Attached are pages 89-98 from a report entitled *KickStart Initiative, Connecting America's Communities to the Information Superhighway,* created by the United States Advisory Council on the National Information Infrastructure, and released in January, 1996. This excerpt identifies the costs of several optional methods of providing telecommunications-based learning applications to schools and libraries.

Note that the telecommunications network cost component is relatively small. For the school "laboratory model," it is only seven percent of the total initial investment, and fifteen percent on ongoing operation and maintenance costs. For libraries, the amounts are four and nine percent, respectively, inclusive of Customer Premises Equipment.

If the laboratory model were to be adopted as part of a nationwide governmental program, and if the telecommunications network costs were to be fully funded, as has been recently suggested,[1] under a four year phased approach, the resulting support needed for network components, in millions of dollars, would be:

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[1] In an April 10, 1996, letter, Representative Markey recommended to Chairman Hundt that core services should be provided without charge to schools. Communications Daily, April 11, 1996.

Schools	1997	1998	1999	2000	2000>
Initial	192.5	192.5	192.5	192.5	0
Annual	150.0	300.0	450.0	600.0	600
Total	342.5	492.5	642.5	792.5	600

Libraries	1997	1998	1999	2000	2000>
Initial	16	16	16	16	0
Annual	29	59	88	117	117
Total	45	75	104	133	117

	1997	1998	1999	2000	2000>
Total	388	568	747	926	717

GTE's identification of these cost estimates is not meant as a recommendation that the telecommunications component be fully funded from a universal service fund. These estimates are provided only to illustrate the upper bound of the amount of funding that could be selected by public policy makers.

The referenced pages 89-98 of the KickStart report
are not available in electronic format.

part 2
Identifying Costs and Sources of Funding

The curriculum adviser rallied administrators, teachers, students, and parents to support reallocation of funds for connecting a Portsmouth, Rhode Island, public middle school to the Information Superhighway. Then the coalition obtained additional funds from local businesses, received free equipment from a high-technology firm, bought used equipment at salvage prices in a sale of U.S. Navy surplus materials, and completed connectivity.

"We search. We search for resources. We never give up, and we make things happen in spite of the challenges."—*Kathy Popp, technology coordinator, Chestnut Ridge School District, Fishertown, Pennsylvania*

In Fishertown, Pennsylvania (a small rural community), public school teachers used a GTE Pioneering Partner Award for free Internet access time to instruct their students.

The private Dalton School, New York City, with more than 250 computers and much more equipment, has received grants from foundations, business, and the Federal Government to expand curriculum and teaching methods using high technology. The school is sharing the results at no charge with public school systems around the country.

These examples bear on two basic questions that community leaders will ask: How much will connecting to the Information Superhighway cost and where will the money come from?

Funding sources must be identified for purchasing and installing equipment, training teachers and other instructors, and operating the network.

One of the more important findings of the Council is that the budgetary increases required to connect all schools, libraries, and community centers to the Information Superhighway are not as high as most people think and, in many instances, can be achieved with some careful reexamination of existing budgetary paradigms. This is not to suggest that the cost will be insignificant or that such an ambitious goal will be easy to achieve. Rather, what it says is that the goal is attainable, and is a reality already in a number of communities throughout the United States. Besides, the costs should be viewed as a community investment that will bring many short- and long-term benefits to everyone.

In a study conducted for the Council, McKinsey & Company* found that connecting every K-12 school computer laboratory to the Superhighway by the year 2000 would require between 1 and 2 percent of the projected K-12 education budget. Connecting every classroom by the year 2005 (with a ratio of five

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*The models and cost estimates presented here for K-12 schools are derived from the study McKinsey & Company, Inc., conducted for the Council. Please refer to their publication, *Connecting K-12 Schools to the Information Superhighway, 1995*, for a more detailed discussion of this information.

students per computer) would require between 4 and 5 percent of the total K-12 education budget. By comparison, about 1.3 percent of public K-12 spending is now devoted to technology.

In every community, the costs for infrastructure development—whether for schools, libraries, government offices, health care, museums, community centers, or the like—will vary depending on the technology selected and benefits desired. The number of possible approaches to infrastructure deployment is infinite. For instance, deploying technology in every classroom in a school district would likely provide strong educational benefits but would be far more costly than deployment at the computer lab level, which would be easier to fund but perhaps less beneficial for students.

SCHOOLS

With assistance from McKinsey & Company, Inc., and based on information provided by numerous educational institutions and bodies, government officials, and private industry participants, the *key insights* about deployment costs for K-12 schools are as follows:

- **Costs for Hardware.** The purchase and installation of hardware constitutes the largest upfront cost. Approximately 55 percent of this cost is for computer hardware and software; and 25 percent is for printers, scanners, security, and furniture stations.

  Twenty percent of the costs for hardware are for retrofitting—electrical and heating, venting, and air conditioning (HVAC) upgrades. This cost could be much lower or higher as a percentage of the total for an individual school, depending on its current infrastructure and the age and condition of its facility. Alternative technologies (wireless local area network, for example) should also be considered, especially in cases where retrofitting costs are prohibitive because of the state of the facilities

- **Costs for Teacher Training.** Teacher training and support constitute the largest ongoing cost during the 5- to 10-year period of deployment. This training would include formal programs, on-the-job support from curriculum specialists, and use of the technology on the teacher's own time (although this latter category is not included in the total). The overall cost should decline over time as teachers enter the system with higher levels of skill and as existing teachers gain more experience with the technology. For the near term, however, it is essential that resources be devoted to this category.

- **Costs for Connection.** The cost of connection per se is a relatively small portion of overall expenditures. Connecting to a school that is installing a computer laboratory is only 8 percent for initial deployment and 15 percent for ongoing costs; connecting within the framework of deployment throughout classrooms is only 4 percent for initial deployment and 7 percent for ongoing costs. Over time, however, increased levels of usage could drive up the relative cost of connection. Depending on the amount of upfront costs, the usage charges thereafter, and the potential

need to upgrade for higher capacity at a later date, schools should consider installing connections that have greater capacity (for supporting multiple users and carrying large amounts of data) than they need today or even project they will need in a few years.

A complete analysis of the costs of the Information Superhighway must take into account ongoing maintenance and support costs as well as initial purchase and installation costs; the costs of the human elements of infrastructure deployment, especially teacher training; the value of the existing technology infrastructure (e.g., the number, status, and distribution of computers already in the public schools); and the hardware necessary to make the networks fully functional (such as file servers or printers). The costs should also include the costs for hardware and software that may be required to adapt to the needs of users with disabilities. Incorporating those needs into the planning stage is typically less expensive than retrofitting. In addition, the analysis should amortize hardware costs over time and include factors in future cost curves that affect technology installation and upgrades.

The costing models presented here are a starting point. These models focus on an array of computer networking technologies found in an ever-increasing spectrum of information and communication technologies. Although these models are useful for understanding costs of selected computer-based infrastructures, they represent only a few of the many options available to schools, libraries, and community centers. For example, these models may offer direction for addressing broader information infrastructure goals requiring greater flexibility and interactivity through integrated video, voice and data applications, and integrated platforms—computer multimedia networks, wide-bandwidth connections (digital wire or fiber), television, VCR recorder/player, wireless transmitter/receiver, digital satellite transceiver, etc.

Individual schools and districts might choose alternative options and make other tradeoffs between costs and potential benefits. For example, purchasing lower cost computers could have a substantial impact on initial deployment costs, but computer capabilities will dictate the range of applications students and teachers can use. Reductions in teacher training could substantially reduce the largest source of ongoing costs during the deployment timeframe, and yet teacher training is one of the most essential elements to ensuring effective implementation. Finally, tradeoffs can be made with respect to exploiting current technology versus experimenting with or waiting for more advanced technology.

The models for technology deployment were selected based primarily on fundamental economic breakpoints between different options—costs rise significantly at certain decision points, such as deciding between connecting at the lab level versus the classroom level.

The major cost drivers and the economic breakpoints between different deployment options depend on the levels of infrastructure, timing, and cost. The models take currently existing infrastructure into account. Although the Council knows that deployment will take place at varying speeds in different schools and districts, it has made the simplifying assumption here that each model is imple-

mented evenly over either a 5- or 10-year period (i.e., by 2000 or 2005). In each case, costs are evaluated in detail across six infrastructure elements:

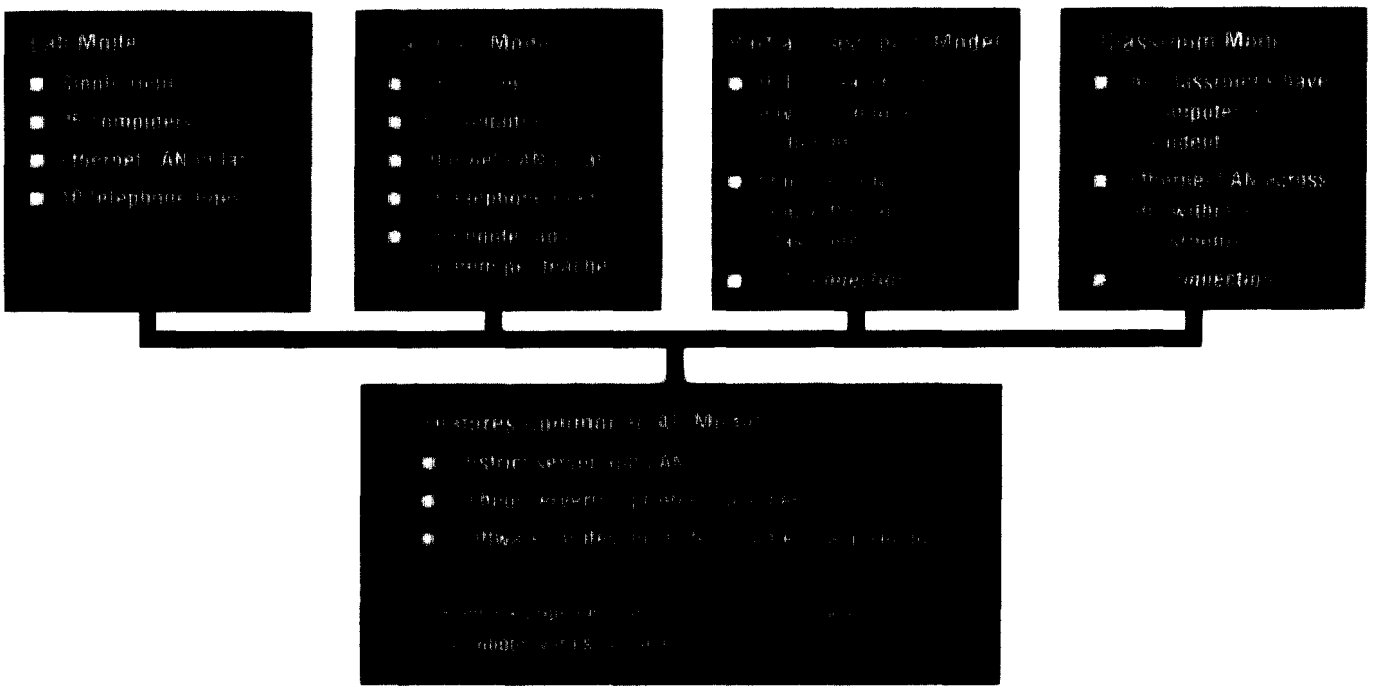
1. The external connection—the wide area networks that will connect schools to each other and to the Information Superhighway;
2. The internal connection—local area networks that link computers within the given school;
3. The computer, video, and related hardware (including the file servers, printers, scanners, and other equipment needed for full functioning of the technology);
4. Software and online service subscription charges;
5. Teacher training; and
6. Ongoing operational support.

Although it is difficult to assess the actual distribution of costs around the average, the major sources of variation have been identified. Assumptions have also been made concerning required technology upgrades and cost reductions over time. Finally, both the onetime purchase and installation costs as well as the ongoing operations and maintenance costs have been quantified.

Given this approach, the models are defined as follows:

- **Lab Model.** The basic "Lab" model envisions connectivity at the lab (or multimedia room) level for each school. It includes 25 networked computers with 10 analog telephone lines per school (although 5 ISDN lines can easily substitute, and double the performance capability at little extra cost, depending on the tariff structures of the particular State). This option gives scheduled access only to teachers and students—for example, a given class of students might be able to use the lab for an hour a day. This intermittent usage requires a higher level of commitment by all involved parties to ensure an effective level of integration into the curriculum. This type of setup may be most appropriate for schools that are just beginning to experiment with technology and connectivity or where building basic computer and networking skills is the main focus.
- **Lab Plus Model.** In addition to all the technology assumed by the basic "Lab" model, the intermediate "Lab Plus" model adds one networked computer for each teacher (i.e., a LAN connects all classrooms). The rationale is to give teachers adequate exposure and access to the technology to expedite teacher skill building, providing them with the opportunity to master and adapt the technology to their specific teaching needs. Ideally, this model might also facilitate migration from access in the lab to access in the classrooms over time.
- **Partial Classroom Model.** The "Partial Classroom" model assumes that only half of each school's classrooms are connected with networked computers. The ratio is the same as with the "Classroom" model—five students per computer with a T-1 (1.5 Mbps) connection (or a substitute if T-1 is not available). The model is designed to illustrate a less costly

Figure 1. Features of Models for a Computer-based Infrastructure



Source: McKinsey & Company.

variant—and possible step on the path—to the classroom model. It also presupposes that some classes or teachers are more logical starting points for deployment than others. For example, a school may choose to begin deployment in specific-subject classrooms or with teachers who appear particularly open to experimentation and change.

- **Classroom Model.** The "Classroom" model connects every classroom of every public K-12 school to the Information Superhighway. Classrooms are connected with networked computers at a ratio of five students per computer with a T-1 long-distance, point-to-point communications channel that transmits data, video, and voice at 1.5 Mbps (or a substitute if T-1 is not available). In this setup, students can work in groups of three to five around a computer and have convenient and relatively quick access to a broad range of potential courseware, online services, and video-based materials. By placing the computers directly in the classroom, the technology can be more closely integrated with the curriculum. Teachers will be able to incorporate computers and connectivity in teaching the full range of subjects throughout the course of the classroom day, and students will have regular, almost constant access to the technology.

Features of these models are summarized in Figure 1

All models include the local area networks, file servers, printers, and other equipment necessary for full functioning of the technology, as well as needed upgrades over time. The models also include appropriate levels of courseware, teacher training, and technical support

Although a "Desktop" model, which puts a networked computer on every student's desk, was also considered, this model involved substantially greater expenditures. It entailed more than 2-1/2 times the cost of the "Classroom" model in the final year of deployment even when deployed over a longer timeframe, and more than 3-1/2 times the cost of the classroom model for initial installation costs. For this reason, the desktop model is not examined in depth, although that model might be desirable from an educational standpoint for certain schools or at some future date.

Costs for dedicated video (i.e., video screen and camera) and dedicated voice (i.e., telephones and voicemail) were calculated separately. Although the technologies may converge in the future, these computer, video, and voice platforms are discussed as separate technologies here. Many computers are currently capable of full-motion video and should be able to handle voice transmission before long.

Summary of Costs for Each Model

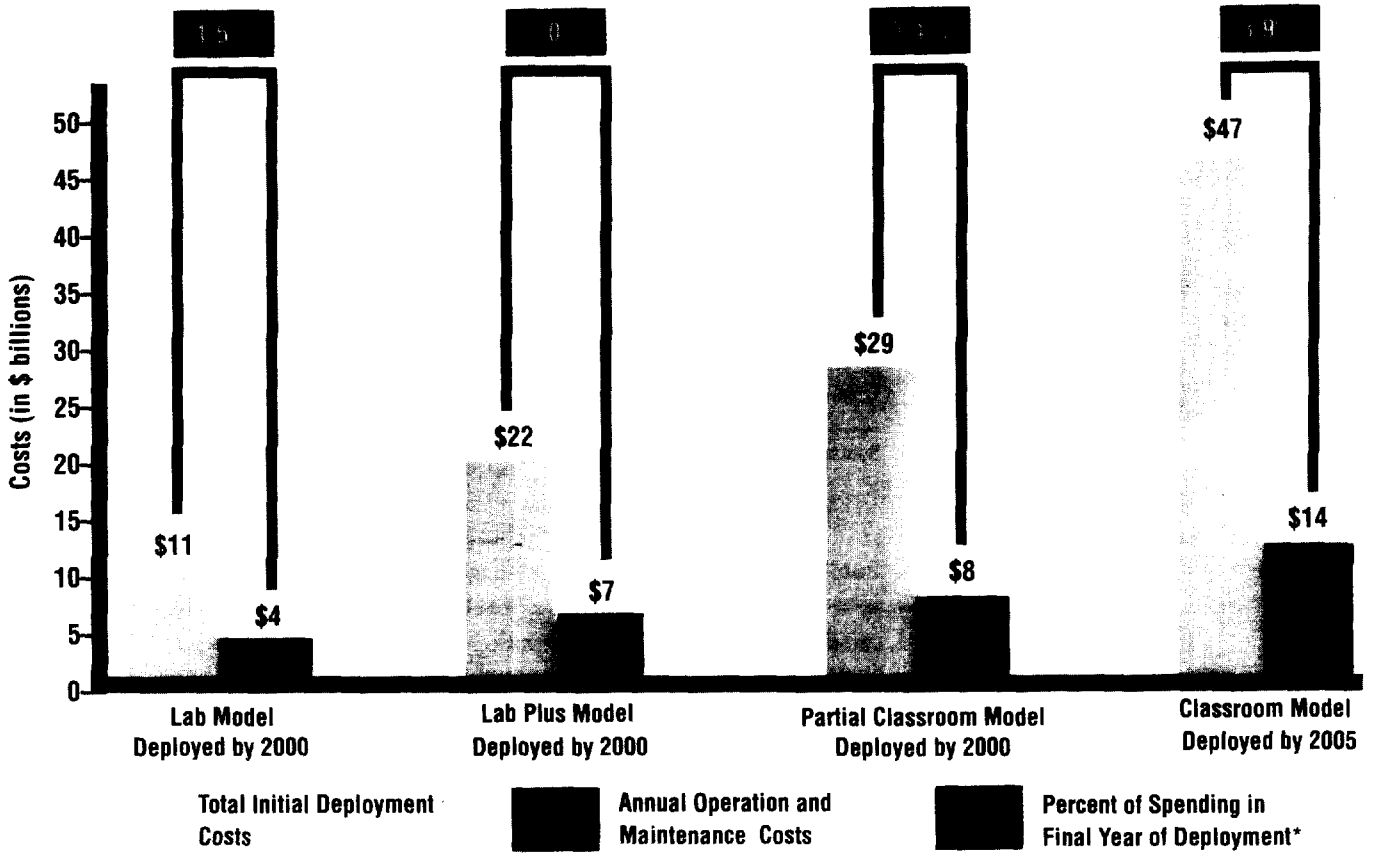
To implement the "Classroom" model across the Nation by the year 2005, onetime purchase and installation expenditures would total approximately $47 billion or $965 per student, while ongoing operations and maintenance expenditures would be about $14 billion per year over the 10-year deployment period or $275 per student. In the "Partial Classroom" model, onetime purchase and installation expenditures total approximately $29 billion over the course of a 5-year deployment or $610 per student. Ongoing operations and maintenance expenditures would be about $8 billion per year or $155 per student. In the "Lab Plus" model, onetime purchase and installation expenditures total approximately $22 billion over the course of a 5-year deployment or $460 per student. Ongoing operations and maintenance expenditures would be about $7 billion per year or $150 per student. In the "Lab" model, onetime purchase and installation expenditures total approximately $11 billion over the course of a 5-year deployment or $225 per student. Ongoing operations and maintenance expenditures would be about $4 billion per year or $80 per student.

Again, as a reference point, current expenditures on equivalent technology are running at about 1.3 percent of the education budget. Figures 2 and 3 break down deployment costs by model and component costs.

PUBLIC LIBRARIES

As with schools, public libraries have a range of options for deploying infrastructure. Libraries have fundamental choices to make both about the level of functionality (what services to provide) and the choice of technology (how to provide services most efficiently). In addition, as with schools, libraries need to plan for the soft infrastructure (training, content—including subscriptions and site licenses to access content—and system operation/support) just as much as the hard infrastructure (external connection, a LAN, computers, and related equipment).

Figure 2. Estimated Cost of Deploying and Operating Infrastructure in Public K-12 Schools with the Four Models



*Reflects the Department of Education's forecast of an average increase in the education budget of 5.6 percent per year (including inflation) through the year 2005.

Source: McKinsey & Company.

Figure 3. Cost Components for Deploying, Operating, and Maintaining Classroom and Lab Models in Public K-12 Schools

	Initial Deployment Costs		Annual Operation and Maintenance Costs	
	Classroom Model	**Lab Model**	**Classroom Model**	**Lab Model**
Hardware	51%	34%	14%	17%
Professional Development	14	19	41	31
Content	14	20	21	26
Connection within School	13	12	4	5
Connection to School	4	7	7	15
Systems Operation	4	8	13	6
	100%	100%	100%	100%
Total Cost (in $ billions)	$47	$11	$14	$4

Source: McKinsey & Company.

Figure 4. Cost Components for Deploying, Operating, and Maintaining Online Services in Libraries

	Initial Deployment Costs	Ongoing Costs
Application Hardware	24%	12%
Application Software	8	3
Training and Support	27	32
Content/Resource Development	—	23
Connection within Library	17	3
Connection to Library	4	9
System Integration and Support	20	18
	100%	100%
Total Cost (in $ billions)	$1.6	$1.3

Source: NIIAC Analysis. Department of Commerce.

Public libraries should be connected to the Information Superhighway by the year 2000. The Council estimates that the initial deployment costs to connect public libraries to the Information Superhighway should be about $1.6 billion, and that ongoing costs will be more than $1.3 billion per year.

The cost model, as shown in Figure 4, is intended to serve only as a starting point for determining the cost of connecting all public libraries in the United States to the Information Superhighway. Existing raw data for determining levels of technology in public libraries is nowhere near as robust as the data available for public schools. Additional research is required for a more accurate estimation of costs.

The Council realizes that public libraries face access and service provision problems that differ from those faced by schools. Bandwidth capacity and other connectivity issues can result in substantial differences in the costs of connecting urban and rural libraries to the Information Superhighway.

Another factor to consider is that public libraries have already made some progress toward providing Internet and other Information Superhighway-related services to the public. *The New York Times*, citing library sources estimated that 9 percent of America's libraries offer Internet access. A much higher proportion offered other electronic services, such as CD-ROMs, online public access catalogs, commercial databases, and electronic texts. Public libraries in several rural regions throughout the United States do have sophisticated broadband networks available to them. Iowa, Nebraska, North Carolina, and other "rural" States have deployed high-capacity, broadband networks that can supply rural subscribers with access to a wide variety of broadband services. Therefore, the overall costs presented in the model may be overestimated, because, to a certain extent, the infrastructure needed to connect public libraries to the Information Superhighway is already being deployed, and to a greater extent than it has been among public schools.

Furthermore, using the lab model to determine costs may be overkill— some public libraries may not need that capacity to satisfy patron demand. A simpler model, say 10 computers with 4 simultaneous users, for example, may be more applicable in determining costs for public libraries where the service area is relatively small. Applying such a model would reduce the overall cost presented in the cost model.

As with schools, the connection charges faced by libraries will differ significantly. The Council's model has attempted to compensate for this difference by dividing public libraries into two segments: libraries with a service-area population of 25,000 or more; and libraries with a service-area population of less than 25,000. Libraries serving a population of more than 25,000 are assumed to have access to T-1 lines (1.5 Mbps), while 60 percent of libraries serving a population of less than 25,000 are assumed to have access to ISDN lines (56 to 128 Kbps) and 40 percent are assumed to have plain old telephone service (POTS—14.4 to 34 Kbps). The model does not take into consideration the bandwidth capabilities of States such as Iowa, Nebraska, or North Carolina, for example, which may be considered rural but have very sophisticated broadband networks in place throughout the State.

Additionally, although software applications for public schools can be relatively uniform across the Nation, the same cannot be said for public libraries. Because customer demand for certain applications varies from library to library, a uniform average for the ongoing costs of software applications could not be developed for this model. The Council used an average ongoing cost of $2,000 per library for the purpose of the cost model, however, the ongoing costs of software applications for public libraries will vary significantly from region to region, depending on what applications patrons demand from their local public libraries.

In addition to information taken from the McKinsey lab model, the Council also employed information from a report issued by the U.S. National Commission on Libraries and Information Science (NCLIS) on the costs of providing Internet access in public libraries to develop its projections of library costs. Although the NCLIS work addressed the costs of Internet provision only, it illustrated the order-of-magnitude costs libraries might expect to incur in providing Information Superhighway access. The study also provided examples of cost considerations public libraries must take into account as they connect to the Information Superhighway.

Categories of Costs for Connecting Libraries

Initial Deployment Costs. The onetime cost for supplying a given number of public libraries with the necessary hardware and software to operate and maintain a lab model (i.e., 25 networked computers with 10 simultaneous users).

Ongoing Operation/Maintenance. The annual costs necessary to maintain a lab model for a given number of public libraries. These costs are primarily for service charges, user and maintenance fees, etc., which must be paid to maintain the network.

Connect to Library. The cost of connecting the public library to the existing communications infrastructure via POTS, ISDN, or T-1 lines. The figure includes the cost of necessary customer premises equipment (CPE) and usage fees (where applicable).

Connect within Library. The cost of networking the computers within a particular public library. The figure includes installation, purchase, retrofitting, and replacement costs for the LAN.

Application Hardware. The cost of computer equipment, including terminals, printers, and scanners.

Application Software. The cost of necessary software needed to gain access to the Internet and other electronic services (e.g., online public access (OPAC) Gateway, commercial Internet navigation software). Average ongoing cost of $2,000 per library assumed.

Content/Resource Development. The cost of software and online services necessary for a public library to be both a consumer and producer of information over the Information Superhighway. In this case, the cost model includes the cost of two services: *Bowker's Books in Print* and *Carl UnCover*. The *Carl UnCover* estimate includes $5,000 for standard access via the Internet and 500 articles downloaded at a cost of $6.50 each. There may be additional software and service required by individual public libraries, each adding an additional cost to this category.

Training and Support. The costs of staff training, public training, and Internet training positions and document development necessary for a public library to support active connection to the Information Superhighway.

System Integration and Support. Consulting costs and the cost of keeping one-half to one trained professional on staff to maintain support of the lab model.

COMMUNITY CENTERS

Community centers represent an excellent supplement to schools and public libraries in terms of meeting the lifelong learning needs of a community and providing public access to the Information Superhighway. Connecting community centers to the Superhighway may also serve to fill in the gaps left by schools and public libraries. Connecting community centers can fulfill the access needs of the nonschool population of a community; can extend the hours that access to the Information Superhighway is available to the community; can bring the community closer together; and can create a point of access for special interest groups within a community—e.g., senior citizens, veterans, Native Americans, etc.—who might not otherwise access the Superhighway.

The Council has defined a community center as a physical location where community members go to meet others, learn, play, or access information resources. This definition encompasses a broad range of locations, such as: centers for "at-risk" populations—e.g., public housing projects or Boys/Girls

Certificate of Service

I, Ann D. Berkowitz, hereby certify that copies of the foregoing "GTE's Comments" have been mailed by first class United States mail, postage prepaid, on April 12, 1996 to members of the Federal-State Joint Board.

Ann D. Berkowitz