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AUTHOR	Ridley, William J.; Hull, McAllister H., Jr.
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ABSTRACT

Designed to assist educational decision-makers at the school and district level, this report summarizes the work of the National Task Force on Educational Technology, which was formed in the fall of 1984 to investigate the potential of appropriately integrated technology for improving learning in American schools. The task force used six primary sources of information in generating this report: descriptions of exemplary programs, commissioned papers, letters from educators and private citizens, existing research documents, site visits, and local public meetings. The report consists of eight major sections: (1) Transforming Education; (2) Observations on the Status of Technology in Education; (3) Technology in Education--the Potential; (4) Educational Applications of Technology; (5) Effects on Education; (6) Beginning the Transformation; (7) Recommendations; and (8) Concluding Remarks. Issues addressed include needed reform in pre- and in-service teacher education programs; negative and positive aspects of the use of technology in education; and the potential of such technological devices as personal computers, databases, and expert systems. Five broad uses for technology in education are then identified and discussed, and recommendations are presented to various constituencies (e.g., schools, school districts, state agencies, parents) for implementing strategies regarding planning; financing; teacher education; curriculum and instructional practice; research, development, evaluation and dissemination; and demonstration schools. Conclusions call for the creation of a system in which an individual learning plan permits each learner to proceed at a rate and pace that is challenging but achievable, makes no unjust comparisons with the progress of others, prevents students from becoming passive, and assures positive reinforcement and steady progress. A bibliography and list of the task force members are included. (JS)

TRANSFORMING AMERICAN EDUCATION: REDUCING THE RISK TO THE NATION

A Report to the Secretary of Education
United States Department of Education
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The National Task Force on Educational Technology

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April 1986

FOREWORD

In the fall of 1984, the National Task Force on Educational Technology was established by Terrel H. Bell, then Secretary of Education, who directed it to investigate the potential of appropriately integrated technology to improve learning in our Nation's schools. Noting rapid growth of information technology at all levels of education, the Secretary called for a report that would help educational decision-makers sort through the deluge of information (and misinformation) on the usefulness of technology for learning.

From November 1984 through June 1985, the full Task Force met in four sessions of two days each, listening to presentations, grappling with complex and competing ideas, and debating recommendations. From the outset, the Task Force agreed on the following:

- o Educational technology. The Task Force discussions emphasized electronic, information-age technology, including hardware and software, but did not exclude older, more traditional forms -- books, radio and television, audio and videotapes, and a range of audiovisual technologies.

- o Scope of the study. The Task Force considered all levels of education, but gave primary attention to elementary and secondary education.

- o Levels of specificity. The Task Force recommends in general terms, but leaves specific application where it belongs -- at the district and school level.

- o Target audience. The report is intended for educational decisionmakers and those who significantly influence them.

The Task Force members agreed to concentrate on the current and emerging needs of learners, not on technology itself. In the course of its work, the Task Force became more deeply convinced that information technology represents a powerful array of tools that when creatively applied and appropriately integrated will help meet three fundamental goals:

- o Improving the quality of learning;
- o Increasing equity of opportunity, access, and quality; and
- o Ensuring greater cost effectiveness.

The Task Force used six primary sources of information:

- o Descriptions of exemplary programs using educational technology;
- o Commissioned papers from experts;
- o Letters from professional educators, representatives of professional organizations, private-sector experts, and concerned citizens;

- o Existing research documents;
- o Site visits to schools and technology centers; and
- o Public meetings across the country.

The Task Force expresses profound gratitude to the many professional educators, political leaders, and interested citizens who volunteered their views and perspectives on this complex and, in many cases, controversial topic. The members learned a great deal from these contributors as well as from one another. Truly representing diverse views among its own members, the Task Force worked diligently and cooperatively to reach essential consensus on the goals and general recommendations that comprise the core of the report. It was a genuine pleasure and honor to work with the truly dedicated, talented, and caring individuals whose collective goal remained, throughout, the generation of a meaningful guide to help improve the Nation's schools.

Professional staff members of the Office of Educational Research and Improvement contributed significantly in the effort by providing the Task Force with research data and administrative assistance.

William J. Ridley
McAllister H. Hull, Jr.
Co-chairmen

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SECTION I. TRANSFORMING EDUCATION

In 1983, the landmark report of the National Commission on Excellence in Education, A Nation At Risk, clearly and deliberately "sounded the alarm" about the deteriorating condition of our Nation's schools and triggered widespread reform movements and programs throughout the United States.

The members of the Task Force on Educational Technology generally agree with the Commission's basic conclusion that our educational system does not effectively serve all students, and as a consequence, our Nation is at risk. Although our schools do serve many students reasonably well, our current and future society demands that we significantly reduce the number who now emerge from the system ill-prepared for productive, self-sufficient lives.

The Task Force genuinely believes that most educators conscientiously perform their critical functions in a dedicated and admirable fashion. They genuinely strive to improve educational opportunity, access, and performance. The Task Force applauds their sincere efforts to reform traditional education with the support and aid of dedicated and creative governors, State legislators, school boards, and citizens' groups.

One of the many recommendations for reform stated in A Nation At Risk referred to the promise of information technology to improve education. The Task Force wholeheartedly supports that recommendation, and members strongly feel the need to underscore its critical importance so that our schools will meet the evolving needs of today's and tomorrow's students.

The Task Force supports, for the short run, the Commission's goal of reform. However, the Task Force respectfully urges all educational decisionmakers to extend their vision beyond simple reform to consider transforming education into the system it needs to become.

The proposed transformation is not new. For at least 20 years, educators have proposed and experimented with education mediated by an environment and set of learning tools and methods designed for the individual learner. In fact, the thrust for individualized learning has its roots in much earlier developments in psychology. The principal obstacles to the success of such a program have been, the Task Force believes the lack of all the requisite tools to carry it out effectively. What is new, then, is not the idea of learning for subject matter mastery in individualized programs but the availability and potential of the tools offered by educational technology to implement that idea.

Just as the automobile has transformed American society beyond the expectations of its originators, so the Task Force believes that the

use of educational technology to enhance the current system and improve its performance will lead to the transformation we envision. Hence, the Task Force recommends that efforts at reformation be intentionally designed to lead to transformation, and that activities to achieve both goals -- reform and transformation -- be carried out concurrently.

Ideal reform, the Task Force believes, includes improvements that were beyond its charge to address: improved teacher reward systems and teacher education; recruitment of superior individuals to the profession; improvements in administration and the clarification of goals; effective parental engagement; and raising the prestige of the education profession to the level its importance demands. These both characterize the transformed system we propose and would hasten its realization. Unfortunately, the Task Force recognizes that neither reform nor transformation is easily achieved. To accomplish either is, in fact, a daunting task for all of us.

To prepare for the ideal use of educational technologies is itself a major effort. New software must be designed, based on research in cognitive science, learning theory, computer science, and artificial intelligence. Such sophisticated software has not been widely used in education, but has appeared in other fields, including advanced applications in design, the development of expert systems, and computer-integrated manufacturing. Significant effort at systems design is necessary to create the integrated, interactive work station that the Task Force envisions, with visual, aural, verbal, and numerical information managed by a computer linked to a network of central data bases. Hardware developed for industry may have to be adapted to school use.

In addition, teachers must learn to become managers of a complex educational environment, designers of an individualized learning program for each student, evaluators (and perhaps constructors) of some of the sophisticated tools offered. These tasks will require significant reform in our pre-service and in-service programs.

There is no easy path to excellence. Educational technology gives us a powerful tool -- more powerful than we have ever had -- to traverse that difficult path expeditiously.

Noting the escalating purchase and installation of microcomputers in particular, astute observers pose a number of legitimate questions:

- Is the expenditure justified?
- Is the movement supported by careful planning?
- Is the technology being applied appropriately?
- Will it prove effective in the long term, or is it merely another fad? and
- Where is all of this activity leading education?

The Task Force carefully considered these questions and found both negative and positive aspects in addressing them. Overall, however, the trend is toward better, more exciting and more effective use of technology, as reflected in observations offered in the next section.

SECTION II. OBSERVATIONS ON THE STATUS OF TECHNOLOGY IN EDUCATION

Despite some obvious shortcomings, the presence and use of technology in education has made many converts among educators, parents and students. To a large extent, resistance has been reduced to financial and quality issues, rather than philosophical ones.

Negative Aspects

While educational institutions have made increasingly large investments in educational technology, the technology has often been misused or underused. For example:

Lack of Planning. Too often, decisions for purchase and use were made without well-conceived plans to integrate the technology into the overall educational plan. Frequently, the technology was either thrust upon the schools by well-meaning enthusiasts or purchased defensively to ward off real or imagined community pressures. Many individual teachers were supplied with microcomputers without first being convinced about their usefulness or receiving even rudimentary training in their proper application. As a result the technology was not used as it was originally designed to be.

Inequitable Distribution. Data suggests that information technology is not being distributed equitably. Poor school districts in remote rural areas and some urban neighborhoods lack the means to provide equal access for each student. Although uneven distribution of learning resources is not new to education, the inequitable distribution of educational technology makes the distinction between educational "haves" and "have-nots" even more stark and unjust. In its recommendations, the Task Force addresses this issue most emphatically.

Inadequate Software. Lack of comprehensive planning, inadequate or nonexistent teacher training, and inequitable access march together with several other critical but less important negative items. For instance, early preoccupation with hardware obscured the more essential need to be discriminating and critical about the quality of educational software. Although such software has been designed better in recent years, considerable improvements still need to be made.

Increased Cost. In most cases, educational decisionmakers consider educational technology to be a supplementary tool; therefore, the costs continue to be incremental. Since the cost of technology usually remains minor in relation to overall school costs, most school districts can temporarily absorb this increment. However, the issue of cost effectiveness will become an increasing problem at first for poorer districts. While technology increases as a percentage of total costs, cost effectiveness will become a problem for all districts.

Obsolescence Finally, as technology proliferates, educational consumers have become concerned about obsolescence and the lack of compatibility among technologies. Although the information industry functions in the free market, where competition reigns and fosters diversification, the astounding leaps forward in the improvement of products and services and the resulting wide product diversity tend to confuse the educational consumer and user.

The Positive Aspects

Quite simply, the general concept of technology in education has been accepted, and its presence and use are no longer viewed as an interloper or threat. Very few people still question whether to use technology, but rather debate how much, in what form, and how to pay for it. This acceptance, in many cases, has been related to one or more of the following:

Increased Effectiveness. As technology's acceptance has increased, so has its effectiveness. Very gradually at first and now at an accelerating rate, the measurements of its effectiveness are being acknowledged and distributed. The best evidence available, although obtained in less than ideal experimental designs and of limited coverage, indicates that well-planned, appropriately integrated programs used by well-prepared teachers are effective -- and are becoming more so. The Task Force does not apologize for being visionary, but it cautions that elements of the reformation and transformation need development and testing as the system is being developed. To this end, it recommends ongoing research and evaluation.

Innovation. As is nearly always the case, when a powerful tool becomes available to conscientious, creative professionals, innovative uses abound. Both teachers and students are discovering creative and distinctive uses of information technology. As their sophistication increases, so will their demands for more and better technological products and services.

New Ways to Learn. Educators are discovering that technology not only gives them access to greater information and more varied learning resources, but it also has the potential to change the way people learn. Alternative learning methods and procedures have begun to emerge that promise new learning options. It is becoming clear that individual learners (and teachers) need no longer conform to one standard teaching/learning pattern for all. Programs can be custom designed to serve each learner. When technology helps make such learning not only possible but universally available and achievable, our hoped-for vision of the educational system of the future will be within reach.

The Task Force recognizes that learning tailored to each student is not appropriate for every stage of subject mastery, nor for the mastery of all subjects. Group discussion and cooperative projects will remain as important for mastery in some areas as they are now. It has been observed that students often work more effectively together where computers are involved. The use of educational technology in cooperative learning environments will enhance their effectiveness, while the appropriate use of individualized learning will allow students to achieve the level of competence needed to participate optimally in group efforts. This prognosis is a part of the transformation the Task Force anticipates.

SECTION III. TECHNOLOGY IN EDUCATION: THE POTENTIAL

The computer is a device uniquely suited for education. With related technology, it enables people to deal with vast amounts of information. It can be programmed to adapt learning to the needs of each student, providing corrective advice and allowing the student to proceed as rapidly or as slowly as he or she is able. However, the computer will never replace the teacher. As an excellent information processing tool, it will require the teacher to become an expert at guiding and managing learning. And, as more students use the computer to learn at home, teachers will have to change courses and lessons to take into account students' greater knowledge and skills.

The Right Tool

It will soon be possible to connect personal computers to local area networks -- other local terminals and data bases -- without excessive interconnecting equipment. Computer terminals in the classroom will have access to much larger stores of information and will be able to manipulate them for educational purposes. By the end of 1986, storage capacity will increase several hundred times; further developments will create storage capacity 8,000 times greater than what is currently available on most school computers. An entire encyclopedia plus several other reference works can be stored on one super-capacity disc.

At the right cost

As computing power has increased, the costs have decreased. The last decade has witnessed an enormous increase in the computing power that can be obtained at a given cost. This trend, already apparent in the 1960s, has brought computing power that once only large companies could afford within the reach of many individuals. Hand-held calculators now outstrip the computing capabilities of early mainframe computers. They are faster, easier to program, and more capable of using simple procedures to solve complex problems. The power they represent must be made available to every teacher and to each learner.

New developments are occurring that continue to lower costs. Soon, the cost of a student's work station will be a small fraction of the annual cost of his or her education. The influx of computer-based technology has created a demand for the development of high-quality educational software.

With expanding power

Large computer memories and high-speed processing of large amounts of data provide opportunities to apply to education the results of research in knowledge-based systems. In particular, the expert

system -- a computer program that incorporates the knowledge and methods of an expert in any area -- can be adapted to the presentation of information and to methods of analysis for the instruction of students. Data bases can be addressed that include more comprehensive information than is available in any single book. Students can learn to draw inferences, even from incomplete information (as in possible medical diagnoses from an incomplete list of symptoms). Methods of design and design analysis can be taught with expert systems.

Such systems can diagnose individual learner problems and direct the student to appropriate corrective thinking. The presentation of a complete course (elementary chemistry or American history, for example) can be made with continued guidance for the student to correct errors and improve critical thinking. Such a presentation can put the student in contact with an expert (as does a well-written textbook, which will be a part of the system), but with the added feature of <u>interactive</u> contact to provide feedback on the student's efforts that no textbook can provide. In time, the student will be able to converse with the program in ordinary language in at least a limited way.

In short, as memory capacity and speed of processing no longer act as constraints, we will have the freedom to present ideas, concepts, techniques, and a richness of information impossible by conventional methods. The Task Force expects this capability to be available within the period of the implementation of the Task Force's recommendations (the next 15 years).

SECTION IV. EDUCATIONAL APPLICATIONS OF TECHNOLOGY

The Task Force sees five broad uses for technology in education which are identified below:

- To develop basic knowledge and skills more efficiently than is possible with conventional instruction;
- To teach higher-order concepts and reasoning skills that are more difficult to develop without the technology;
- To develop an understanding of information technology and its uses in society and the work place;
- To enable teachers to manage a learning environment in which learning is tailored to fit each student's needs and progress is based upon prescribed levels of achievement; and
- To develop proficiency in applying computers and related technologies.

A discussion of these uses follows.

Basic Knowledge and Skills. Many schools now use computer-assisted drill and practice sessions. A number of studies have shown them to be effective, especially in teaching rote skills. For example, one study analyzed 51 separate studies of computer-assisted instruction for high-school students. Students who received the instruction performed better on objective tests than students taught by traditional methods, moving them from the 50th to the 67th percentile.(Kulik)

The advantage of such lessons over conventional ones is that they combine the precision and clarity that can be built into the presentation with the computer's incredible patience. More important, the student can set the pace of instruction and receive immediate feedback for each response. The student must participate actively for any learning to take place. The participation, plus the capturing and retention of student attention, are vital to the success of the procedure. For most students, the undivided attention of an automated tutor that is not sitting in judgment but simply providing further knowledge in response to the student's efforts has proven both congenial and motivating.

Higher Order Skills. People have found it possible to create more effective environments and improved procedures that computer technology makes feasible. Schools should explore and capitalize on technology's potential for expanding educational horizons to include what can be taught through simulation, games, or applications of knowledge-based systems. Computer technology, for example, can be used to simulate a chemistry laboratory. Students can learn and apply the theory behind the combination of various solids, liquids, and gases in a realistic dry run that leaves students and equipment unscathed even when results are explosive!

Understanding the Technology. In an information society, the schools must give students an understanding of the technologies that are shaping their lives and creating new patterns of job opportunity. In this use, information technology becomes the object of study as well as a tool for learning. Students learn the history of computer-related technologies and their impact on society.

Furthermore, courses in this field will show students the impact that computers are having on the working world they will be entering. Data bases can be used to estimate which fields of employment will grow through the end of the century and which ones will diminish. The impact of information technology on politics, entertainment, commerce, international trade, diplomacy, and other areas will be studied. Schools should integrate this information into all subject-matter areas rather than create a new course.

Instructional Management. For the student, technology-based education promises to help fit learning to his or her individual needs. For the teacher, it promises to keep track of the rapidly multiplying complexity of records that such learning requires. A classroom in which different individuals and groups move in their own patterns and at their own pace requires a good deal more monitoring and adjusting than one based on common assignments in which all students are expected to take the next step at the same time.

The computer's ability to manage large amounts of information quickly and logically offers the teacher a tool to keep track of varying rates of progress and individual problems without being overwhelmed by record-keeping demands. By removing these administrative tasks from the teacher's role, the technology frees the teacher to give more attention to the needs of each student. The conservation of teacher time gained through greater efficiency in managing individualized learning will be offset somewhat by the added demands of managing a more complex program. But it seems fairly clear that the learning gain from this trade-off will be large.

Applying the Technology. Schools need to teach students the skills that are fast becoming passports to better-paying jobs. These skills include word processing techniques, calculating routines, alternative ways of transmitting data, and the use of electronic mail and electronic bulletin boards.

SECTION V. EFFECTS ON EDUCATION

Evidence of Effectiveness

The accumulation of evidence of the effectiveness of technology in education has been restricted by the limited access of students to computers and by the relative newness of the technology in education. In addition, valid tests have not yet been devised to assess the effectiveness of some of the more advanced instructional applications of computer-related technology.

But enough evidence has been gathered on relatively limited applications of technology-based education to give the Task Force confidence that the technology can produce the transformation envisioned. An analysis of 169 research studies found that computers were an effective teaching tool at the elementary, secondary, postsecondary, and adult education levels.(Kulik) Findings of that analysis include:

- High-school students who received computer-assisted instruction scored significantly higher on objective tests than students who received traditional instruction. Based on the analysis covering 42 separate studies, the average student using computer-assisted instruction would have scored better than 60 out of every 100 students taking a standardized test.

- Students who received computer-assisted instruction in each of 28 studies in elementary schools received better examination scores than other students. In no study did students receiving only conventional instruction achieve higher scores on a final examination on course content.

- In nearly 80 percent of the cases, the analysis found that college students receiving computer-based education had a higher examination average than students instructed with traditional methods.

A report on this analysis in Electronic Learning states, "In the area of affective/motivational outcomes of Computer Assisted Instruction, the news is almost all good. At the college, high school, and elementary levels, students have good things to say about learning from computers. They also emerge with more positive attitudes about computers."

Computers in the Schools

For years, educational institutions at all levels -- business, the military, government, and the home -- have used elements of information technology for educational purposes. Training films, video and audio tapes and discs, radio and television programs, and

telecourses have been and continue to be used in various ways for instruction. Increasingly, computers have been integrated into most educational settings.

Recently, the number of computers in the schools has increased dramatically. A market research firm estimates that the number of computers in K-12 classrooms increased from 291,000 in June 1983 to 1,075,000 by June 1985, and will further increase to 2,400,000 by June 1988. Virtually all schools have at least some computers, but only a relative few have them in sufficient numbers to provide students with adequate access to a work station.

At present, there is, on average, one personal computer for every 40 students in the public schools. The projected installed base of 2.8 million computers in 1989 represents an average of one computer for every 15 students, still a fairly high ratio. This ratio needs to be further decreased, particularly in environments that emphasize subject-matter mastery for each student.

The growth of personal computers in the home will greatly magnify the potential for technology to improve learning. There are currently about 10 million personal computers owned by families. Many of the home computers are and will be used for educational purposes, making it even more important for the schools to be ready to teach computer-literate young people.

An additional positive feature of the emerging technologies is their availability on a constant basis. When installed in schools, they are available not only during school hours, but also in the evenings and on weekends for adults in basic skills programs, specialized training, and recreational learning. Through availability of the technologies, school boards and administrators can expand the learning opportunities for community members of all ages.

SECTION VI. BEGINNING THE TRANSFORMATION

The educational system the Task Force envisions will not be achieved quickly or easily. Substantial changes will be required to deliver learning tailored to each student's needs. The Task Force believes that education should proceed on two tracks.

First, today's schools need to gear up to improve traditional delivery to the maximum that technology-based education helps make possible. They need to prudently acquire hardware and software and apply them effectively. One work station for every ten students is an achievable goal and an important step in the right direction.

Second, in improving current learning practices through technology-based education, the schools will need to pay careful attention to planning, financing, teacher education, and improving the curriculum and instructional practices. The Task Force offers recommendations in each of these areas.

Transformation is needed. The next 5 to 10 years should be a transition period in which education is transformed from traditional delivery of learning based on time-in-grade to a system in which each student learns in the way and at the pace best suited to him or her. At the same time, education needs to create new educational environments in which learning for subject-matter mastery can be explored with the assistance of computers and related technologies. The Task Force recognizes the complexity of carrying out this project -- a complexity that could not be treated satisfactorily in a report such as this. Hence, the Task Force is recommending a comprehensive program of research, development, and evaluation to support the transition.

Based on adequate knowledge. Research and development are needed to understand the cognitive and affective consequences of the new information technologies and to guide their development and application in educational settings. The research must be interdisciplinary and involve teachers, principals, cognitive scientists, educational technologists, software designers, and curriculum experts as full partners. One means of providing a laboratory for the evaluation of the results of such research and development is the demonstration school. Hence, schools should be established that can be managed cost-effectively and that combine the best in educational theory and practice with the capabilities of the technology to create a learning environment adapted to the needs of each student.

To fit changing requirements. The growing complexity of American society demands an education that is the very best we can make it, that fits the learning needs of each student, and that develops each student's potential to the fullest. The intelligent application of technology can be of enormous help as we strive toward these goals. But the transformation of American education will not happen without careful planning and the investment of time, money, and our best collective wisdom. To realize the full potential of the technology -- to develop learning geared to each student -- will require the commitment, effort, and cooperation of all segments of society.

The transformation will not occur overnight. Nor will it occur through the haphazard introduction of computer-related technology into traditional educational process.

The Task Force, therefore, has aimed its first five recommendations at the immediate needs of schools through 1990. It also makes more general suggestions for steps the schools can take now or plan for in completing their transformation in the 1990-2000 period.

The Task Force's final recommendation -- the creation of demonstration schools -- is designed to provide a model of the educational system that the Task Force believes is necessary and feasible.

In making the following recommendations, the members of the Task Force recognize that few of these ideas are new. They have been expressed by others at other times. The national reports on education called for excellence and prescribed some ways to achieve it. The synthesis of learning for subject-matter mastery by each student using technology-based education promises to provide the transformed learning environment that will ultimately provide the excellence we seek.

SECTION VII. RECOMMENDATIONS

RECOMMENDATION: PLANNING

The effective use of technology in education requires careful planning at every level of the educational system. The needs of our rapidly changing society cannot be met, nor can available resources be optimally employed, if technology is allowed to percolate randomly through the school system. It is not intended that the technology be allowed to determine educational goals, but must be used to help achieve them.

The Task Force recommends that every educational decision-making group participate in ongoing planning for the incorporation of technology into the educational system to serve its purposes effectively. Technology planning needs to be integrated with other aspects of planning, and include all appropriate areas -- particularly financing, teacher education, curriculum and instructional practice, evaluation, and dissemination.

Implementing Strategies

Schools should:

- Begin to plan for the management of the computer-managed learning environment, that will use all forms of technology, and will allow students to progress at varying speeds according to their individual abilities; and
- Plan for the orderly acquisition of both the hardware and software needed to serve the school's educational goals.

School districts should:

- Plan to include as line items in the regular school budget all the costs of employing technology -- the acquisition of hardware and software, maintenance and replacement, and the education of teachers and other school personnel in its use.
- Develop strategic plans for educational improvement that recognize the needs of a changing society and that provide for continuous planning that anticipates change. Plans should include the development of a district office of technology to help teachers and school administrators implement the strategic plan. A central facility should be established to serve as the hub of a local area network to be implemented once the technology makes it feasible.
- Involve parents in the planning process from the outset.

School boards should:

- Set policies for planning at the district and school levels to ensure that decisions to purchase and use technology are made within the context of overall school improvement strategies.

State education agencies should:

- Ensure that local plans and their implementation provide equity of access to educational technology.

- Encourage and support local planning and implementation efforts. The support should include funds and technical assistance to help schools plan. These agencies should recognize the developing need for technology-based education and reward good planning at the district level with financial support, including seed money for well-planned development efforts.

For 1990-2000

Education should begin planning now (and be prepared to update plans to account for future developments) for completing the transition to the full utilization of educational technology during the 1990s. Such planning needs to account for the flexible education system required for mastery of subject matter that will be centered in the schools but also incorporate the home and work place as educational settings. Plans for the school of the future include the design of physical space appropriate to technology-based education, provision of data bases and the resource of computer-assisted lessons in all subject areas that are accessible to student work stations in school and at home, and access to national data bases where needed.

RECOMMENDATION: FINANCING

The Task Force believes that education can be made more cost-effective and its quality enhanced through technology-based education. Technology should enable education to buy more learning per dollar and thus expand its benefits to society. Overall costs may be higher in the short term, and perhaps even in the long term. But the costs of acquiring, maintaining, and replacing technology will have to be met if education is to serve the growing needs of an increasingly technical society.

Moreover, the members of the Task Force believe that the recommended transformed education system will prevent many of the "casualties" common to the traditional format. By reducing dropouts, for example, and providing continuing opportunities for more and better learning by each student, millions of dollars currently spent on corrective social programs will be saved. A high percentage of the casualties of the current system will reach desired levels of self-sufficiency.

The Task Force recommends that the financing of technology-based education occupy a central and continuing place in the budgeting of education.

Implementing Strategies

School districts and boards should:

- Include technology as a regular budget item, recognizing that amounts budgeted for software, maintenance and replacement of hardware, and for educating teachers in its use, will exceed the amount budgeted for the initial acquisition of hardware.
- Work with the information industry to secure favorable prices and cost containment through district-wide or Statewide mass purchases.
- Use all sources of information to select the most useful and best technology on the market to attain the goals established by the district.
- Work with parents, industry representatives, and economic development offices of State and local government to secure support for adequate funding for technology purchases.

Parents should:

- Recognize and support efforts of school boards to raise funds to buy computer-related technology and encourage State legislatures to provide necessary support.

The Federal Government should:

- o In cooperation with State legislatures, provide incentives to encourage businesses to participate in partnerships to help schools adopt the new technology.

Industry should:

- o Continue to provide support to the schools through equipment gifts, development grants, and favorable prices.
- o Establish scholarships to help exceptional teachers extend their education in the effective uses of technology.
- o Increase the number of partnerships with schools to underscore the relevance of knowledge in the work place and to demonstrate the shared goals of industry and education.

For 1990-2000

The improvement and transformation of education to mastery learning will demand continuing support. The Nation needs to recognize that the education of its citizens provides the basis for the economic, social, and cultural health of American society. Enlightened national self-interest should justify the support of the well-planned educational transformation that the Task Force proposes.

RECOMMENDATION: TEACHER EDUCATION

Many teachers do not understand how to exploit technology as a teaching tool. The optimum use of technology-based education is too complex to learn casually. Successful incorporation of educational technology in the classroom cannot occur without appropriate teacher education. Both pre-service and in-service education are essential. Technology will not transform education to meet the needs of society if teachers do not learn to use it as both an instructional and a management tool.

The Task Force recommends that all organizations responsible for pre-service and in-service teacher education design and implement effective programs to prepare teachers to use technology to its best effect for instruction and instructional management. Particular attention should be paid to educating first-year teachers.

Implementing Strategies

Schools should:

- Provide in-service teachers with adequate time to learn to apply the technology to learning processes through paid release time, the use of substitutes, and on- and off-site classes.

- Select at least one teacher who is or can become an expert in technology to serve as a resource for other teachers to organize and oversee the induction of in-service training programs for the school.

- Encourage teachers, by appropriate incentives, to be lifelong learners in their subject areas and to remain abreast of developments in technology-based education (especially software) that apply to their respective subjects.

School districts should:

- Collaborate with universities offering teacher education to develop programs for in-service teacher education in the applications of technology-based education.

- Use technology in the development of programs for in-service education of teachers, particularly for those from fields other than education, to train them in educational techniques and the uses of technology, as well as in general educational methods.

State education agencies should:

- Urge all teachers to become effective users of computer-related technology for educational purposes.

Higher education institutions should:

- o Redesign pre-service teacher education programs to include the effective uses of technology, including its uses in teaching for subject-matter mastery.

- o Ensure that those who prepare our teachers themselves are fully competent in applying technology to education.

For 1990-2000

By 1990, teacher education at all stages will incorporate the best uses of technology to deliver, support, and manage learning. Teacher preparation programs will continue to reflect the changing needs of the society and the opportunities presented by technology that drive the changes.

Social and cultural education must not be neglected as education for economic development is improved and unity of knowledge and general education should not be shortchanged as specialization and in-depth education is intensified. Education will need to incorporate the best of research and development in teacher education programs.

RECOMMENDATION: CURRICULUM AND INSTRUCTIONAL PRACTICE

The most significant impact of technology on education will come from the extensive transformation of the curriculum and instructional practice. The movement should be toward learning geared to each individual. The continuing goals of education may be more nearly realized through the use of the very technology that produces rapid domestic and international societal changes.

The Task Force recommends that schools use technology-based education to make learning more active and interactive for each student, including pacing at a rate appropriate to each student. Schools should explore ways to modify classroom organization to capitalize on the opportunities presented by the technology. Instruction in the uses of technology should be included in courses where it applies. Finally, schools should capitalize on the power of the technology to help develop higher-order thinking skills.

Implementing Strategies

Schools should:

- Develop the curriculum for the new basic skills required by an information society. The curriculum should include the applications of information technology to acquire and process information for the diverse activities of that society. It should also include the development of higher-order skills of reasoning and analysis that successful accomplishment of such activities demand.

- Develop an integrated curriculum across all levels and subject matter areas of education that takes advantage of technology-based education to achieve coherence in learning.

- Provide a flexible learning environment that encourages each student to move through the curriculum at a pace that suits him or her best. It should also allow groups of students to work together when that is the best learning method.

School districts and boards should:

- Provide leadership and support for the schools in developing the new curricula and transforming them into the desired learning models.

- Provide opportunities for parents to learn about educational technology, how it can improve teaching and learning, and how they can become partners in the educational process.

State education agencies should:

- Establish standards for graduation to ensure that all students will acquire both new nd traditional basic skills, as well as higher-order reasonir_ skills in a number of fields that allow the graduate to function effectively in today's complex information society.

- Cooperate with higher education institutions and work with publishers to ensure that textbooks form ar integral part of the instructional package that includes technology.

Higher education institutions should:

- Help schools undertake the massive task of curriculum revision to meet societal needs and to adapt technology to accomplish that revision.

For 1990-2000

The reforms begun in 1986 should continue. The principal effort in the 1990s will be to develop and secure the software necessary to implement the mastery-based learning model. The Task Force recommends that the curriculum prov : both general education in all subjects and opportunities for more in-depth study in areas of individual student interest and ability. During the 1990s, education should implement integrated curricula that are responsive to the economic, social, and cultural needs of the developing society. In addition, an instructional management system should be implemented that allows each student's progress to be effectively monitored and encouraged so that only the stude.t's native potential limits mastery of subject matter.

RECOMMENDATION: RESEARCH, DEVELOPMENT, EVALUATION, AND DISSEMINATION

A broadly-based research and development effort is required to realize the promise of technology-based education. Continued and expanded research is needed in cognitive science, expert systems, learning theory and its classroom applications, computer science applied to education, and the integration of interactive software packages for learning. Research is also needed on managing learning for subject-matter mastery, both to enable teachers to select the best learning tool and to monitor student progress. Software development, in particular, must keep pace with advances in learning theory and hardware. In addition, mechanisms need to be established for evaluation of software and the rapid dissemination of successful practices.

The Task Force recommends that State education agencies, the schools, higher education institutions, and the information technology industry cooperate to: perform research and development; transform education through applications of technology; evaluate the effectiveness of the new methods and materials; and disseminate successful practices to the field. Since the States and the school districts cannot bear the full cost or the research needed, the Federal Government should support these efforts.

Implementing Strategies

State education agencies should:

- Work with the school districts in defining the needed software.
- Establish the capability to evaluate the effectiveness of software in conjunction with schools and in cooperation with industry.
- Define for the software industry the areas where software products are needed and the form they should take.
- Provide financial support for research on effective educational practices using technology.

Higher education institutions should:

- Perform research on the emerging role of the teacher as diagnostician of student needs, designer of individual methods of instruction, and manager of technological resources and learning processes.
- Assemble teams of discipline experts, classroom teachers, learning theorists, and computer scientists to develop expert systems of software and to improve existing, less sophisticated software to support improvements in current instructional practice.

The information industry should:

- Provide the educational community with information to allow it to anticipate advances in technology so the schools can prepare to take advantage of them.

- Work with educators to establish standards for performance evaluation and for learning management criteria to ease the integration of software programs into the overall curriculum.

The Federal Government should:

- Establish or designate an agency equivalent to the National Science Foundation or the National Institutes of Health to support peer-reviewed research and development in the application of information technology to education. This agency should work with the States, the information industry, and the demonstration schools to disseminate successful practices to all schools.

- Support cooperative research with the information industry.

- Support the implementation and evaluation of model plans for improving education through computer-based technology. Plans should include support, in partnership with the States, of State-level centers for information technology.

For 1990-2000

The proposed research and development program for the next 5 years will provide a sound base for extensive research in the next decade. The Task Force urges that education join the information industry under the auspices of Federal agencies responsible for educational research to plan for research during the 1990-2000 period. The Federal Government should consult with educational leaders, discipline experts, and the information industry to establish a research and development agenda and plan for the next 15 years.

RECOMMENDATION: DEMONSTRATION SCHOOLS

To attain the full potential of technology to help transform education to mastery learning, model schools will be needed to create new learning environments in which computer-related technologies will be used to the maximum extent required for effective learning and instructional management. The creation, operation, and successful demonstration of such schools will require substantial periods of time. These demonstration schools will provide for an interactive learning environment requiring full participation by each student.

The Task Force recommends that each State establish one or more demonstration schools by designation of existing schools or by creation of new ones. Ideally, at least one school should be established for each level of K-12 education in the State (elementary, junior-high or middle, and high school). The schools might begin with the first year at each of the levels and expand upward one grade per year until all grades are included. The schools will explore and demonstrate technology's ability to provide the interactive learning modes that fit each student's needs, abilities, and learning styles.

Implementing Strategies

- The demonstration schools require the leadership of the State education agency for their establishment and support. Two models are possible: either existing schools designated as demonstration schools; or new schools created and managed by the State, a designated school district, or a higher education institution.

- Each State should ensure that the demonstration schools eventually cover the K-12 scale.

- The schools should be financed under existing mechanisms, except that some additional resources will be needed to get started and to ensure rapid progress.

- Planning for the schools should involve teachers, administrators, colleges of education, parents, legislators, State education officials, and experts from the information technology industry. Planning should be comprehensive and ensure that at least the first year of the school's operation is understood in detail before the school is opened.

- Teachers and administrators who volunteer to serve in the schools should be educated to use information technology for mastery learning and its management.

- The demonstration schools should develop and use differentiated staffing formulas to work toward more cost-effective, productive, efficient learning environments.

- Parents and students should be encouraged to volunteer for enrollment by disseminating information about the schools.

- The demonstration schools should establish a systematic program that will use their experience to help other schools in the State to transform their programs to deliver learning for subject-matter mastery.

- State and local authorities, the designated Federal agency, and the technology industry should cooperate with the demonstration schools to publicize successful practices.

SECTION VIII -- CONCLUDING COMMENTS

The greatest promise of technology is that it has the capability to manage and deliver learning geared to the needs of <u>each</u> student. Through its range and power, technology-based education can promote the transformation in quality and quantity that American education will need to achieve in the years ahead.

Although Americans acknowledge individual differences, we have grown accustomed to a system in which young people are taught in groups with uniform practices and pacing and are evaluated against group norms. The results have been made clear in more than a dozen national reports on education -- a mediocre system that discourages and underserves both the most able and the least able. Advocated reforms predicated on more rigorous course content, more time in the class- room, and stricter discipline will not by themselves produce an excellent education for all, for the means will not have been provided to assist each student to reach his or her full potential.

To transform education, we must create a system in which an individual learning plan permits each learner to proceed at a rate and pace that is challenging but achievable, makes no unjust comparisons with the progress of others, prevents students from becoming passive, and assures positive reinforcement and steady progress. Such a plan will allow the most able to move to new realms without restriction and the least able to find their own distinct achievement levels.

The Task Force believes that in the long term the overall cost of an education geared to the needs of each student will be no greater than that projected for the current system. Technology-based management will yield more productive use of teacher time and will eliminate the need for special programs, since, in effect, each student will be in a special program. In addition, enormous savings will accrue to society from the reduction of the out-of-school costs of dealing with the casualties of our current system -- savings that can be utilized all or in part to further improve education conditions for both learners and educators.

The United States has stood as a beacon to the world in devising an educational system that serves all of its citizens. Up to and including the 1950s, this system served the Nation well. But it is no longer adequate to deal with the needs that have emerged in our society during the past two-and-a-half decades. Technology-managed and assisted education provides the means to deliver the solutions that the changing times demand.

The profound respect for the individual that separates our way of life from that of most other societies and the human resources we need to make that way of life flourish compel us to make every necessary sacrifice to provide the best learning environment possible for each of our citizens. Clearly, now is the time to begin that needed transformation.

A SPECIAL WORD TO TEACHERS...

The school of the future will make the role of the teacher even more important and more challenging than it is today. Teachers in the classroom today can begin to gain familiarity with computer-based technology by learning word processing and other productivity skills that make their task easier. They should be assisted in reorganizing their work so that much of the time-consuming paperwork and record-keeping can be relegated to the computer, thereby freeing more of their time for interaction with students. And they can begin now to teach the impact of information technology on society in all subject-matter areas.

The Task Force also believes that teachers should use technology for their own education. The new technology can help them improve their knowledge of their subject areas and their teaching skills.

A serious teacher shortage has been forecast. Reasons for the anticipated shortage include unsatisfactory compensation, lack of upward mobility potential, little voice in management decisions, frustrating working conditions, and general lack of support and appreciation. The Task Force sincerely believes that the transformed school environment proposed in this report will improve the working conditions and the positive atmosphere of the learning environment so as to stimulate current teachers and to entice prospective high-quality individuals into the profession. The transformed school will make the teacher's job more feasible, more enjoyable, and more fulfilling, and, one can hope, more appreciated and better compensated.

...AND TO PARENTS

Parents must continue to do what wise parents have always done: work as partners with the schools. This partnership will become more important as high technology moves into the schools.

Like teachers and other educators, parents face important challenges. First, they need to understand how technology can be used as a learning tool, and they should insist that the schools offer them instruction in the educational uses of the technology so they can better help their children. Second, by becoming involved with schools, parents can help to ensure that the best technology possible is acquired and is used in the most effective manner -- in effect, becoming lobbyists for the schools their children attend. Finally, parents need to make sure their children have access to computer-based education, either at home or after school hours in the school library or computer laboratory.

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NATIONAL TASK FORCE ON EDUCATIONAL TECHNOLOGY

LIST OF MEMBERS

Mr. William J. Ridley (Co-chairman)
Vice President for Academic Strategies
Control Data Corporation
Minneapolis, Minnesota

Dr. McAllister Hull (Co-chairman)
Counselor to the President
University of New Mexico
Albuquerque, New Mexico

Mr. George J. Adams, P.E.
President
Mobility Systems and Equipment Company
Los Angeles, California

Dr. Roberta Anderson
Academic Vice President
Morehead State University
Morehead, Kentucky

Mr. Carlos Benitez
President
United Schools of America
Miami, Florida

Dr. Robert Benton
Superintendent
State Department of Public Instruction
Des Moines, Iowa

Mr. William H. Booz
Teacher, Fairfax County Public Schools
Annandale, Virginia

Dr. Barbara Bowen
Director
Apple Education Foundation
Cupertino, California

Mr. Robert C. Bowen
Executive Vice President,
Education, Publishing, and Training
McGraw-Hill Book Company
New York, New York

Mr. William H. Bowman
Chairman of the Board
Spinnaker Software
Cambridge, Massachusetts

Mr. Bruce Brombacher
Jones Middle School
Upper Arlington, Ohio

Mr. Richard T. Bueschel
Senior Vice President of Technology
Houghton-Mifflin Company
Boston, Massachusetts

Mr. Barry J. Carroll
Vice President
Katy Industries
Des Plaines, Illinois

Dr. Sylvia Charp
Editor-in-Chief
T.H.E. Journal
Upper Darby, Pennsylvania

Mrs. Bobby Goodson
Education Consultant
Sunnyvale, California

Dr. Gregory Jackson
Graduate School of Education
Harvard University
Cambridge, Massachusetts

Dr. Lorrin Kennamer
Dean, College of Education
University of Texas at Austin
Austin, Texas

Dr. Daniel Kunz
Executive Director, Government Relations
Commodore Computer
Washington, D.C.

Mr. Bernard Oliver
Technical Advisor to the President
Hewlett-Packard Corporation
Palo Alto, California

Mr. Joseph F. Potts
Product Manager, Personal and
Educational Software
IBM Corporation
Boca Raton, Florida

Dr. Billy R. Reagan
General Superintendent
Houston Independent School District
Houston, Texas

Dr. Judah Schwartz
Co-Director
Educational Technology Center
Harvard University
Cambridge, Massachusetts

Mr. Gordon Stulberg
PolyGram Picture/PolyGram Corporation
Culver City, California

Dr. William W. Turnbull
Distinguished Scholar in Residence
Educational Testing Service
Princeton, New Jersey

Mr. Richard L. Warner
President
R.L. Warner Enterprises
Salt Lake City, Utah

EX-OFFICIO MEMBER

Dr. Paul Resta
Director of the Center for
Technology and Education
University of New Mexico
Albuquerque, New Mexico

OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT (OERI) STAFF

PROJECT DIRECTOR

Dr. Elizabeth VanderPutten

STEERING COMMITTEE MEMBERS

Ms Patricia Allen
Mr. Thomas Ascik
Ms. Ola Clarke
Dr. Charles Baughey
Ms. Eileen Nicosia