newcomers.

☚ (Have) Support of Administrators for Implementing Networking (Carlitz, 1995, Urban Setting)

Suggestions above about using internal competition and effective planning will not work without "...the support of administrators in the school district."

Lesson: "While grass-roots efforts must be at the heart of any effective educational reform, such reforms can never pass out of the classrooms of the first adopters and across the entire school district unless they are clearly endorsed at all levels of the school administration. (IV-6)"

☚ (and Have) Supporting Infrastructures (Carlitz, 1995, Urban Setting)

"Any technology plan must include not only the elements of necessary hardware and software but also a supporting infrastructure adequate to maintain equipment that has been purchased and to assist teachers in its effective use in the classroom. (IV-9)"

Lesson: Maintenance, network information services, network operations services, and network projects related to curriculum objectives must all be available to teachers for networks to provide benefits.

✉❋ (Use) TCP/IP (California Guide, 1994; Gargano, 1994; Warner, 1994)

Lesson: As described above, even Novell has provided TCP/IP as an alternate to their proprietary IPX networking protocol. Since the Internet and its many tools have been built on TCP/IP, it has become a standard throughout networks.

☚ Teacher Training (Addessio, 1994; Apple, 1995, Staff Development; Benson, 1994; Bull, 1994; Carlitz, 1994; Chamberlain, 1995; CPB, 1995; Espalin, 1995; Fulton, 1995; Gallo, 1994; Guerette, 1994; Harris, 1995, Hunter, 1995; Internet World, 1995, Global Schoolhouse; McKanna, 1994)

No single factor for the success of networking is mentioned more often than teacher training and professional development. Section IV of this report discusses the issue of teacher training in relationship to networking models and the benefits of networking.

⌘ (Use) Technology to Promote Change (Hodas, undated, Culture; Solomon, 1995)

School culture, change, reform, and conditions are the subject of many discussions and debates. Section IV discusses these issues in relationship to technology.

Lesson: While technology can aid in school reform, technology, alone, will not cause reform.

✿ (Use) Telecomputing Projects (Rogers, 1990, 1994, undated)

Rogers and others have studied many instances of successful and unsuccessful use of telecomputing projects in schools and learning. Above, under the discussion of Learning Circles, Levin's discussion of the theory of telecomputing projects provided a number of characteristics of successful projects. Here we review Rogers' guidelines for "successful online learning experience with your students (Rogers, 1990, line 70)"

➩ Design a project with specific goals, specific tasks, and specific outcomes. The more specific, the better; the more closely aligned with traditional instructional objectives, the better.

➩ Set specific beginning and ending dates for your project, and set precise deadlines for participant responses.

➩ Phased deadlines establish a sense of accountability to the other participants in the project and make it easier to secure follow through. Even if the teacher is inclined to drop out, students who know the deadlines will often hold their own teachers accountable to complete the project.

➩ If possible, try your project out with a close colleague first, on a small scale.

➩ Request collaborators by posting messages on electronic bulletin boards, and by sending out flyers if possible

➩ Give specific information about your project in the call for collaboration including goals, your location, grade levels desired, contact person, timeline and deadlines, how many responses you would like, and what you will do with the responses.

- ➾ Provide examples of the kinds of writing or data collection that students will submit.
- ➾ Find responsible students and train them to be part of your project.
- ➾ At the conclusion of the project, follow through on sharing the results with all participants.

Lesson: "For some teachers, telecommunications expands the horizons of their classroom, opening the doors to real audiences and exciting interactive activities from locations around the country and the world. These teachers know its capacity to motivate students and involve them in productive learning experiences. (lines 13-18)"

✿ (Use) Telementoring (Means in Levin, 1995)

Lesson: Stanford Research developed telementoring structures for on-the-job learning

✿ (Use) Telecollaborative Projects (Harris, 1995 in Levin, 1995)

Lesson: Harris describes sixteen different activity structures for telecollaborative projects, which she groups into three "structure genres": interpersonal exchanges, information collections, and problem-solving projects

☛ (Find) Time for Teacher to Learn to Use Technology (Means, 1995)

"Providing time for technology-supported education reform is critical. Observers of pioneering efforts in this area argue that changes do not occur overnight. In earlier studies, researchers have concluded that something on the order of *3 to 5 years* is required for teachers to become really adept at incorporating technology into their teaching practice (Sheingold, 1990; Sterans et al., 1991). (p. 76)"

Lesson: The relationship between technology adoption and the practice of teaching is not a simple one. This issue is discussed further in Section IV.

✉❋ (Make use of) University Assistance (Graham, undated; Rothstein, 1995; Carlitz, 1995)

Many K-12 schools received both technical assistance and connections to the Internet in the late 1980's and early 90's. NASA, NSF, and other government agencies support projects through Universities that assist K-12 schools such as the "Common Knowledge Project" between the University of Pittsburgh and Pittsburgh schools.

However, with increasing numbers of schools developing networks, the majority will not be able to receive such individualized attention.

Lesson: Universities may be an alternate source for expertise and advice, depending on circumstances.

✉❋ (Make use of) Vendor Information (Graham, undated; Lipman, 1994; Graham in Priest, 1995)

Earlier we noted that Ken Graham saved 2/3rd's of the cost of installing a network by specifying the network himself. Yet he was "only" a remedial English teacher.

Graham relied on two sources of information: 1.) the expertise of a principal member of a local networking company, and 2.) the literature from networking and network supplies vendors.

For example, he related how the MilesTek (1995) catalog of Ethernet supplies provided short tutorials on subjects from choosing the correct "Thinnet" cable to trade-offs in kits supplied to terminate fiber connections. A simple call (see bibliography) brought this most informative resource in a couple of days.

Another expansive catalogue of networking products is by Black Box (1995). This distributor carries not only a wide range of cabling but hubs, routers, and associated equipment . Another call to Xyplex brought Xyplex's introduction to ISDN (1995). And another call to Novell brought materials on Netware. [Note: these are illustrative sources and may not be the lowest cost/best service vendors for you.]

In addition to advice from vendors, there are numerous people who have placed detailed, how-to guides on the Internet. We note Rackley (1994) on network wiring standards, Spurgeon (1995) on many aspects of both 10 Mbps and 100 Mbps Ethernet, Bigelow who describes both LAN and WAN choices including the use of Frame Relay (1995), the California Guide (1994) with a wide variety of practical information, various Apple tutorials in text and PDF format (Apple, 1995, many), PacBell's ISDN Guide in PDF format (PacBell, 1995), Smart Valley's networking plans and guidelines for schools (1995), HaLevi's postscript file on the evaluation of intelligent 10Base-T hubs, and Wasley's technical model for school networks in postscript. (For a PDF viewer consult Adobe, for a postscript viewer consult Aladdin, both in the bibliography of this report. Recall that a PDF or postscript file is able to include vital diagrams and figures that simple text files cannot.) Cisco, a leader in routers, has posted many materials on internetworking and connectivity (Cisco, 1995, several). Another "jumping off place" is to visit http://www.industry.net. This site has a page dedicated to networking hardware, software, and cabling. (Do keep in mind that this is a selective subset of many possible vendors.)

Lesson: Whether it is someone who comes from within the school, or someone you hire from the outside, your technical support person should rely on local networking companies, vendors, and Internet resources to fill out his/her knowledge and save the school money, time and aggravation.

☛⌘ (Use) Volunteers (Boulder Community Network, 1995; Snow, 1995; Komoski & Priest, Eliminating Virtual Ghetto; Massachusetts Tech Corp, 1995; W3.COM, 1995, NetDay96)

It is important to distinguish between four types of volunteers that relate to school networking:

1. Community Interest Volunteers — these are the kinds of volunteers that have supported the community bulletin board movement (see Snow, 1995; BCN, 1995) and have supported broader learning community efforts such as LINCT (Learning and Information Networks for Community Telecomputing) see Komoski & Priest (1995).

2. School Project Volunteers — these volunteers are organized around a project, such as wiring a school (see for example W3.COM, 1995, NetDay96; Reuters, 1995).

3. Networking Assistance from Local Companies - these are people who often aid specific individuals in schools on networking questions out of an interest to "be of assistance."

4. US Tech Corps - a project begun by Gary J. Beach, publisher of Computerworld. In Massachusetts the co-sponsors are Comnputerworld, Deloitte & Touche, and the Massachusetts Software Council. In early 1995 over "300 volunteers were recruited in January and February, with schools and volunteers meeting in early March to define their projects." "The Tech Corps provides human resources that can support and enhance the school's technoogy planning, training, and implementation power. The 'people power' offered through the Tech Corps helps schools offset a portion of their costs of bringing classrooms and schools in the the Electronic Age. (Mass. Software Council, 1995, lines 41-45)"

A Massachusetts Tech Corps Newsletter (http://www.swcouncil.org:80/techcorps/newletter. html#projects) describes over 100 projects involving local volunteers, e.g.:

- ➩ A Hingham volunteer assists staff once a week with hardware and software questions
- ➩ A Worcester volunteers is providing network support for a LAN
- ➩ A Dennis-Yarmouth volunteer is mentoring an advanced high school technology student
- ➩ A Pentucket volunteer created a brochure to assist with community outreach

Lesson: Schools have several important volunteer resources to choose from. To establish a community base, start a chapter of LINCT. For access to technical assistance contact either a local networking compnay or a chapter of the US TECH Corps. While Massachusetts may be further ahead than other states, there are TECH Corps chapters in every state (send mail to ustech@cw.com to obtain a contact).

✿ Well Defined End Points (Fredman in Teles, 1991)

"Timeline considerations must be taken into account: short projects with well-defined end-points have been successful. (p. 6)"

Lesson: Keep the project short and contained.

✉ Wireless (Frezza, 1994; response to Frezza (1995) by WinForum; Komoski and Priest, 1995, Vision Paper for Workshop; Metricom, 1995, Lovette, 1995)

Bill Frezza, president of Wireless Computing Associates and the chairman of the wireless modem standards committee of the PCCA, caused a stir when he published an article (1994) called "Bypassing Your Way Onto The I-way" in *Network Computing*.

In reference to the problems of on-ramps to the superhighway he said "Why not just skip over the whole mess by slapping an antenna on your PC." Frezza was responding to Metricom's ability to connect a PC to the Internet using a wireless modem.

Metricom sells a wireless modem, which will operate at "raw" rates of up to 100 Kbps. Data throughput is less than the raw rate, but distinctly higher than a 28.8 Kbps modem. The wireless modem sells for $299 when a one year subscription is purchased and $600 separately.

Internet access is charged at a flat $29.95/month. In a recent press release (10/11/95) the prices of other wireless services (ARDIS, RAM) which charge by the amount of data were quoted as follows:
"If you send/receive 10k in e-mail or Internet/Web data per day, other packet data services cost: $100-$250."
"If you send/receive 50k..., other services: $475-$1,250"

There is a major qualification, however, for Metricom's Richochet network. It requires a set of transceivers to be installed every 1/2 mile. So far only a couple of communities are connected, such as Santa Cruz, CA, but Washington, DC is projected for some time in 1996. ARDIS and RAM wireless services are available nationwide. These services began as an extension of paging services, and the bandwidth is limited, thus requiring charging by the amount of data. The transceivers are located miles apart in contrast to the Richochet arrangement.

David Hughes raised awareness about wireless possibilities when he purchased two of the modems and demonstrated wireless Internet connectivity. Since the modems can talk to each other as well as to the transceiver, Hughes could place one modem on a phone line to the Internet and the other (within a few hundred feet) to the PC. Hughes is currently evaluating a wide range of wireless equipment under an NSF grant.

Metricom makes use of a frequency hopping technology in an "unlicensed" part of the spectrum (902-928 mhz). While this is crowded with other wireless applications, there is usually sufficient clear channel capacity. Metricom recently petitioned the FCC to prohibit vehicle monitoring uses of the band for fear that this use would interfere unduly with their applications.

Also, there is competition from the providers of digital cellular services, but, again, this is not widely deployed.

Priest and Komoski (1995, Vision paper; Priest, Spectrum, 1995) see the opportunity for a $100 PC modem using vast unused areas of the UHF spectrum and by hopping around users in other bands, such as 6 meters (used by Amateur radio operators). Such a wireless board would have a 10-20 mile range and could place an entire community on a wireless LAN estimated to carry a total capacity of 300 Mbps. While such a network would not meet the demands of a heavy Internet user, it is ideal for universal service. Further, as the solution is deployed in rural areas, the technology has more unused bandwidth and performs better. Priest and Komoski are promoting the concept to regulatory commissioners as a means of providing digital universal service for the country at extremely low cost.

There have been other proposals for wireless access. Lovette (1995; Warren, 1995) petitioned the FCC for additional unlicensed wireless space and last year the FCC granted 20 mhz from 1910-1930 mhz for unlicensed wireless use. And Lovette has petitioned for additional space, some are calling the NII band, in the 5 ghz area.

✎ Radio spectrum consists of transmitters and receivers that send and receive "radio waves." These waves are described in terms of how many times they cycle in a second. An AM radio station transmits in the area of ten thousand cycles per second. Recently, in honor of Heinrich Rudolf Hertz who was first to artificially produce a radio wave, the term "cycles-per-second" was replaced by "hertz." Thus an AM radio transmits at around 1000 khz (kilo-hertz, or thousand hertz). The FCC band granted last year is at 1910 mhz (or 1,910 million hertz, also called 1.91 gigahertz, giga for a thousand - million). Shannon's theorem (Van Nostrand, 1995, Bandwidth) describes how much data can be transmitted over a certain bandwidth, at a certain radio frequency, in the presence of noise. Bandwidth is the "width" of the signal, usually centered around the signal's frequency. There is always "noise" in radio bands - tune a radio (that doesn't shut off noise) in-between stations and you will hear noise or "static."

One characteristic of radio waves is that lower frequency waves travel further (Meresman, 1995). Thus higher frequency transmissions, especially those in the gigahertz, can only be reliably used over hundred's of feet. Tennenhouse (in Priest, 1995, Trip Report) describes the world moving toward smaller and smaller "cells." A cell is an area covered by a radio transceiver for local signals. This is why we have the phrase "cellular phone." As frequencies reach the 5-6 ghz range, cells typically drop to less than 100 feet.

For reliable universal service using the Priest/Komoski wireless card plan, lower frequencies such as in the range of 50 to 500 mhz are more reliable in semi-urban areas.

Another popular use for wireless transmissions is for "point to point" communications. Companies such as Proxim, Freewave and several others offer transceivers for around $1200, each, that can reliably transmit, point-to-point, at distances of up to twenty miles at data throughputs of around 120 Kbps. These are comparable to ISDN speeds but incur no monthly charges. In the right setting, say between one school building and another, a wireless point-to-point link will be more cost-effective than any other alternative.

Lesson: Schools should consider wireless for inter-building, point-to-point connections. A pair of transceivers is around $2400 and have no monthly costs except for possible maintenance. Within schools, solutions such as Metricom's are more expensive and lower bandwidth than typical wired solutions. Other services that charge by the message are distinctly too expensive.

Support of the Priest/Komoski $100 wireless card would help connect communities. At this cost, any student with a wireless card and a donated PC have a means of reaching out to the learning ecology of his/her local and global communities (see Section V).

<u>Survey Results with Participants of the Council of School Networking List</u>

Over seven hundred people subscribe to the list cosndisc@list.cren.net. We posted a series of 6 questions on the list at different times, asking questions about cost-effective techniques.

Over the course of six months we received a total correspondence of about 350,000 bytes (around 80 pages). This compendium is available as a separate document (Priest, 1995, CoSN Survey).

Responses ranged from very specific technical instructions about hub choices to discussions about the morality of using lottery funds to support education. We recommend that technology coordinators download the document when it is posted on the Internet for "a read." It is a set of stories and excursions that provide a down-to-earth sense of the experiences of schools at varying stages of networking.

There were no "magic bullets" in the responses, but there were a lot of sensible comments about the networking process. The following are selected quotations from the survey:

> We leverage a common Linux box (486 running Linux as operating system - $3300 for hardware, software is free) as our name/mail/web/gopher server.
>
> Or we start simple LANs from scratch. We just came back from Smithburg H.S. They now on [are] online with hub connecting macs and Linux box and router in a simple 10BaseT net. We know a heck of a lot more than we did a year ago.
>
> Two teachers from each school will receive training in integrating techniques of computational science into their courses at special workshops
>
> We use CATV broadband cable to shape one T-1 connection between five districts, two municipal governments, and a public library [see Cable Modem, Mundt, Glenview, above]
>
> My school system wants to train high school wizards to fix/install/salvage computers, but we haven't started yet
>
> [regarding school-home connections] This is surprisingly cheap - $1200 in hardware and $1K in software, and you have a complete 4 port voicemail system with total flexibility. Of course, since most schools don't have phones in the room, how do the teachers use it?
>
> Pull Cat[egory] 5 4 pair, even if you don't need it now
> Use a punchdown block & octopus for maximum flexibility at low incremental cost
> Use a central "stackable" hub, with at least one connection per room. This allows any room to have a low cost hub if there are more than one computer per room. Use another stackable in a lab. Cheap hubs work fine
>
> Pull video and phone at the same time
>
> Borrow a wiring certifier. Wonderful device, and I've always found someone willing to let me use it for a few hours.
>
> My company [a local networking firm] allows teachers in our town a dial-up account on our Unix servers for free. I volunteer in my schools to select equipment, install, train
>
> I am a parent. We did it ourselves, no consultants were used. [We] conducted a survey of kids, parents, teachers, administrators, staff, board members and community members about their familiarity, attitudes, needs and desires with respect to technology... Having the kids do the demo rather than staff or parents was very effective. Made a good impression on the board... Establish a fund for in-house grants.

One important thing you want to make sure of in any purchase is that you buy a "PBX" type [telephone] system and not a "key" system. The reason you want a PBX is that the total cost is always, in my experience, less. The more phones you have, the more this is true.

Buy a used phone system. Used phone systems are cheap, and if you buy a quality system, will last a very long time. [And] buy a software controlled system; there aren't many really old software controlled phones around. Insist on all the manuals before you sign the contract. Make sure you get everything you need to program it yourself. Negotiate spare cards with your purchase. A spare line card and a spare station card will allow you do do most first level maintenance yourself.

When you install [telephone], install network wiring at the same time. If you do nothing else, do this one.

Let me add that you can upgrade these systems [donated from corporations] as well as your older PC systems inexpensively:

- We will train several enterprising high school computer buffs to do upgrades
- We can buy 486SX motherboards with 2MB of memory for $150, plus an Ethernet card for $40. We keep case, power supply, floppy disk, hard disk, video, monitor & controller
- We will clean the machines, swap the motherboards, clean the floppy disk drives, reformat the hard disk, and reload DOS
- We also purchase and load Windows and also load a public domain network client. With a Linux based server, we can live with the small hard disks that are typically on these systems.
- On some of the monochrome systems, we buy a new monitor ($150-$200) and an SVGA card ($50)
- We are careful to make sure that the motherboard is a standard size, with standard mounting holes.

I'm looking for a way I can connect 24 IBM clones (386SX33mhz) to the net without having 24 MODEMS, and 24 phone lines

> [In response] I have been thinking about this for our local school system, and there has been some discussion about it in past posts. The general answer is that you network your 24 IBMs together, hook a single modem to one of them, and they share the access. Saying that is easy, doing it is less easy. One possible solution is to buy Windows with Workgroups, and a program that will share the serial port across the network. All the IBMs would be networked with WfW, and the serial port sharer would be used to share access to the modems. This is easy, and not very expensive, but only one user at a time could access the network. If you have a machine that can be used as the server, then this [an Ethernet network] will cost you less than $200.

✎ The Terminal Server software discussed above a discussion box, provides yet a different alternative. Serial lines are used to connect the PC's and they all have simultaneous telnet capabilities running as VT-100's. For machines of the class, here, this is probably a waste of their ability to run Windows and Netscape, etc. If the machines were more limited, say Apple II's, the Terminal Server solution is ideal.

For your Netware buildings, there are a number of NLM servers that will allow TCP/IP connections. I favor running a TCP/IP stack in parallel with the Novell IPX/SPX stack. Commercial TCP/IP servers (PC-NFS, Chameleon, etc.) does this, and, I think you can run WfW with Microsoft's TCP/IP stack with Novell. It eats memory to do this. [See discussion above about newer products that will provide Novell IPX and TCP/IP as a single stack, reducing memory requirements.]

For the Unix server, an excellent choice is the new Sun Netra line. If you are strapped for cash, a perfectly acceptable alternative is a decked out PC running Linux (free, or <$100), but you need more expertise to set it up. The Unix server is not "in line" with all the clients, it is used to interface DOS clients to the net, and it is the e-mail "post office", as well as the name server, etc.

[teacher speaking] The trouble with our profession is that while we prepare children for the world, we're so busy we often do not know what the rest of the world is doing!!!

[for installing Frame Relay] Just went through this. I recommend a Fastcomm EtherFRAD. For about $1500 total, you get a CSU/DSU, FRAD and IP routing for 56K frame relay connection. The router is not at all as configurable as, say, a Cisco, but it's a whole lot less expensive, and works very well.

[the following is a multi-step program suggested by Brian Rosen (br@nomos.com)] ... so here is my list, assuming that budget dollars are available, but pretty tight. Warning - I'm a Do It Yourself kind of person, a taxpayer and a techie. This plan only works if you can beg, borrow or steal some expertise. Find a parent who will help.

1. First year - building nets, frame relay WAN. In each building:
    - Pull Cat[egory] 5, 4 pair to each room, RJ 45 wallplate termination in rooms. If lengths are short enough, terminate all in one closet, otherwise, multiple closets & pull Cat 5 from each closet to one central site. Note: if you don't have it already, pull a 2 or 3 pair telephone cable, and a video cable at the same time. Wire is cheap, labor is not, but the whole job can be done by volunteers. [Note: EPIE/CITS also advises pulling 4 strand glass fiber if the labor costs exceed $10/foot, but leaving the fiber unterminated for later use]
    - Terminate closets with Cat 5 rated punchdown blocks. I find 66 blocks with telco connectors + octopus the least expensive, but patch panels with 110 [volt] style IDC contacts and patch cords to the hub are nicer.
    - Get the wiring certified to CAT 5
    - Cost: depends on labor, materials are $200/1000' wire, $5 wall plate, $4 per room for block + $5 octopus or patch cord.
    - Put an unmanaged, stackable hub in the closet. Choose one that can be upgraded to SNMP managed: $35-40/port.
    - If you have to use multiple closets you can:
        - Best - purchase a low cost router for the building, connect the closet hubs to the router. This will allow you to use a hub to the router. This will allow you to use a hub in any room that has more than one computer in a room. Use cheap unmanaged hubs in the rooms if you must. If possible, buy ones that can be upgraded to SNMP managed later. Router costs vary all over the map. Cheap unmanaged hubs are $150, upgradeable ones are $250.
        - Not as good - use a bridge to connect each closet hub to the central hub. Also allows a hub in any room. $1000 per bridge.
        - Worst - pull cable for each computer to the computer hub, or very carefully plan the system so that there are no more than 3 hubs between any two computers.
    - Get the least expensive Ethernet adapter you can find. I like the Kingston one, which is about $40 apiece.
    - Connect buildings together & to the Internet with Frame Relay. Use a Fastcomm EtherFRAD (CSU/DSU, FRAD & IP router for $1500) one per building.
    - Get a decked out (big disk, big memory) PC & run Linux to be your server ($3K). If you have more money, use a Sun Netra (?$8K), or something like it. You can go for Netware everywhere but that is big bucks. You only need one in the district if you don't provide file sharing this year. Run e-mail, news (bulletin board), ftp, WWW, Gopher, Telnet, etc. everywhere.
    - This gets every computer in the district on one big, not very well routed network.

2nd Year:
- Put a server in every building, provide file sharing using NFS, LAN Manager, Netware, Appleshare or some combination.
- Put in a district router for the WAN & Internet traffic.
- If you needed multiple closets, and you didn't get a building router, do it this year.
- Upgrade to SNMP managed hubs. Purchase a decent SNMP management software package. [EPIE/CITS Note: SNMP is Simple Network Management Protocol, an industry standard, that permits the network manager to analyze traffic flows, balance the network, and find faults.]

3rd Year:
Upgrade WAN to T1, or better if available

Our asbestos abatement crew has offered to lay our lines above the ceiling tiles. We will have four Asante Hubs with 24 RJ45 ports.

[Kurt Richter FTKBR@aurora.alaska.edu provided this reality check] Well ... Our technology committee pushed for this for this [volunteer wiring of schools] for past three years. When we finally met with the director in charge of buildings, he pointed out at least three areas that would be impacted by parent accomplished wiring of a computer system.
First, the liability issue is a major concern. Were a parent to injure themselves during a volunteer activity such as this, the school's liability would be total. This was not acceptable to our administration.
Second, there are too many connections and too many possible technical problems that could be a problem. Though this was less of a concern, it might negate the efforts of the individuals and still result in a system that was not able to function properly.
Third, the issue of structural and fire codes being violated is real, at least in our school. There are any number of walls which would have to be dealt with and the subsequent holes and penetrations were not acceptable from a structural and public safety point of view.
Thus, saith the buildings guru ... and our wiring plan for the building remains stalled within the lineup to get all the building wired. We'll likely be wired up soon ... before the turn of the century ... hopefully ... maybe.

✎ The issues raised here are serious and certainly challenges the idea of using volunteer wiring. But they can be dealt with:

1.) Liability -- have all volunteers sign release forms that have been drafted by the school's attorney; make sure there are no glaring dangers in your school (while a release form usually protects the school, an unusual danger might still become grounds for a law suit);
2.) Connections: indeed, each connection is a potential source of network difficulty and needs to be performed very well; have a technically proficient person perform the actual connections, preferably someone who does network wiring regularly; check the network with a device that locates faults (while these devices do not find all faults, such as an intermittent problem, they will reveal many);
3.) Firewalls: wires that run through firewalls may not be PVC covered (such wire is more expensive but necessary), all holes through firewalls must be sealed (or sufficiently tight) — have your local building inspector involved to be sure. In summary, the highest cost to wiring is the labor cost. Many schools have been successfully wired using volunteers.]

We had a lot of insurance/liability concerns raised, but in the end, it was not a show stopper. In one building that had asbestos, we couldn't even talk about it. We did not have union concerns in our district. We do use the maintenance staff to do incremental wiring. [in response to the EPIE/CITS question on using parents to wire schools]

I am a district technology coordinator and I have worked with a student and with maintenance men to add 10BaseT cabling in our building. If proper attention is paid to a few details, students and parents ought to be able to be very helpful in laying cable. [A KY coordinator]

Our computer club is putting in 10BaseT wiring to about 5-8 locations. They have already done our main computer lab. We received permission from the district - main caveat was to avoid asbestos areas - in this situation the wire is run along the intersections of wall and ceiling.

[This respondent spoke to networking content] This past winter we launched the Discovery Learning Community (Focus On: The Promised Land)... and our focus has been on providing teachers, learners and their educational partners, a supportive environment (lots of hand holding) so that they might find the significant reasons to incorporate technology into education on their own. The media specialists in each school have played a critical role - once the interest has been sparked, the media specialist can help the teacher one on one. We are finding a *projects based* approach most helpful ... it gives teachers, learners and their educational partners (community based mentors, museum, institutions, research centers, etc.) a REASON to log on.

I have many wiring stories. I first wired the building with single pair for a Corvus network in 1986 or 7. [This respondent is a veteran of school networks, Paul Reese] I purchased a heavy drill and masonry bit and then plotted paths through our 1917 building. Realizing that the New York city bureaucracy might not be supportive I wrote a very general letter to the Custodian not asking for permission but stating in as general a way as possible what I planned to do. I had the good fortune that general repainting of the building was planned for the summer. When that wiring became obsolete I resorted to draping long lengths of Apple LocalTalk cabling out windows and around the outside of the building. It worked find for several years. The school had a local exchange installed. All planning was done at the central board without asking about our possible needs. However, with rare but limited foresight they put redundant level [Category] 2 wires. They also installed large wire chases with removable covers. However, they failed to provide conduits through the walls. In any case I learned how to use punch-down tools and attach wires to the blocks. Within a week I have been drilling new holes; then running coaxial cable along the wire chases for an even faster network. This time we left a string in the chases so that we don't have to remove the covers.

> ✎ if you can't convince your school to buy fiber, at least run a strong nylon cord when you wire through any enclosed areas, so, later, someone thanks you mightily for your forethought.

On Unix hosts on the Internet I use PPP (Point-to-Point Protocol) for dial-up access. I use native SMTP Sendmail with Pine or Elm for native mail reader. I use Popper and Eudora for client/server mail. I use Tin as my newsreader. Gopher and Web Servers are standard and public domain. I use Lynx as my generic Web browser, but the Gopher Browser can also be used. FTP and Telnet service is standard on Unix. On LANs, I use DECnet LAT or TCP/IP to workstations and terminal servers. On small DOS machines I run Kermit as the Terminal Emulator. [Note: this user has extensive Unix and DEC experience. Kermit supports a telnet presence on a DEC LAT net. Kermit also, as discussed above, supports a telnet presence on a TCP/IP net as well. Both Kermit connections require an Ethernet connection to the network, in contrast to the serial terminal telnet software discussed from Coker.]

To run general TCP/IP out a DOS Ethernet card, you need a driver [as well as a TCP/IP stack]. The Crynwr Driver Collection is free and covers most popular cards.

[regarding the use of donated machines] The rare ingredient isn't hardware. The rare ingredient is knowhow. Schools have auto mechanics shops where they do miracles with old clunkers. They have to do the same with computers. [Note: see discussion above on Computer Shops]

At our HS we are planning to use the extra existing phone cable (we have 25 pair into the school but only have 5 lines) for our first phase of networking. Though it is only Cat[egory] III, it is capable of carrying Ethernet traffic. It has the tremendous advantage of being ubiquitous at our school and we won't have to dig up the enormous concrete patio. It will let us get started while we figure out if we can pull the fiber through the existing conduit. [An Albuquerque teacher]

The BD of ED in NYC has put in three different phone lines into our school building which is 6 floors tall. WE have used the phone line which precedes our current line to use as our Internet connector from network room to network room to office to library. We are using an abandoned phone line, which is adequate for such purposes, to alleviate the cost of having to do it again. In addition, we have been told that when the third, most recent and current system was installed, they also attached a data line with the voice line. It just requires minor work at low expense.

NETWORKING YOUR SCHOOL ON A TIGHT BUDGET OR "JUST DO IT!" Networking was certainly not a new notion to many of us, and indeed the long-range plan for technology on our campus [Germantown Academy Lower School] already included a fiber-optic network for our entire school community. But, because of the expense, such a system loomed out-of-reach. A consulting firm provided us with a figure of $18,000 (not including net modem and QuickMail software - an additional $3000) to wire the lower school on a "make-shift" basis, providing what would indeed be a "throw-away" network once fiber-optics become a reality. ...we decided there had to be a better or, at the very least, a cheaper way.... By mid-July our fearless group was ready for the "fun" to really begin. Neil showed us the technique and we were off. Hoisting a drill with a 15 inch bit, first grade teacher Sally Wolf began drilling holes in every classroom on the first floor. Following close behind were Micki Vieille, fourth grade teacher, Sue Hunsinger-Hoff and Charlie Muir who wielded, believe it or not, paper clips with which he secured the wire to the ceiling ... inch-by-inch connecting their vacationing colleagues to the network. Becoming technicians, they spliced wires and mounted phone jacks. ... And now, the addition of a NetModem we've begun to explore the exciting realm of cyberspace on the Internet all for a total cost of under $5,000. No more excuses. Just do it!

Yes indeed! It's a great adventure to learn how to wire your own school. It's an even greater adventure to construct a working network out of surplus computers. Randy Zeitvogel and I [Barry Kort, bkort@copernicus.bbn.com] do it. You can do it too!

[commentary from a Fairfax County, VA, Training Specialist] One of our first lessons in this job was to realize that spending money on technology puts computers in the classrooms, but the equipment often sits there, unused, because the teachers have no time to learn to explore how to implement the technology in the classroom! We all want our students and children to have access to this technology, but who is going to make it happen? Who will learn how to work the technology, integrate it with curriculum and train others to do the same?

[in response to an EPIE/CITS question about cost-effective alternatives to ILS'] There are lots of alternatives! But what is cost-effective? Products range from the basics, Reading-Writing-Math from PK-Adult to packages that include Sex Ed, Drugs, Employment Skills, Social Skills as well as the basics. Prices range from $6500/station to $400/Station or less in some cases...for some that is a paid up license, for others you can add a recurring 5-20% annual charge to be current. Some work on PCs, some on Macs, a few on both! Some require Windows, some won't tolerate it! Some expect to OWN the server, some are good neighbors to third parties. Nearly all are rehashes of out of date teaching and learning models, several are trying to break the mold, many are illusory with spiffed up graphics with no substance... they're kludgy at integration, but good in pieces. Is there an expert system frontend to any of them? Haven't seen one at the ILS level but would LIKE to Anyone working on that? I'd love to do some testing! [Larry Noyes, lanette@k12.com]

The growth of the World Wide Web comes at an exciting time in education and school reform. In the Web environment, users engage in an interactive process of learning, discovering, and responding to online information. The term "interactive" has become something of a buzzword in American education. Yet beyond all of the hype and rhetoric surrounding interactivity in education, many educators agree that students of all ages learn better when they are actively engaged in an interactive process, whether it comes in the form of a multimedia package, a classroom debate on current events, or an online encounter with real science data [excerpt from Andy Carvin's Web page, see Carvin, 1995)] Around Claremont High School, we have nearly 6000 feet of Level 3 wire pulled through old conduits which span our 30 year old campus. 'Twas a real headache to locate any specific run since the District office had no electrical blueprints! Using extended-length unshielded twisted pair (UTP) Ethernet, we could span long distances using unused phone "pairs" combined with pulling new wire where necessary. To date, we've got drops to over 80 locations and nearly 200 computers fully on the Internet. The cost of wiring, routers & gateways, bridges, and repeaters to date is less than $30,000. While we may not have fiber everywhere, we _ARE_ adequately connected.

[continuing] There are lots of highly-paid advocates of "structured wiring" schemes. These consultants will insist that, as you design your network topologies you should have cat 5, full home-runs, dedicated conduits, etc. While all that may be well-intentioned advice, it is often unrealistic within most school budgets. As many have testified [in the CoSN discussions], "pragmatic wiring" -- doing what you can within budget constraints -- though not ideal, is quite functional. Also, when deciding on networking design... In spite of the many advantages of 10BaseT, don't forget that 10Base2 (thin coax) allows for longer segment lengths, permits "daisy chaining" as more boxes are added to the networks, and doesn't require additional hubs as the network grows. In our experience, 10Base2 provides for flexible LAN design well suited to dynamic LAN structures. Each has its strengths.

✎ This testimonial to 10Base2 over 10BaseT stands out because many systems default to 10BaseT. This observer reports that 10Base2 is the better choice in a dynamically growing environment. The reasons presented are convincing.

[in response to the EPIE/CITS question about schools that were using lottery monies to wire schools and the possible moral problems with this form of funding, one Riverside, CA teacher commented] My school, and many other schools in my district, use lottery funds for technology. In California, a certain amount of all lottery revenues are given to the schools, but because the amount may fluctuate, the monies cannot be included in the regular budget. (This is not to say that sometimes the lottery money doesn't end up in salaries, anyway, if the budget is off!). So called one time lottery funds have helped my school site purchase hardware and software. We are wiring part of the school this year, and will wire the rest once we have determined the educational effectiveness of the Internet connection (or have inserviced the teachers well enough that they understand its effectiveness). We see no moral dilemma ... Our children benefit.

[another response to using existing wiring] I worked on a major, campus wide, wiring project at Goddard College in Plainfield Vermont. This college is an old farm. Their main administrative building is a huge barn. Their main office building is the old farmhouse. There is a ten year old phone system installed that used 25 pair category 3 wires to most of the offices. We discovered, by borrowing a 10 Mbps network tester, that these wires were just fine for the shorter, inside runs. We used new category 5 for any additional rooms, often going from an adjacent office that had extra cat 3 pairs. We also used Cat 5 between buildings. The moral of the story is... If you are on a tight budget (who isn't?) beg, borrow, or steal a network tester and see if you can use existing cabling.

[in response to the EPIE/CITS question about school inequities within states and between states] Equity is something I chuckle at because of our position. We are a school district that is in great financial difficulty but yet we are not in the bottom quarter of districts in the states [OH] $-wise. That bottom quarter will be helped considerably by the state to bring computers in the classrooms and wiring in those districts. Our state has a program called SchoolNet that will provide money to every district that applies for it for wiring. The dollar amount will be based on our "daily membership" and for our school district that means at best the amount provided by the state will be about half the cost of wiring. At the present time we do not have the other half. And, of course, that does not include any classroom hardware. We are just beginning to work in creative ways with our community and the university here to formulate some technology plans for the future. This is a slow process. Many of us are hopeful.

[continuing] In our state the equity problem comes from the way schools are funded. If that changed, maybe the equity problem in technology would take care of itself. It is a bigger problem than one school district can solve and it goes all the way to the state legislature and the voters state-wide.
[in a Rhode Island school] This year's budget started with a line item of $500,000 to support a district wide plan for technology that has been two years in the making. The line was quickly cut to $400,000 but we were told at every turn that we were over the hump and that real progress at all levels was going to be made. This week as the school committee wrestled with the funding offered by the Town Council (who publicly supported our technology efforts) the entire line item was slashed. We are back to square one and as you might imagine very discouraged.

[continuing] I don't know what the answer is.  School districts can't rely on grants, there aren't enough to go around and successfully applying requires too much energy that could be better directed toward instruction.  My district is middle class.  If we can't do it, I don't know who can.
[regarding connecting rural and isolated urban high schools] I would encourage rural areas -- any isolated site, urban or rural -- to investigate wireless technology.  FreeWave makes a great wireless transceiver for $1,300.  Optimum range: 20 miles. Optimum speed: T1.  Spend another few hundred dollars on an omnidirectional antenna for the hub site and about $95 each for directionals at the remote sites.
[EPIE/CITS Note: The FreeWave transceiver described here is more likely a 120 Kbps unit.]

[A librarian in Elmira, NY, who is located in a cable modem test area had this to say]   We provide Internet access to our schools through the WAN.  Every workstation has the potential of being on the Internet.  But, and this is big in our area, we do not have the bandwidth to provide graphics.  Our Internet connection is a T1, but our WAN is 56Kbps and also carries 20,000+ e-mails daily, payroll, student info, etc.  So with the cable modem, there is at least one access point within each building with graphics.  The cable congestion is new and is not always consistent.  There are certain times in the day when it is "slow" but keep in mind that slow is fast compared to 14.4 modems.  The software is not one I would choose and I hope it changes with the new year.

✎ One of the greatest unknowns about shared cable modem access in a community is the response time, once there are many subscribers.  The first few customers enjoy a speed (10 Mbps) which is faster than anything they will likely connect to (such as the Internet), but as the 10 Mbps channel is filled with, say, 1000 customers, the performance will be very uncertain.

[Michael Radlick, Dir. Ed. Programs, NYSERNET commented to CoSN recently] First of all schools have only a very limited amount of funds allocated for technology each year.  These limited funds force schools to focus on just trying to add a few workstations each year or to replace outdated equipment.  To give you a sense of the shortfall in technology funding, I did a study about a year ago while I was still Director of Technology for the New York State Ed Department in which I examined actual school expenditures.  I computed this technology to total expenditure ratio with the actual expenditure data from each of the 717 public schools in New York State.  the State average for technology expenditures (as was very broadly defined) was a little over 2% of total budget.  The range of expenditure was from 0% to 8% across the 717 school districts.  Data from industry varies, but I have seen reports (IDC) suggesting 5-6% average expenditure in industry for technology, and in knowledge intensive "industries" which presumably one might consider schools to be in, the percentages are much higher.  The bottom-line?  I believe that too little funding is committed in school budgets, on an on-going basis, to technology.  Technology can be a powerful tool in restructuring teaching and learning, but only if it is accessible and used in schools.

[Terry Lee of USWest] Anyone using Novell & IPX is living in the past in my book.  They bought a cheap network paradigm that only provided file sharing service.  They are now trying to hand on to that legacy service when they want IPX to run over TCP.

[Terry Lee on issue of CD-ROM storage of Internet materials for school access] Now I see your point.  The teacher needs reliable, well researched information sources.  They are not all that reliable nor well done.  In this way though, the media you suggest becomes like a giant encyclopedia.  Not only that, it is a "net" encyclopedia."  So, yes, I can see your point.  The content is stable enough to have some Gigabyte resources on-line and static.  Teachers even need that more than the interactive communications the net brings.  I can now see how you have to make the distinction early when introducing the technology to teachers and work with them towards a reasonable emphasis on USE of the information available on the Internet.  Such emphasis would help to build the CD-ROM farm you speak of instead of spending as much on the Internet connection.  I guess it depends on if they want/need the communication more or the research arm more.

[Steve Sisler of Apple Computer on our NASA/Hodas proposal for fast disk caching of resources] Fast disk caching is probably a good idea, but some commercial discs don't allow that for license reasons. Maybe with the new sizes [of CD-ROM discs] they will re-think that prohibition. In the old day when Lotus was selling a product on CD-ROM for a lot of money, they actually recommended moving it all to a hard drive. I think the etiquette and politics revolving around who can mirror Internet information and how is going to be a big issue. For instance, I don't want AOL caching the things I write on their servers, but I don't have the time or clout to prevent that legally. Still, it's in my copyright notice. Storing a snapshot of part of the Internet on a big CD-ROM may be possible technically very shortly, but the rights and permissions issue may hold it back.