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DEC 2 0 1991
Federal Communications Commission
Office of the Secretary

December 19, 1991

Office of the Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

Dear Chairman Sikes and Commission Members:

I would like to comment on the FCC Notice of Proposed Rule Making "In the Matter of Advanced Television Systems..." MM Docket No. 87-268. Specifically, I want to urge the Commission to fully consider the importance of assuring that ATV technology is compatible with other media.

I have no financial interest in this matter, and have never before submitted comments to the FCC. But this is a subject of such fundamental, long-term importance that I want to register my views.

My firm, the Institute for Alternative Futures, was co-founded by Alvin Toffler to help governments, associations and voluntary organizations bring a long-term perspective into current decision making. The intersection of computing and communication technologies has been one of our major areas of research. Our clients in this field range from the Information Industry Association (we produced their forecasting study, The Information Millennium) to the National Commission on Libraries and Information Science.

Our most recent study, 21st Century Learning and Health Services in the Home, produced in partnership with the Consumer Interest Research Institute, will be published in January. A pre-publication draft is enclosed. The report makes a strong case that future home information services for **learning** and **health** will be much more useful for consumers and valuable for society than has usually been imagined. It also looks at developments in the overall information infrastructure that will be needed to make different kinds of interactive multimedia services available in the home.

Multimedia interactive applications have enormous potential in education for enhancing motivation, individualization, cooperative learning and parental involvement. Advanced home health information systems can support disease prevention and health promotion, advanced forms of home care, and systematic evaluation of treatments and

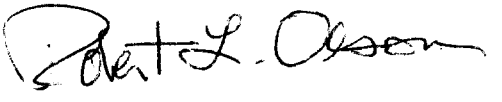
providers, improving health care and holding down the costs of care. But this potential will be delayed considerably if government and industry cannot see the bigger picture beyond HDTV.

I urge Commission members to approach ATV decisions not as "television" decisions but as decisions to ensure that multimedia interactive applications for education, health, and many other important social needs will be accommodated by the national information infrastructure of the future.

The key decision, in my view, involves choosing an "open architecture receiver" approach to HDTV to allow a flexible, extensible system to evolve which can use scalable standards. This type of system could receive low-power transmissions on vacant channels, so that current TV viewers could continue to receive service while consumers who purchase new receivers could receive high resolution video entertainment as well as interactive multimedia services of many kinds. Later, as broadband networks spread to homes, and other new technologies come into place (high resolution flat panel displays, gigabit storage and recording devices, PCN/satellite networks), the open architecture receiver approach would provide the basis for rapidly evolving capabilities in homes.

A unified approach to TV and computing will accelerate the development of both. Mass economies of scale would bring down the cost of chips rapidly. This decision is an opportunity to accelerate the information revolution, and to do it in a way that will help close what could be an enormous, emerging gap between capabilities available to business and other large institutions and capabilities available to all of us as consumers and citizens.

Yours truly,



Robert L. Olson
Senior Associate

Enclosure

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DRAFT

21st CENTURY LEARNING AND HEALTH CARE IN THE HOME: INFRASTRUCTURE CHOICES

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January, 1992

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Additional copies of this report are available for $15 from CIRI, 1631 Suter's Lane, N.W., Washington, D.C. 20007.

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INTRODUCTION

The Institute for Alternative Futures (IAF) and the Consumer Interest Research Institute (CIRI) have joined together in this study to explore emerging information services in the home. The study focuses on how new consumer information services can improve the way we learn and care for our health, and examines the changes in the information infrastructure needed to make these services available to the general public.

The study looks ahead to the turn of the century and beyond to get a sense of possibilities that are not yet widely appreciated. From this long-term perspective, it becomes clear that the information revolution has only just begun. In its next stage, intelligent terminals of all kinds will be increasingly linked into **networks**, and many will become **multimedia** devices that handle video, high resolution images, text and sound. During the 1990s, a sharply increasing number of these terminals will be used in homes. We may call them smart telephones, video game machines, PCs, interactive television or digital HDTV, but they will all be interactive and capable of handling multimedia communications.

We believe this technological revolution will have much larger social impacts within the home environment than is commonly expected. Many home information services will become important during the 1990s, including entertainment-on-demand, telecommuting, home shopping and banking, and home security. But we believe that services in two areas -- **learning** and **health** -- will have the largest social impacts.

Dramatic improvements in learning and problem solving appear possible over the next two decades as access to new interactive multimedia resources enhances motivation, individualization, cooperative learning, and parental involvement. Home health information systems can support disease prevention and health promotion, advanced forms of home care, and systematic evaluation of treatments and providers, improving health care and holding down the costs of care.

For decades to come, the main barrier to grasping these opportunities will be the limited information carrying capacity of existing communication networks, particularly local telephone networks. Corporations, universities, and other large institutions are already beginning to put into place the kind of broadband fiber optic networks that will be needed for the next stage of the information revolution. But in homes, network limitations will be a severe bottleneck. At the present pace of deployment, it will take until nearly 2040 before broadband networks reach to every home and small business in the U.S.

The dilemma confronting policy makers and business leaders involved in the development of these technologies is to determine how networks into the home can be developed in the most efficient and effective way. Some argue that the market alone is the

best regulator of development and will ensure that the required investment will emerge when sufficient market demand for new products and services exists. Others argue for a more active government role, pointing to a chicken and egg dilemma: whether the public needs, wants or will use any of the information services which new technologies can provide cannot be determined by the market in the traditional sense because the public cannot demand what it does not know about or has not even imagined.

The largest obstacle to the market's development of advanced residential services for health and learning is the absence of the means for these services to be delivered or used in the home. Information service providers who want to develop products and service applications for home use are reluctant to do so until they are assured that the infrastructure necessary for the public to access their products will be in place at some specified time. In this situation, using the market effectively may require some more affirmative, proactive policy actions -- at least for the development of the communications infrastructure necessary to transmit advanced multimedia services to the home.

Resolution of this public policy /market forces debate is particularly critical in view of legislation now pending before the Congress which mandates the deployment of a broadband network in the United States by 2015, the date when Japan is due to complete its national broadband network. The legislation provides that state regulatory agencies and the FCC approve deployment plans which give priority to health and education facilities and insure that network modernization takes place at the same rate in inner city and rural areas as in affluent and populous areas.

To determine whether this or some other type of deployment incentive is justified, it is critical to understand the types of applications which new technologies make possible for home use and the information infrastructure which these applications require. This report examines these issues in the context of emerging applications for learning and health.

The report focuses on how reforms and advances taking place in education and health care may increase the demand for interactive multimedia residential services and shape their evolution in ways that were not anticipated even a few years ago. It looks first at examples of new services and the value they could have to learners and patients, to their families and to professionals in the field, and second, at the infrastructure and terminal developments which are required to make these services available to the general public.

In preparing this report, we have drawn on a wide variety of forecasting studies that the Institute for Alternative Futures has done in the areas of health and medicine, learning, and information and communication systems.[1] In addition, we conducted two dozen interviews with leading applications developers, technologists, researchers and industry leaders.[2] Our preliminary analysis was deepened and illuminated by the views of 15 leading experts from the education, health care and information technology fields who we brought together in a one day workshop to discuss the initial draft of this paper (see Acknowledgements on the inside back cover).

We draw three initial conclusions which we believe deserve consideration and point directions for further study and action.

1) New, advanced information services for learning and health go far beyond what has usually been imagined. If new services are conceived and designed to amplify positive changes that are gathering momentum in education and health care today, the benefits to consumers and to society could be surprisingly large.

2) Many advanced learning and health services can only be provided when broadband networks reach into the home. A few emerging services could be delivered today, and more can be delivered through upgrades of existing telephone and cable TV networks. But many of the most important advances such as parent-teacher video consultations, cooperative learning groups, video instructions and reassurance for home bound patients, and remote consultations and diagnostic evaluations of medical conditions must await the widespread deployment of broadband networks.

3) The potential benefits of advanced learning and health applications are sufficiently large that they justify a fuller consideration of whether the evolution of broadband networks should be accelerated by deliberate public policy. Speeding the deployment of broadband networks requires investment resources, but the alternative of leaving network deployment soley to market forces may exacerbate division between the affluent and the less well off and miss major opportunities to improve the quality of our workforce and constrain health care costs.

We believe these findings form an essential bedrock for the policy dialogues which consumer and industry leaders, state regulators, and other public officials need to initiate in order to assess the future policy steps which must be taken to bring the benefit of new information technologies to the American public.

LEARNING IN THE HOME

Learning Introduction

Education became a major national issue during the past decade, and many forces are working to make education an even greater concern over the decade ahead. Young people are being pressed to learn more and learn faster because a highly skilled work force is critical for U.S. economic competitiveness. People of all ages are being pressed to keep learning in a society where the knowledge requirements for jobs are escalating, where many people change careers three to five times during a lifetime, and where technological change is so rapid that half of an engineer's training is obsolete within four years. Immigrants and adult dropouts as well as children trapped in environments of poverty and crime desperately need literacy and employable skills. An aging population creates new demands for learning related to retraining, leisure, health and community participation. New developments, from global warming to the collapse of communism, challenge us to create a "learning society" in which all our institutions become "learning organizations" committed to the kind of continuous learning needed to adapt to rapid change.

One of the most important insights for meeting our society's growing learning needs is that schools cannot do it all. Other community institutions and learning sites play important roles, and the information infrastructure provides an enabling framework for this larger learning context.

Another important insight is that of all the learning sites besides schools in our society, the home is the most influential. The behavior of children is deeply effected by family attitudes toward learning, access to learning resources in the home, and parental involvement. The home is also a major learning site for adults. Recent studies indicate that something like 80 percent of lifelong learning is done as "personal learning projects" at home or on the job, apart from formal institutions of education.

New attention to the importance of the home as a learning environment is being paralleled by a growing appreciation of the kind of learning resources that emerging information technologies can bring into the home. During the 1990s, surprisingly powerful information systems will enter the home as smart phones and "teleterminals," multimedia PCs, interactive television systems, CD players, advanced video games, HDTV and other technologies evolve and compete. New kinds of electronic links between and among students, teachers, libraries, community leaders, and scholars and experts around the world will begin to emerge. A wide variety of new consumer information services and multimedia programming will become available.

By the turn of the century, we will be living in a new world of interactive multimedia. Vastly expanded home access to learning resources of every kind will empower people to pursue self-directed learning. The ability to learn through interaction and involvement and to integrate high-impact video imagery into learning materials will make interactive multimedia a powerful motivator. Sophisticated software will increasingly be able to customize learning material to take into account students' particular learning styles, cognitive strengths, interests and cultural backgrounds. Truly significant improvements in learning will be possible as these new capabilities become widely available.

But new technology, in itself, will not transform learning in the home or in schools. Changes in ideas and institutions are needed to meet the principal needs of education today. The most fundamental need is to continue to improve the basic ideas and assumptions about learning that underlie modern pedagogy -- the art and science of teaching.[3] For example, the older "fluidic theory" of education, which viewed students as passive, empty vessels who take in knowledge poured from full teacher-vessels, is being replaced by the idea that students learn best when they are actively seeking out information and constructing their own views. The idea that there are only a limited number of innate "ways of thinking" is being revised in the light of a new understanding that we can deliberately learn new skills for learning and thinking that can enormously expand the understandings we can attain. The notion that there is a single "common reality" which schools should convey is being replaced by the view that there are competing images of reality so that students need to learn to compare viewpoints, weigh factual evidence and clarify value issues, and construct their own images of reality.

Other important educational needs today include making organizational changes that encourage innovation, expanding parent's participation in their children's learning, reducing teacher isolation, and supporting lifelong learning for adults. The key to progress, therefore, is neither technology-in-itself nor skepticism of technology, but technology thoughtfully integrated into a larger process of educational reform.

Educational Reform and Its Impact on Home Learning

Underlying the national debate on our educational system lie basic questions about how much can learning be improved in our society and what can information technology contribute to this improvement. Educational experts wrestling with these questions have directed their research along several lines, including the structure of school systems, the role of schools, the curriculum, and the ways children learn and what factors are most critical in helping them to learn more effectively.

Research on the structure of school systems has illuminated the adverse effects of the centralization movement of the early 1920s which reduced the number of school districts in the U.S. from 150,000 to 17,000. The current emphasis on "restructuring" schools is largely a response to those adverse effects. Goals of restructuring include encouraging more local

initiative, giving individual schools greater decision making authority and freedom to innovate, and fostering more participation by the community, parents and teachers in the educational planning for their schools. Efforts to use information technology to support learning in the home, and to facilitate the interaction of parents, teachers, students and other community members, are in harmony with today's larger restructuring efforts to foster decentralization and participation.

Educators looking at the role of schools see enormous changes underway. Schools are increasingly being called upon to play a central social service role in the lives of their children, dealing with violence, death and dying, divorce, sex education and AIDS, homelessness and countless other aspects of their students' lives far beyond the more traditional role of developing their students' intellectual skills. To the extent that these multiple roles are unavoidable, better services and administrative efficiencies may be possible through using information technology to improve the coordination between schools and other social service agencies.

Curriculum improvement has become a high priority for both researchers and practitioners. Recent major reports by subject matter organizations such as the American Association for the Advancement of Science, the National Council of Teachers of Mathematics and the National Council of Teachers of English recommend substantial curriculum changes. These studies also come to surprisingly similar conclusions about how to help students learn more effectively.

The commonalities in these studies reflect research findings over the past decade in the cognitive sciences, the neurosciences, and other fields related to learning. Important developments include work in multiple types of intelligence and learning styles, learning strategies and thinking skills, creativity, positive reinforcement, and cooperative learning. These lines of research represent real scientific progress, not just fads.

This research also points the way to how information technology can be used more effectively in learning. In the past, for example, computers in schools have often been used to support rote learning of "right answers." But information technology can be used in far more creative ways to help students actively explore and create, test ideas, and learn through cooperative projects.

Below are ten "common themes" that people engaged in the different areas of educational research frequently single out as critical in helping students learn more effectively. These themes are just as relevant for learning at home as they are for the school classroom. All these themes need to be consistently brought to bear in the development of learning technologies.

1. Active Learning. Students learn best when they are actively constructing knowledge by exploring, creating, experimenting, physically manipulating things, engaging in creative dramatics, and seeking out vivid, multisensory experiences. Teachers adopting this approach

seek to actively involve students and encourage them to be self-directing learners. A good example of active learning is provided by a social science class teacher who recently taught her class about how different cultures treat older people. She assigned her students the tasks of interviewing older people in their homes and of selecting clips from TV documentaries showing how Hispanics, Afro Americans and Anglo cultures treat their elders. The teacher edited a video, essentially created by the students, to use as teaching material for that particular unit.

2. Personalization. Students learn best in a context of things which they can identify with personally. An MIT research project found that learning was enormously more effective when students used material which they themselves had prepared -- in this instance, their own video tapes of their running styles superimposed on to a computer graphics screen. Students computed and compared the impact of variables such as stride length, knee angle and proportion of legs to body torso on running speeds of the students in the class. The students were not only motivated to learn a great deal about mathematics; they learned from first-hand experience about the thinking skills of scientists.

3. Individualization. Research clearly demonstrates that different people learn best in different ways. This is partly a matter of differing cultural backgrounds, but it goes deeper. For example, some people rank high in logical/mathematical types of intelligence, while others are strongest in verbal, visual/spatial, body/kinesthetic, musical, interpersonal, or intrapersonal types of intelligence. Most people are more image-oriented than oral in the way they take in information, so that more learning materials in a video format would be helpful for them; and many people take in information more effectively in oral rather than in written form -- but there are wide differences among individuals in the "media" from which they learn most easily. Students learn best when materials and teaching approaches are customized to respond to these individual differences in learning styles and cognitive strengths.

4. Cooperative Learning. Cooperative learning is seen as a powerful teaching tool to encourage active engagement by the students in learning, to create motivation through person to person involvement and peer approval, and to build skills of teamwork and oral explanation. Cooperative learning involves group acceptance of common goals for achieving together, and mutual help between students to achieve those goals. It also reduces social isolation (a danger of instructional technology as well as of TV, video games, etc.).

5. Learning Strategies and Thinking Skills. Intellectual effectiveness is based on intelligence, content (what one knows), and effective learning strategies. Consistently practicing relatively simple but powerful strategies for learning and problem-solving is increasingly recognized as the easiest way to produce large improvements in intellectual effectiveness and motivation for learning. A related approach, the Thinking Skills Movement, emphasizes teachable skills that contribute to effective thinking such as persistence, active listening, adopting and testing alternative viewpoints, and identifying and questioning basic assumptions.

6. Contextual Learning. Learning "in the abstract" is difficult for many students, and less motivating for most people than learning that is related to their own cultural and personal experience. Economics, for example, can be made more interesting by relating economic concepts to current news stories and to personal choices about employment, spending, saving and investment.

7. Learning to Learn. Memorized knowledge of fundamentals remains important, but another type of knowledge is coming to be viewed as equally important: an effective overview of the kinds of knowledge that exist, and knowledge of how to go about acquiring the knowledge one may need.

8. High Standards for All. Typically in classroom settings, time per topic is constant and learning per student is highly variable. As emerging learning technologies allow greater individualization, learning can be the constant and time the variable. Even slower students can achieve real mastery of a minimum "essential curriculum."

9. **Sophisticated Evaluation Strategies.** Standardized testing provides a rough measure of learning, but is seldom very helpful to learners. A low standardized test score in mathematics, for example, only identifies a few broad areas in which a student is having problems. Sophisticated evaluation strategies that provide a more detailed understanding of what students can and cannot do and what specific skills they need to learn are much more useful.

10. **Parental and Community Involvement.** If we are to become a "learning society," all our institutions need to be more supportive of personal learning. Parents, community leaders, company executives, librarians and others can play more effective and innovative roles as student motivators, role models and sources of information.

We believe that information technology can be used to support and advance each of these themes of a more sophisticated pedagogy. The synergy between new pedagogical approaches to learning and emerging technological capabilities can be a powerful force for change in our society by the early 21st century.

Emerging Learning Technologies

Home learning applications for children and adults will be based on an evolving set of technologies that are being developed specifically to implement a more sophisticated approach to learning and teaching. The major types of learning technologies which already exist today, at least in prototype form, are described briefly below.[4]

Some of these technologies may seem remote from current experience. But they will all be commonplace by the turn of the century and will be making new demands on the information infrastructure. In general, these technologies address two major learning needs

of students: communication needs to reach beyond their immediate environment and to experience and visualize situations or places which are difficult to grasp or otherwise inaccessible to them; and information access and selection needs to facilitate student identification and use of personally relevant information resources.

Communication Needs: Because all students are essentially home and school bound, they are limited to people, resources and educational opportunities which they can access or interact with personally. They are even more severely limited in their learning abilities by what they can "see" and "hear". Information technology can significantly extend students' experiential range, and address the new pedagogical understanding of how students learn and the importance of active involvement, personalization, individualization and cooperation with their peers in their learning processes.

Distance Learning through electronic links can bring together teachers and students in several geographic locations via technology that allows for interaction. Where video is used, the "telepresence" of skilled teachers can establish emotional bonding, a shared purpose, and agreed practices of interaction -- just as in a successful classroom. Distance learning initially served isolated rural schools and some urban systems, but uses are expanding rapidly. For example, fewer than ten states had K-12 distance learning arrangements in 1987, but now every state is involved. Universities and community colleges and corporate training programs are also increasingly involved. Distance learning is proving especially useful for addressing problems of scale (not enough learners in one location), rarity (specialties not available locally) and convenience (elimination of travel and scheduling constraints), allowing groups to communicate without having to "be there together".

Technology-Mediated Interactive Learning (TMIL) plays a somewhat similar role in facilitating cooperative learning. Communication links and a form of computer software called "groupware" allow teams of people to study and work together, transcending barriers of geography and time. Being developed to facilitate the work of corporate teams with members in different locations, groupware points the way to new forms of cooperative learning in which sophisticated software can facilitate collective thinking and problem solving. Educators are exploring how computer-supported cooperative work software can be adapted to a great variety of learning situations, from group homework projects to group debates to managing a school newspaper. Besides supporting classes and other temporary groups, groupware can facilitate the creation of ongoing "virtual communities" of adults with similar learning interests who keep learning together over time.

Simulations and Microworlds enlarge students' learning experiences by creating simplified models of some aspect of reality. Microworlds go further and enable learners to change the rules, thus allowing them to see what happens if underlying principles or assumptions are altered. A simple physics microworld, for example, can let a student learn about Newton's laws of gravity by "playing baseball" on the moon and then on Jupiter. These technologies facilitate learning by allowing people to "visualize" causal relationships

and mental models. Apple Computer is operating an experimental project, testing capabilities that will be available in the home ten years from now, where grade school children are observing a natural ecosystem and creating simulations of the interacting behavior of different species of animals.

Artificial Reality also addresses students' needs to learn visually. An artificial reality is a computer-generated world that mimics real-world experience. Artificial realities can be used in learning for surrogate travel and experience such as walking through a "virtual" museum or exploring the lunar surface.

Information Access and Selection Needs: During the 1990s, network and desktop technologies will make a vast array of diverse materials available to students in a full range of formats -- print, graphics and images, sound, and video. As a result, both adult and student learners will confront the risk of being overwhelmed by the sheer volume and complexity of the resources which will be available to them. Fortunately, technology is also bringing new artificial intelligence (AI) tools for searching through the vast "haystacks" of information and finding the "needles" of relevant material. AI capabilities will also be the key to developing more "user friendly" learning technologies, making it possible to interact with computers using handwriting and ordinary speech, or making it possible to create complex simulations and microworlds that even children can use.

Emerging tools for information access and selection, like those described below, can address students' needs to participate actively in their own learning process, to use materials which relate to their experiences and cultural backgrounds, and to individualize learning by responding to individual learning styles and cognitive strengths.

Hypertext and Hypermedia are designed to facilitate student explorations through large collections of learning materials in electronic form. Hypertext systems contain only text, while hypermedia systems contain multimedia material. Text, still images and even video are all linear, sequential media: one concept or image follows another in a predetermined stream. Hypermedia enables students to retrieve linked material from various media. Learners can follow their own paths of interest and curiosity through hypermedia materials, moving, for example, to the full text of a footnoted source, or to a video that illustrates an idea, or to an encyclopedia entry that explains a term. Numerical information can readily be displayed as tables, charts, graphs and other visual forms. Multiple representations of knowledge in different media allow learners to deal with information in whatever form is most effective for their own learning style. Enthusiasts believe that hypermedia is an entirely new medium with the potential to transform the way we learn and even alter our underlying "patterns of thought." Other analysts are more cautious, pointing to the high front-end costs of developing hypermedia and potential problems like user disorientation in navigating through large bodies of multimedia information.

Knowbots[5] or knowledge robots are mobile artificial intelligence programs that operate in the network and on the desktop. The most revolutionary of the various kinds of "information searching" technologies being envisioned today, knowbots will eventually be essential for navigating through the vast variety of scattered information resources. Knowbots will search electronic databases looking for information of the kind the user has specified. As a knowbot user reacts over time to the information being supplied -- saying this is useless, that is not exactly what I'm after, or this is just what I'm looking for - the knowbot will get better and better at selecting information that exactly fits the user's interests and learning style. John Scully, the President of Apple Computer, argues that within a few decades people will look back and wonder how anyone could have kept up with new knowledge and learned effectively without the assistance of such devices.

Intelligence Extenders are collections of "tools for thought" designed to help learners in particular fields. A word processor with a spelling checker, dictionary, and thesaurus, perhaps supplemented by more sophisticated outlining and "idea processing" software, is an intelligence extender for writers. Customized collections of tools are being created for mathematics, geography and other fields. Intelligence extenders can also be developed to help with particular kinds of learning disabilities such as difficulties in organizing tasks.

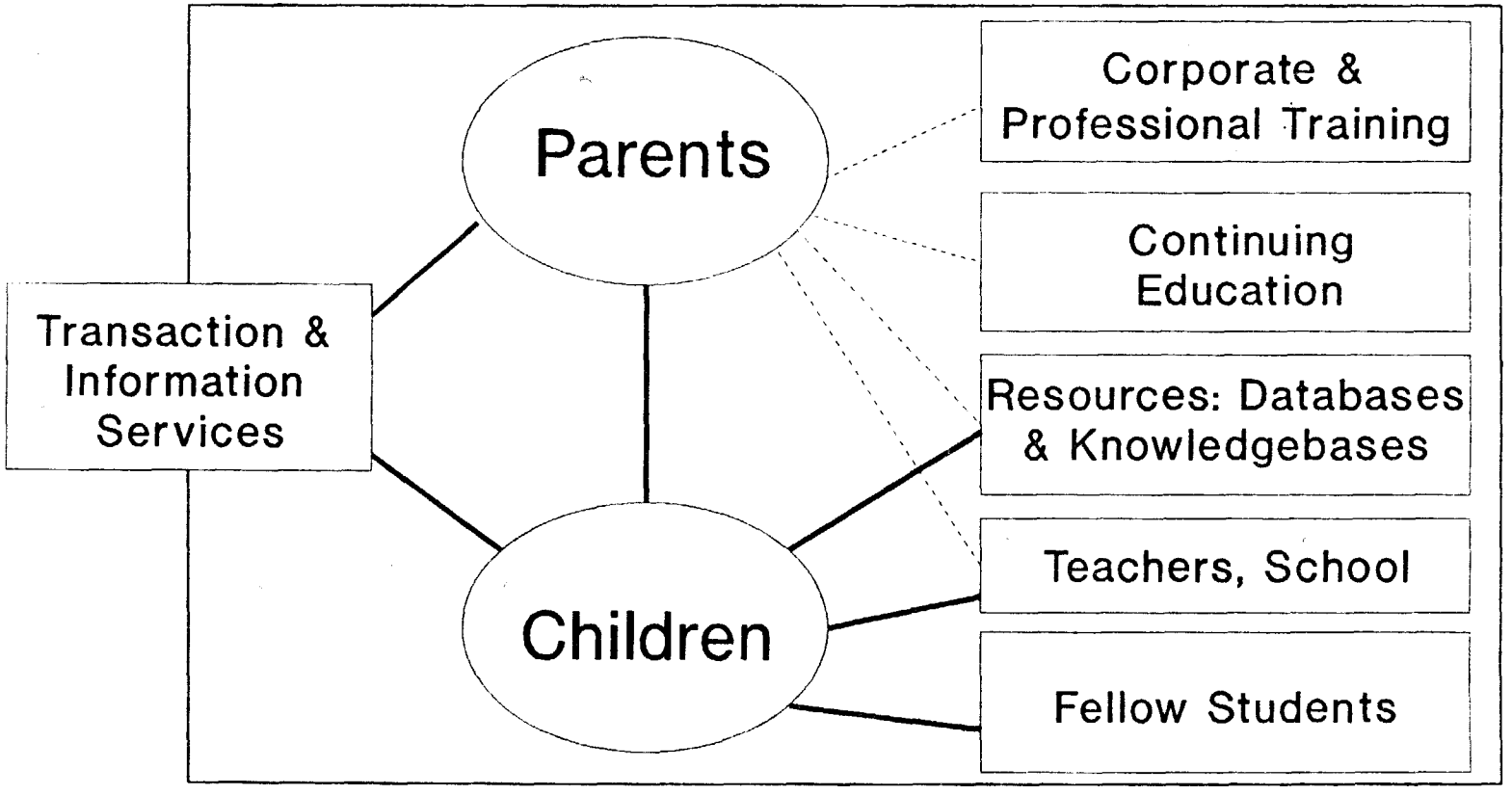
Intelligent Tutoring Systems add capabilities from artificial intelligence to traditional computer-assisted instruction, enabling the electronic tutor to "understand" what, whom and how it is teaching. Intelligent tutors can keep cognitive "audit trails" of student work, diagnose errors and articulate to learners the detailed nature of skills and problem solving methods needed to "do it right." They can employ varied teaching strategies and media options, and can be programmed to adapt to individual learning styles and cognitive strengths. Prototypes already exist for subjects such as geometry, Pascal programming, and high school algebra, subjects that follow easily describable rules. It will be far more difficult to develop intelligent tutoring systems for subjects such as history and the social sciences.

Three Examples of Emerging Applications

Figure 1 illustrates a general model of the kind of electronic family learning environment that we believe will emerge between now and 2010 to help meet our society's growing learning needs. Home access to learning resources will serve both children and adults. It will provide opportunities for parental involvement both in their children's school work and in pursuing their own educational goals.

POTENTIAL ELECTRONIC FAMILY LEARNING ENVIRONMENT

FIGURE 1



Three examples below illustrate how different aspects of this general model of learning activities in the home may evolve.

These examples are an imaginative exercise, not an attempt to make exact forecasts, but we have tried to anchor them in technical realism. We consider these examples "optimistic but plausible." They illustrate services that could become available in homes between now and 2010, though not necessarily services in universal use.

Example 1: Parental Involvement

Repairing the severed connections between parents and teachers is a high educational priority, and a difficult challenge given the time pressures confronting families, especially single parent and dual income families. Parents are not a replacement for skilled teachers. Their most effective role in their child's learning is often that of role model, motivator, and occasional tutor and disciplinarian -- a complementary role to the K-12 teacher.

To help parents perform this kind of role more effectively, a number of schools around the country have recently set up homework hotlines that allow parents to get clear instructions from teachers about class homework assignments. Expanding this service requires wider school use of the voice messaging services already available. Personalized parental alerts such as notification of attendance and tardiness problems, low grades and missing assignments are soon likely to become a part of these hotline services.

By 1995 or shortly thereafter, with the spread of "smart phones," which are already becoming available in the corporate environment, parents will be able to dial up assignments, class schedules, school menus, notices of meetings and other information displayed on-screen. More widespread use of voice messaging services will also support voice mail consultations, which can allow parents and teachers to communicate without the usual difficulties of arranging "live" conversation during working hours.

Expert systems to respond to some of the more routine questions that parents ask about their children's progress and development will also be available by the later 1990s. These systems not only can save parents and school officials and teachers the time and burden of trying to meet face to face, but they can also identify parents whose questions require more than routine answers, and flag a school official to send information to that parent, telephone the parent or arrange an appointment.

Problems of arranging meeting dates and places, barriers of social or class differences and other obstacles to face-to-face parent contacts are substantially minimized in the electronic communications world, although basic written communications skills are needed to use these communications systems. By 2010, voice to text and voice recognition systems will eliminate even this barrier.

Schools will also be able to make available to parents on demand detailed student performance assessments, identifying specific skills that need to be improved. Teachers would regularly add information to detailed running assessments of all students' performance, much of this generated automatically by intelligent tutors and class information systems. Parents could access recent information, and examine any aspects of the historical record -- for their children only.

Video parent tutorials with suggestions on how to work with their children at different grade levels in different subjects can be available on-demand. Parent-teacher video conversations, including video messaging, could create a more vivid sense of social presence than voice mail and forge a stronger bond between parents and teachers.

Parents will be able to participate electronically in interactive electronic meetings among parents or between parents and teachers, principals, school board members or even legislators. Meetings with school boards or legislators might involve parents' concerns about school restructuring or with specific policies or practices, curriculum or the like. Meetings between parents and teachers could deal with personal concerns, such as how a child is behaving, or what learning materials in the home could help a child catch up in areas where he has fallen behind. Such parent teacher contacts can serve important needs of parents. They can also help parents appreciate their teachers as experts rather than as lecturers or baby sitters for their children.

Some parents may also desire to contact other parents in more spontaneous and informal settings than PTA meetings about their children or about specific school activities or general school policies. Such parent-to- parent dialogues are an important reinforcement tool for parents concerned with their children's education but fearful of their own capabilities to raise these issues with school authorities.

Today, cable and low cost camcorder technology can enable parents to watch and listen to school board meetings. Asynchronous electronic contacts without video can also take place today given access to a telephone line and a terminal. As optical fiber reaches into homes, it will be possible to provide interactive participation by parents from their homes with full-motion video.

Example 2: Access to Teachers and Fellow Students:

Growing interactive multimedia information capabilities in the home will make it possible for students to consult with teachers, do library research, tap resources literally all over the world, interview community leaders and experts, browse through a variety of suggested materials, analyze historical, scientific and cultural documentaries, work on laboratory simulations, and create multimedia projects as part of their homework. As a result, educators will be increasingly challenged to integrate the home with the schooling process, separating the notion of "school" from the physical school building.

Adults will be able to access continuing education courses and training. Today's "distance learning" applications are likely to evolve over the next two decades into a diverse "virtual school" community with a large national and global student body of all ages and with supporting industries. Short courses and institutes, conferences, whole courses and full degree programs are already available to learners participating from home and work. Programs of this kind are likely to grow rapidly as information technology advances improve the effectiveness of learning in the home. Corporate training will also expand into the home environment. IBM estimates that only 25% of its vast corporate training program will take place in its classrooms later in the 1990s. Most of the rest will be available in electronic form and accessible in the home if the residential infrastructure can support it.

Some of the most exciting and technically demanding home learning applications being imagined today involve peer teaching and cooperative learning projects. Both adults and students serving as experts and tutors to each other is one of the most effective forms of learning, whether it is in the context of formal learning or of people pursuing their own interests and hobbies. Creative "distance learning" activities being done between schools today -- learning circles, online research projects carried out simultaneously in different communities, pupil projects in media production, and shared electronic field trips -- give a sense of what it will be possible to do in or from the home. Advanced distance learning applications to the home will come to be seen as tools for everyone to use as appropriate, not as a second-best approach to traditional school attendance.

Sophisticated "groupware" for technology-mediated interactive learning (TMIL) will enormously expand possibilities for cooperative learning. The major driving force in the development of TMIL will be the emergence of computer-supported cooperative work (CSCW) in the corporate environment. A significant body of CSCW research already exists on topics such as cooperative computer-aided design, project management, and group decision support. Between 1995 and 2000, CSCW will become a major influence on the operation of large organizations. Early uses in the home will center on electronic conferencing and multimedia mail applications. The most sophisticated home applications will be done as part of telecommuting and corporate training programs.

Some analysts believe that by the turn of the century and beyond TMIL will incorporate so many powerful and useful features, pioneered in the development of CSCW, that it will be the preferred approach for certain kinds of cooperative learning. Chris Dede, director of the Center for Interactive Educational Technology at George Mason University, forecasts several technical features that are likely to be incorporated into TMIL.[6]

o "What You See is What I See" (WYSIWIS) Interfaces -- A window on the screen that shows the same information to all cooperating learners, who can each alter the contents of the window.

o Telepointers -- Learners interacting with the WYSIWIS window can point to things and move icons on the screen using a mouse or other interfaces.

o Electronic Archiving -- Automatic storage of interactions, so that important ideas are not lost.

o Hypertext Representation of Complicated Sets of Ideas -- Shared thinking and alternative views can be mapped in hypertext form. The broad outline of such a mental model can be portrayed as a relatively simple visual image, and any part of the model can be entered and explored in complex detail.

o Specialized Software for Cooperative Interaction -- Dividing a learning activity into different phases and then using specialized software tools to facilitate each phase can dramatically increase learning efficiency. For example, different software tools might manage different activities such as brainstorming hypotheses, inventing experiments that would test hypotheses, sharing points of view, debating, or decision-making.

o Intelligent Agents -- AI agents that can carry out user-defined independent actions (like the "knowbots" discussed previously) could support a wide variety of group support functions such as gathering task-relevant information and scheduling group activities.

o Two-way video interaction -- The ability to see and talk to other learners strengthens social bonds, and can be especially important in conveying subtle shades of meaning. Non-verbal cues in face-to-face discussion convey many of the clues that let us know if the listener believes us, is confused, agrees, is amused, disinterested, and so on. Two way video restores many of these important cues stripped away by audio or one-way video.

Features like these may seem "futuristic" today, but many of them are already standard in the best corporate CSCW applications. Over the next two decades, capabilities like these will transform the way we all learn and work.

Access to Learning Resources

Providing students - children and adults - with learning materials that respond to their individual level of knowledge, abilities, interests and learning styles is perhaps the greatest challenge confronting teachers today. Emerging technologies can help meet this challenge, enabling students to access an enormous range of multimedia materials from their classrooms, from libraries, and from their home wherever it may be located.

In the 1990s, new forms of child-oriented, interactive and participatory multimedia learning resources will proliferate in the home, at first mainly as stand-alone devices using compact disk (CD) storage, but then increasingly in the form of services provided over cable and phone lines.

These emerging multimedia applications will allow home access to newspaper, magazine and journal articles, TV news or program clips, books, community information, encyclopedias and reference materials, new kinds of "animated articles" and information presentations, full bibliographies from libraries around the world, and many other kinds of resources. Emerging artificial intelligence applications will make it possible to monitor and search a vast range of information sources, not just the encyclopedia or the daily newspaper and weekly news magazine that come into many homes today.

Today, educational TV, from Sesame Street to the Discovery Channel on cable TV, is the main electronic learning resource available in homes. Families with PCs and modems can seek information from commercial databases, but most of these information services are too expensive, too difficult to use, or not relevant to the interests of most children and adults. Educational software for personal computers is improving, but much of it is relatively crude and oriented toward rote learning. Until recently, many software producers tended to "play it safe," producing familiar format materials that often could be done just as well and more cheaply by workbooks. Nevertheless, PC owning consumers spent about as much on educational software for home computers in 1988 as did all K-12 schools.

By 1995, as compact disc (CD) players, electronic networks, interactive cable and new home communications terminals become common in homes, the residential market is likely to expand explosively for educational and "edutainment" software and videotext services. Major firms in the field such as Disney Software, Lucasfilm, Grolier, ABC News Interactive, Warner New Media, Discovery Channel, and Electronic Arts will be bringing new products into the marketplace during the next two years. There is also likely to be a major expansion of interactive educational programming on cable television with many new channels and experiments with limited interactive formats. For example, the new Interactive Network is negotiating with the Children's Television Workshop on joint development of interactive educational programming and the Discovery Channel is also actively exploring this area.

Information services will increasingly offer AI programs to make complex "key word" searching easy for users. Home learners interested in exploring a subject will also be able to submit the best example they have of the kind of material they are interested in (an article, book selection, their own writing, etc.) to an "article matching" service. The service will use massively parallel supercomputers to identify other articles with a content "most like" the submitted writing. (Dow Jones already offers article matching for their own published material.)

Starting in the latter 1990s, **information utilities** are likely to emerge that integrate media, databases, information searching and retrieval, and communications. Information utilities will offer one-stop shopping access to integrated sources of information along with artificial intelligence tools for searching and assimilation. This development will clearly have massive implications for the vendor community.

As broadband communication networks become widely deployed, video on-demand through both cable and phone lines can make vast quantities of educational video programming immediately available. Full time and continuing education students will use two-way video to attend "virtual classes" and consult with tutors. Camcorder technology integrated into broadband networks will literally open up the world to student and adult learning. Students will be able to create their own video materials for group projects and classroom discussions. A national interactive network will facilitate student access to an enormous variety of peers and materials, as well as experts, community leaders, legislators and administrators, specialized public interest organizations and industry managers.

Learners will also have access to rapidly growing databases of multimedia learning material (DBLMs). A new type of educational flexibility can arise based on the concept of guided hypermedia navigation through vast DBLMs. User/learners using telecommunications networks would employ various kinds of educational software to access relevant material in the DBLM. Authors could add new material, but would also draw as much as possible on multimedia material already in the DBLM, dramatically reducing the development costs of high quality multimedia courseware.

Libraries and other information providers will provide full text and image access to national and international library resources. Knowbots that act independently under general user supervision will revolutionize personal information access, making it much easier to keep up with new knowledge. "Broadcatch" (using knowbots to catch information of interest from multiple media) will come to rival the importance of broadcasting.[7]

These three examples suggest that information technology can powerfully support the common themes emerging from today's educational reform movement such as active learning, cooperative learning, personalization and individualization, and parental and community involvement. The examples also begin to suggest the scale of the changes coming in learning technology and in the role of the home environment as a learning site.

The scale of coming changes appears truly historic, comparable only with the largest developments of the past such as the rise of printing technology. Printing made mass education possible. But providing mass education in a society without computers and telecommunications required a kind of intellectual mass production with large groups doing the same things at the same time in the same way. Advanced learning technologies will increasingly allow us to customize and individualize mass education and will bring the whole world's knowledge into every home.

HEALTH CARE IN THE HOME

The Health Care Crisis and The New Image of Health

Our nation's health care system faces a growing crisis of runaway costs, poor health outcomes for the money spent, and mal-distribution. The United States spends more on health care than any other nation. Health care costs rose from $240 billion in 1980 to $666 billion in 1990, and are expected to increase at 10-14 percent annually over the next several years. Health expenditures already constitute 12.2 percent of GNP and the Federal government expects them to grow to 15 or 16 percent by 2000. Yet the cost effectiveness of these expenditures is questionable. On key specific measures, such as infant mortality, the United States stands almost at the bottom of the list of western industrialized countries, most of whom spend in the vicinity of 7% of their GNP on health care. Even in regard to life expectancy the U.S. ranks eighth. And over 33 million Americans have no health insurance coverage. These poor rankings are partly explained by the fact that there is more poverty in the U.S. than in other industrial nations, but the rankings also show that our health care expenditures could be far more efficient and effective and more oriented to preventive than to acute care medicine.

While the greatest leverage for change in the health care system is soaring costs and other problems, there are also many positive forces at work. These include a new image of health and aging among consumers, serious health promotion efforts, movements toward greater cost effectiveness in health care, breakthroughs in many areas of disease which are likely in the years ahead, and the decentralization of much health care expertise and service. Our forecasts suggest that over the next twenty years the changes could be profound. Taking ever more effective self care and health promotion into the home is a critical component of these improvements.

Health Care Changes and What Can Be Done at Home

Three fundamental developments are changing the whole picture of what home based health care can be like: increasing attention to disease prevention and health promotion, the growing importance of home care, and advances in biomedical research.

Disease Prevention and Health Promotion. Sickness care is still the dominant orientation in our medical system: 96 percent of medical expenditures are related to treatment, and less than 4 percent go to prevention. However, this traditional concept of health care as disease and hospital based intervention is changing rapidly. There is a growing appreciation that the leading causes of death and disability today, such as heart disease, cancer, and diabetes, are greatly influenced by our behavior. The Surgeon General

noted some years ago that over our lifetime half of our illnesses are related to our lifestyle, while only 10% are related to medical care. And once we have a disease, particularly the major chronic diseases such as heart disease and diabetes, there are many lifestyle changes which we can use as effective treatments.

Health promotion has been one of the strongest consumer movements of the 1980s. Over 80% of consumer health care decisions are already being made in the home. Consumers are being asked to make choices about their own therapies, selection of physicians and hospitals and use of medication and of life sustaining measures. In confronting these choices, information will become an increasingly essential commodity. Demand will grow for new knowledge bases on issues of treatment as well as of prevention and handling of chronic disabilities. Health care consumers and their families will be assuming more responsibility for their own wellness and self care and for the care of others in their homes.

Wellness and preventive health care measures are also being promoted by employers and insurance companies as a significant means of reducing the incidence of health problems and restraining their skyrocketing health care costs. During the 1990s, both employers and policy makers are likely to come to regard disease prevention and health promotion as the best single strategy for reducing costs while still improving health.

Growing Importance of Home Care. Several factors are acting to increase the importance of home based care. The massive "baby boom" generation is becoming a massive "age wave." As the population ages, health care will deal more and more over the next fifty years with chronic and degenerating conditions involving decreasing mobility and visual and hearing impairments. The main focus of care will increasingly shift toward helping patients deal with their impairments and minimizing their impact on their daily lives.

At the same time, medical improvements are shifting more health care out of hospitals and nursing homes. Many procedures that formerly required long hospital stays now require only short stays followed by convalescence at home. Many treatments that once required hospital care can now be provided in outpatient and home care settings.

Demands for cost containment are also leading toward more home care. As patients are referred from home to primary care to hospitals to specialist centers they ascend a steep hierarchy in costs of treatment. To the extent that more care can be provided in the home, without loss of quality, costs can be kept down and some of today's inequities in access to health care resources can be ameliorated.

The quest for improved clinical effectiveness is also beginning to focus more attention on home care as "best practice," not simply as cost effective. For example, telemedicine in the home can allow health care professionals to monitor and define their patients' clinical status and assess the outcome of therapies.