ton, D.C., 1965). Potential casualties were calculated by multiplying the area of the average tornado by the number of tornadoes in a 2° square, and then dividing this sum by the area of the 2° square. This quotient was multiplied by the quotient of the population of a 2° square divided by the area of a 2° square.
6. "A tornado-death may be regarded as a 24-hour period, between an instant after midnight on one day and midnight the same day, during which one or more deaths occurred and/or during which one or more persons received tornado-induced injuries that subsequently proved fatal" (*3*, p. 3).
7. This decade was selected because, beginning in 1953, tornado data became more reliable as a result of the implementation in 1952 of a more elaborate detection network by the National Weather Service.
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19. T. D. Graves, *Time Perspective and the Deferred Gratification Patterns in a Tri-ethnic Community*, research report No. 5, Tri-ethnic Research Project (Institute of Behavioral Science, Univ. of Colorado, Boulder, 1961).
20. J. Rotter, *Psychol. Monogr. Gen. Appl.* **80**, 1 (1966); H. M. Lefcourt, *Psychol. Bull.* **65**, 206 (1966); V. C. Joe, *Psychol. Rep.* **28**, 619 (1971).
21. The data analyzed here are drawn from our larger study, which involves a total sample of 420 interviews from four different areas of the country—Kansas-Oklahoma, Alabama, Illinois, and Massachusetts-Connecticut. For the particular problem addressed in this article, a sample of 57 respondents was chosen from Illinois and Alabama, controlling for education, income, sex, age, and occupation.
22. Using the chi-square one-tailed test, the differences shown in Tables 2 and 3 are significant at the $P < .05$ level.
23. Only examples of the data themselves can adequately convey the two very different meanings of "luck" used here by the two groups of respondents. Illinoisans define luck as a *random* phenomenon: for example, "The survivors of a tornado are lucky to be alive . . . it is a hit-or-miss thing"; or, "The survivors of a tornado are lucky, it could so easily have been them." Alabamians, on the other hand, define luck as *nonrandom* good fortune: for example, "The survivors of a tornado are lucky, it wasn't their time"; or, "The survivors of a tornado are very lucky, but tragedies cannot be questioned; it's all God's Will."
24. T. Fujita of the University of Chicago has developed a scale of tornado intensity that correlates wind speed with extent of property damage shown in aerial photographs. Since January 1971, state weather officials have been evaluating tornadoes according to Fujita's criterion photographs. At this time, only the data for January through April were available. As the geography of tornado occurrence is seasonal, moving northward during the late spring and early summer, it is too early to compare the North and South on this measure of storm violence.
25. This study was supported by Natural Hazards Research, a program funded by the National Science Foundation in a grant to Toronto, Clark, and Colorado universities; the program is directed by I. Burton, R. Kates, and G. White. Earlier drafts of this article were delivered at the annual convention of the Association of American Geographers, Boston, April 1971, and at the International Geographical Union Seminar on Natural Hazards, Budapest, 1971.

Information Technology: Its Social Potential

By means of cable television, an information utility could be made available to most U.S. homes by 1985.

Edwin B. Parker and Donald A. Dunn

Broadcast television is like the passenger railroad, taking people to scheduled places at scheduled times. Cable television has the potential of becoming like a highway network, permitting people to use their television sets in the way they use their personal automobiles; they may be able to select information, education, and entertainment at times and places of their own choosing.

The technologies of cable television (especially two-way cable television), video cassettes, computer information systems, and communication satellites are now at a stage that could permit the creation of an "information utility" for the purpose of fostering equal social opportunity in the United States. The unit costs of public access to information could be reduced so much that the total expenditure on information services would probably increase substantially. In the same way that the automobile led to greatly increased expenditure on transportation, and the printing press led to greater expenditure on production and distribution of information, so the newly developing technology of information accessibility will have broad social effects. The main difference between the present period of technological change and the earlier periods is that our society now has a greater opportunity to direct the development of the technology to meet positive social goals, instead of becoming the beneficiary (or victim) of uncontrolled technological change.

The greatest single potential of an information utility might be the opportunity to reduce the unit cost of education to the point where our society could afford to provide open and equal access to learning opportunities for all members throughout their lives. Total expenditures for education are unlikely to be reduced, but an information utility could make possible the provision of quality education at an economical rate to those not adequately served by the present educational system. Significant gains in economic productivity as a result of education may be the most promising way to stimulate general economic development. Denison's analysis of past sources of per capita economic growth in the United States supports such a conclusion (*1*).

The benefits of an information utility will not be attained quickly, or be guaranteed, unless there are major federal expenditures on the research and development needed for their accomplishment and some measure of coordinated planning and management of the overall system. The federal government has the continuing challenge of providing equal social opportunity for all citizens; this includes the provision of equal access to education and information, as well as the maintenance of an economy that provides equal opportunity of employment.

An information utility could be made available to every urban home and

Dr. Parker is professor of communication and Dr. Dunn is professor of engineering economic systems at Stanford University, Stanford, California 94305.

rural community in the United States by 1985. Such a national goal would, like the goals of the space program, have the glamor of new technology. It would differ from national space goals in two respects. One is that an information utility would be built largely by private enterprise with private capital; federal planning, research, and development funds could provide the additional incentives to ensure that the needs of education and other public services are met. The other difference is that instead of the information utility being justified in terms of national prestige and "spin-off" benefits, it would be designed to serve people directly in a way they could understand.

Before such a national goal could be adopted or have wide political appeal, the launching of a first "Sputnik" would be required in the form of credible pilot projects demonstrating the technical and social feasibility of the larger goal. By means of these pilot projects, it would be possible for the government to determine the combination of factors needed to guarantee the social, political, and economic success of the venture while still reserving the option of not proceeding further. In this article we present arguments that support the idea of financing pilot projects and coordinated planning that will test the technical and social feasibility of a national information utility.

Present Cable Television Systems

As of January 1971, there were 60 million households with television sets, 5.3 million of which were served by cable (*2*). In Fig. 1, the projected curves for 1971 to 1980 are based on an assumption that growth will continue for the next 5 years at the same rate as it has done for the past 5 years; it is also assumed that there will be a saturation effect in the number of households with cable television starting in 1976.

The typical cable television system now has a capacity for 12 or fewer channels, all of which are used primarily for retransmission of television programs broadcast over the air. Revenue for the cable system is obtained by selling (at rates of about $5 per month) better quality television signals than those available over the air, or by selling reception of distant signals not locally available. Some cable systems are also being used to provide local television service directly over the cable

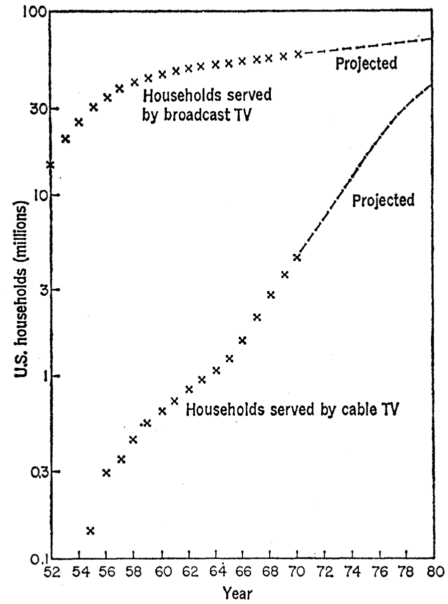

Fig. 1. The number of U.S. households served by broadcast television and the number of households served by cable TV. Figures projected for 1971 to 1980. [From *Television Factbook* (*2*)]

without broadcast transmission. Growth of cable television has been slowed by Federal Communications Commission (FCC) regulations preventing the importation of distant signals into the top 100 markets (the larger metropolitan areas containing more than 85 percent of the nation's homes). There is a general discussion of cable television policy issues in the recent report of the Sloan Commission on Cable Communications (*3*). New FCC rules that went into effect in April 1972 permit at least two distant television signals to be imported by each cable system, although copyright rules make that option less attractive in the top 50 markets than in the second 50 (*4*).

A single television cable has the capacity for many more than 12 channels

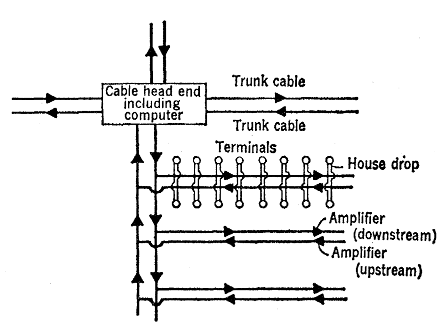

Fig. 2. A two-way cable television network. Two separate cables can be used to carry downstream and upstream signals, as shown here, or two separate frequency bands in the same cable may be used.

because the cable amplifiers now available can amplify frequencies from near zero to about 300 megahertz; a bandwidth of 6 megahertz is required for each color television signal. If there were economic incentives, the number of cable channels could be increased indefinitely by laying more cable. The older cable systems can be made to supply more than 12 channels by changing the amplifiers that are spaced throughout the system.

Television and radio signals, and digital communication signals, can be transmitted directly over a cable without the necessity of allocating broadcast frequencies. Charges to those wishing to transmit signals over the cable can be much less than for broadcasting over the air for two reasons. First, charges can be closer to actual cost because access to a cable does not require payment of the opportunity cost associated with preempting a scarce resource. Second, it is not necessary to pay for larger audiences than the originator wants to reach, because cable systems can serve groups of 10,000 (or fewer) subscribers instead of entire regions with populations of the order of millions.

To estimate the cost of the hardware for a 24-channel system (and of more complex systems discussed below) the capital cost of a complete cable system is first calculated. The capital cost is then converted to a monthly cost and then to a cost per terminal hour that a user would expect to pay and a cost per channel hour that would have to be paid by any group or individual making exclusive use of a channel. These calculations are summarized in Table 1 (*5*).

Two-way Communication

Many of the new cable television systems now being installed have sufficient channels to enable subscribers to communicate data back to a computer at the head-end of the cable system (*8*). Such systems, referred to as subscriber-response systems (SRS), now permit a single computer to collect information from as many as 10,000 subscribers in less than 2 seconds (*9*). These same systems can automatically record whether the television set is on and what channel it is tuned to. Figure 2 shows the network configuration for this type of system.

The terminal configuration at the subscriber's end of such a system will probably have the form shown in Fig. 3, if it is built during the next few years. In this configuration, the lines leading from the trunk cable to the house (house-drops) are connected to a unit containing a modulator-demodulator (modem) and a digital memory. The signal received in any one of the regular television channels may be passed directly to the television set. Alternatively, a separate tuner and channel selector may be included. When a signal is received from the computer in the data channel it is demodulated and, if the address is that of this terminal, the data signal stored in the memory is read out, modulated, and transmitted upstream to the computer. Messages from the subscriber are written into the memory through a 12-button pad. A paper tape recorder may be used to record the subscriber's messages as he types them or to record acknowledging signals from the computer. The 12-button pad could be replaced with a teletype keyboard at a cost of about $100.

The cost of a terminal configuration of this type, apart from the television set, is in the range of $100 to $300, depending on the detailed design requirements and the quantity produced. We have estimated $200 for all items in Fig. 3 except the television set. The production of large quantities, on the order of tens of thousands of terminals per year, is assumed. Additional costs for a two-way system of this type include the cost of a return cable or of upstream amplifiers in the existing cable, plus the cost of a computer at the head-end for polling and for storing and processing data. We estimate $10 per subscriber for these items in a 10,000-subscriber system of the type and density considered above. When these costs are added to the costs of a one-way system, the total capital cost per subscriber becomes $320. The costs for this type of system are summarized in Table 1. It should be emphasized that the costs are based on the present state of the technology. Systems built 5 to 10 years from now will probably have improved performance at lower costs than those estimated here.

Computer and Satellite Communication

Cable television may turn out to be the most economical way to provide some kinds of digital communications to homes, such as computer-aided instruction, information retrieval, and time-shared computer services (*10*). The potential of time division multiplexing (sending messages from many users over the same channel at different times) on polled systems may permit cheaper communication from computers to individual remote terminals on the shared "party line" type of system than on dedicated (space division multiplex) communications systems such as that provided by the present telephone network.

Techniques such as those recently demonstrated in the Reston, Virginia, cable system also permit time-sharing of particular channels for analog data (still pictures), with the television set becoming a computer display terminal (*11*). Completely individualized computer-aided instruction, information retrieval, and other computer services can thus be brought to every home. This technique, with the aid of a local video storage device, permits the viewer to select, on demand, displays of digital or still video messages transmitted from a central location at reasonable cost.

This device is usually referred to as a frame-grabber, because it takes a single television picture (or frame) lasting 1/30th of a second, grabs it out of all the other frames being transmitted on the cable, and then repeatedly supplies it to the set so that the viewer sees this frame as a still picture on his set. The key component of such a system is the unit that stores the frame locally. For the system demonstrated in Reston, a commercially available video tape recorder was used as the local storage unit. Other methods of storage are possible, such as the plasma display tube (*12*), silicon storage tube (*13*), or delay line systems in which the delays may be 1/30 second or more.

A critical cost parameter in such a system is the number of subscribers that can share a channel. If the average time between frames for each user is 1 second, then the maximum number of subscribers per channel is 30. If the average time is 10 seconds, 300 subscribers can share the channel. We have estimated $200 per terminal for a frame-grabber that could be integrated with the subscriber response system in which the 12-button pad or keyboard is used. The total costs for this type of system that we summarize in Table 1 are less accurate than the other cost estimates given here because the technology is still in a state of rapid change. The cost per channel hour is given in Table 1, first for this system as a cost for the channel as a whole and then as a cost for an individual using the channel either 1/300th or 1/30th of the time, corresponding to an average time between frames of 10 seconds or 1 second.

To provide instructional or other services via such systems, additional computer hardware, computer software, and program production would be required. Hardware costs are likely to be small compared with other costs. Nevertheless, the costs of communication hardware can be critical to a decision as to what type of information system should ultimately be used. Costs as low as those indicated may be sufficient to make the costs of information distribution in this form cheaper than other forms, such as classroom instruction or printed newspapers delivered by truck and bicycle.

Schemes for providing individual homes with direct access to centrally stored motion video on demand do not appear to be economically viable at this time because of the high cost of transmission associated with the use of a television channel on an exclusive basis. The cost per channel hour given in Table 1 is an average transmission cost that would have to be paid by an individual subscriber desiring his own motion video service. The price during prime time would be greater than this. In addition, there would be costs associated with a video tape or video cassette player at the head-end and the cost of the tape or cassette. If these costs were acceptable, remote controlled video jukeboxes providing on-demand, motion video with slow motion, stop action, and instant replay under the viewer's control could be made available. A more probable development is that video cassettes in the home will provide the motion video capability, with requested "movies" perhaps being recorded onto home cassettes from the cable during nonpeak hours. Alternatively, motion video could be made available on a shared basis by means of cable; groups of 10 to 100 subscribers sharing a channel might be adequate to reduce the cost to an acceptable level.

There are a variety of means for interconnecting local cable television systems into a national information network. Conventional, terrestrial microwave links provided by American Telephone and Telegraph (AT & T) are now used to interconnect broadcast television stations. Communication satellite systems appear to provide the most economical long-term approach. Hughes Aircraft has proposed to the FCC that it be permitted to construct a domestic communication satellite system for the purpose of interconnecting cable systems. Special-purpose common carriers, such as Datran, might also play a significant role in the interconnection of cable systems (*14*).

An Information Utility

The information utility that we propose be established might be visualized as a communication network providing access to a large number of retrieval systems in which nearly all information, entertainment, news, library archives, and educational programs are available at any time to any person wanting them (*15*). Many of these services, such as retailing in the home, entertainment, and various specialized business services would be provided by private enterprise. Other services would depend on public support.

The social goal of such an information utility could be to provide all persons with equal opportunity of access to all available public information about society, government, opportunities, products, entertainment, knowledge, and educational services. From the subscriber's perspective such a system would look like a combination of a television set, telephone, and typewriter. It would function as a combined library, newspaper, mail-order catalog, post office, classroom, and theater.

The configuration of the information utility is likely to be that of a number of overlaid computer-communication networks, some competing with one another to provide similar functions, others providing different functions. These separate networks could share many of the same physical facilities, such as subscriber terminals, communication lines, and a switching computer. Each different network or service would probably have its own separate computer, central data file, and computer software.

Although competition might develop between the telephone system and the cable system for some of the services, the different physical characteristics of the two networks would probably lead to different and complementary services. The cable network would, like the telephone system, develop a local monopoly in each geographic area because it would be too costly to lay competing cables. To guarantee both freedom of speech and freedom of access on such a communication system, regulatory means would have to be found to guarantee nondiscriminatory access to both the sending and receiving ends of the information utility. Present FCC regulations for cable television are moving in that direction (*4*).

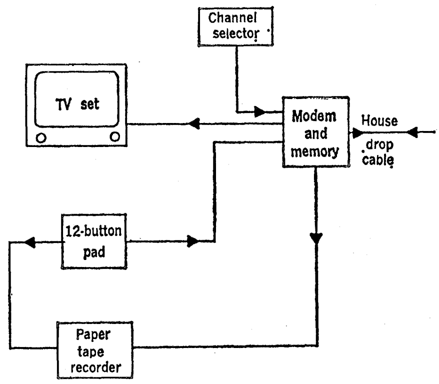

Fig. 3. Terminal configuration of a two-way cable television system. A 12-button pad allows subscriber responses to be entered into the system and a paper tape recorder gives the subscriber a record of his transactions.

Economic Potential

We have shown that the capital cost per subscriber for a system of this type, apart from the cost of the television set, is likely to be around \$500 to \$700. Of interest as a basis of comparison is the fact that the U.S. telephone system has a total capital investment of about \$50 billion, which is an investment per telephone of \$500 or an investment per household or business office of \$700. Eventually, cable television will probably reach residents of every small town in the United States, but perhaps not every isolated farmhouse. On this assumption the total capital investment might be of the same order of magnitude as that for the telephone plant, or about \$50 billion. This capital investment for hardware will be accompanied by an annual expenditure for programming and personnel that may be substantially greater than the equivalent annual cost of hardware. In the telephone system, annual operating costs are about \$130 per telephone which is about equal to the equivalent annual cost of the hardware

Table 1. Typical costs in dollars for three types of cable television systems (not including cost of television sets); SRS, subscriber-response systems.

Type of system	Cost category (dollars)				Maximum numbers of		
	Capital (per subscriber)	Monthly (per subscriber)	Per terminal hour	Per channel hour	Simultaneous users	User terminals per channel	Pictures simultaneously displayed
	National average costs for underground cables						
Conventional 24-channel one-way TV	110	2.29	0.03	2.38	10,000	10,000	24
Interactive TV with SRS	320	6.67	0.07	6.95	10,000	10,000	24
Interactive TV with SRS and single frame local storage	520	10.82	0.14	11.26*	720 to 7,200	30 to 300	720 to 7,200
	Typical costs for underground trunk cable in central city locations						
Conventional 24-channel one-way TV	250	5.20	0.07	5.44	10,000	10,000	24
Interactive TV with SRS	460	9.60	0.12	10.00	10,000	10,000	24
Interactive TV with SRS and single frame local storage	660	13.75	0.17	14.32†	720 to 7,200	30 to 300	720 to 7,200

* Cost per subscriber sharing a channel is \$0.04 to \$0.37. † Cost per subscriber sharing a channel is \$0.05 to \$0.48.

for the system. Both hardware and software segments of the information industry are thus likely to grow and to create new jobs during the coming decades.

Electricity, transportation, and communication facilities provide a basic economic structure that permits and stimulates further economic development. In the early stages of industrial development, production and distribution of goods dominated economic development. Now, production and distribution of information has taken on increasing economic importance. Although some people consider any services other than entertainment that might be provided by cable television as speculative, most knowledgeable observers expect strong growth to take place in additional services developed for or made more economical by large capacity, two-way communication. That such growth will take place may depend on there being guaranteed, nondiscriminatory access to the information utility. This will provide incentives for large numbers of entrepreneurs to invest in the development of the programs and services that will be necessary if all potential customers are to be reached. The development of such an information utility in the next decades may provide an infrastructure for economic growth somewhat analogous to that provided by the development of railroads more than a century ago.

An economic analysis of the sources of economic growth in the United States attributes 23 percent of the growth from 1929 to 1957 to increases in the level of education and 20 percent to advances in knowledge. When this figure is translated into economic growth per person employed, 42 percent (the largest single factor) of the economic growth is attributed to improvements in education and 36 percent to advances in knowledge (*1*). This indicates that if the United States adopts a policy of continued economic growth while reducing the rate of population growth, we should plan more productive investment in education. The information utility may permit the needed increases in productivity of educational services that could, in turn, spur general increases in economic productivity. The total costs of such a technology-intensive system will be higher, but the economies of scale in reaching many more students without extra building costs or labor costs should permit an increase in productivity.

When a majority of the working force was engaged in agriculture and industry, concentrated investments in the acquisition and distribution of new knowledge and technology related to these activities paid handsome dividends. By providing agricultural experiment stations and extension services, and by setting up land-grant colleges and investing in science and education generally, the federal government played a major role in the growth of the U.S. economy over the past century. Now that the productivity gains in agriculture and industry have significantly reduced the percentage of the labor force engaged in such pursuits, the next place to look for major productivity gains is in the knowledge "industries" themselves.

By making quality education readily available to those not now able to take full advantage of opportunities in present educational institutions (including culturally deprived minorities, those beyond school age, and some women), additional economic and social gains should be possible. Such facilities for education could reduce the unemployment rates of people undereducated for the kinds of jobs available in a technologically advanced society. The present, temporary underemployment of highly trained scientists and engineers could also be alleviated if the information utility that we propose were to be established, because of the research and development that would be required to make the system effective.

Communication technology without the development of educational content and human services would not be sufficient to accomplish the ambitious goals we are proposing.

Social Potential

The low cost, large capacity, and local nature of cable television relative to over-the-air broadcasting could lead to a greater amount of local programming and greater variety of program content that would satisfy many minority interests not now served by television. Regulations permitting pay-by-program television on cable would stimulate even greater diversity because some viewers will be willing to pay more than the approximately 1 cent per viewer hour paid by advertisers for "free" television.

As access to information becomes easier and the cost of this accessibility is decreased by improvements in communication technology, it might also become harder for the subscriber to maintain privacy. In the absence of legal barriers, the general trend would be to more openness (less privacy) as information costs come down. However, if there are legal guarantees of nondiscriminatory access to both the sending and receiving ends of the cable system, the resulting openness should make it more difficult for any single viewpoint to dominate the media.

While an impersonal communication source cannot be sensitive to the individual receiver's emotional state, it can present the same content consistently and fairly to everyone because it is also blind to the age, sex, color, religion, or hair style of the receiver. The impersonal information system is likely to be valued as being more responsive to social needs because it makes information available to larger numbers of people.

If access to these information services is not universally available throughout the society, then those already "information-rich" may reap the benefits while the "information-poor" get relatively poorer. A widening of this "information gap" may lead to increased social tensions. On the other hand, policies stimulating universal availability may permit those presently economically or culturally deprived to gain information that could help them narrow the gap in economic and political power between themselves and the rest of society.

The present location, distribution, and congestion of many urban areas can be attributed to earlier stages of transportation and communication technology. The development of an information utility could reduce the need for transportation. The information utility could also lead to greater physical decentralization of business and other facilities, while maintaining the same or greater administrative centralization of control. Improved communication services may thus provide a key component for the solution of other urban problems. The National Academy of Engineering committee on telecommunications has recently suggested the importance of this possibility as a means of encouraging portions of our population to move into uncongested regions of the country (*16*). This overall trend may be important also in slowing down the rates of energy consumption by providing access to information by means requiring less energy and creating less pollution.

Political Potential

To some extent, information is power. More widespread access to a greater variety of information will lead to an increasingly enlightened electorate and consequently to their greater participation in the political process. It will thus become more difficult for political power to be concentrated in a small group of people. A greater variety of information services may be the most effective way to bring power to all the people in a nondisruptive way.

Political candidates for other than national or statewide office often can not afford television coverage in their districts because it requires paying for coverage in a wide region, most of which lies outside their district. By means of cable television, local candidates would be able to reach only the voters in their district (or precinct) without having to pay the large costs of present television campaigning. The services provided by the information utility could permit voters to retrieve information about the candidates and their records in detail not possible with present media. Thus there would be various ways of increasing the subscribers' opportunities for political participation.

Educational Potential

In a recent article in *Science*, Pake (*16*) discussed the crisis in higher education in the United States and pointed to the productivity problem as a key issue (*17*). He cited costs per unit of instruction that increased by a factor of 4 during the decade of the 1960's in many universities. He said a major challenge to educational institutions is to find a way to use technology to increase the teaching productivity of the individual teachers. The same comments can be applied equally well to education at all levels. The difficulty is that given the financial crisis in most of our educational institutions, the research and development funds needed to make possible productivity gains must come from outside sources, presumably the federal government.

Changed conditions in society are placing the three following demands on educational institutions: equality of access to educational opportunity, lifelong learning, and diversity of curriculum content.

1) Demands for open enrollment in institutions of higher education are increasing, but the limitations of classroom and laboratory space and the costs of teaching personnel may make it difficult for many institutions to respond to those demands. In the Open University in the United Kingdom, television is being used to provide higher education to those not served by the traditional universities. This concept could be extended here to include all levels of education. Thus any person would be able to attempt any course he wanted to without requiring classroom space or teacher time. If success were rewarded without failures being recorded or there being other potential penalties for the student, many inhibitions about learning might be avoided and people might find their own levels of ability without others telling them what they can and cannot do. Regardless of economic efficiency, political and moral judgments will eventually require the provision of educational systems providing equal opportunity of access to education.

2) Formal education learned early in life can seldom last a lifetime. The need for periodic (or continuous) retraining is particularly great in occupations with a large scientific or technical component (for example, medicine, engineering) and is well recognized. It seems unlikely that the concept of industry sabbaticals would be quickly implemented as a response to this need. In any case, much learning is often required between sabbaticals. Night school classes may provide a partial answer for some, but busy people or people with irregular schedules are often unable to make the kind of commitment required. An information utility that made education available on demand in homes and offices would provide a more flexible solution.

Lifelong learning in the home could start with appropriate preschool instruction. Supplementary or extracurricular instruction could be made available for school children as well as adults.

3) The trend in mass media and in education itself is toward more variety. This cultural pluralism is already evident in the variety of special-interest magazines available and in the decrease in the number of mass-circulation magazines now published. The diversity of curricula now available to students lags behind the variety of occupations and interests available in society. Because it is already evident that no fixed curriculum will meet the present requirements for relevance and variety, the logical culmination of the situation is the provision of completely individualized instructional programs—a state we are unlikely to attain without significant technological help.

If we project the labor costs and the building costs of meeting these three educational needs by traditional means, the projections become absurd. No matter how rich a society we become the percentage of resources needed would be too high to permit other essential activities.

Federal Planning and Coordination

The forces of the market will cause the information utility to take shape in some form without any governmental initiative. However, we believe that a more effective and widely useful system would come into being if there were a federal program to coordinate the planning and development of the system.

For example, if the market for new entertainment services turns out to be the first to develop, the hardware that is first installed may not be adequate for the provision of education and information services that develop later.

If there is adequate planning, it should be possible to design a system that can readily be adapted to the provision of new education and information services when they become available. Without adequate planning and a minimum level of standardization it may be unnecessarily costly to add new services to an existing system.

A similar favorable effect in the area of software and programming could be brought about by federal planning and coordination. Some minimum level of standardization of format would be helpful. A catalog of materials available and a mechanism for national distribution of such materials could facilitate the development of services on the information utility.

The need for federal planning and coordination is partly a result of the fact that the development of the information utility requires the cooperation of a number of otherwise separate industries. Hardware systems will be provided by the computer industry, the telephone industry, and the cable television industry; and components will be supplied to all of these by the electronics industry. The aerospace industry and the National Aeronautics and Space Administration are also involved in communication satellite subsystems.

The provision of information content for the utility involves another set of industries including the entertainment industry, the education industry, and new information service industries. The establishment of minimum technical and administrative interface standards under federal supervision will greatly facilitate the interaction of these industries. Similarly, the establishment of nondiscriminatory rules of access to the utility for providers of entertainment, education, and information services will encourage the development of new services by providing assurance to these service industries that their products will have access to potential markets.

The total federal investment needed for planning and coordination of the utility is likely to be much less than 10 percent of the total investment in the utility. Yet this part of the total may be critical to the development of the utility in a form best suited to the provision of many of the most socially significant services.

Pilot Projects

A very significant part of the planning process is the gathering of information by means of experiments or pilot projects. In the case of the information utility many experiments are likely to be performed by the private sector to gather information needed in order to plan private sector services. Similarly, federal investment in pilot projects is needed in the very near future, in order to plan public sector services and to coordinate the interface between public and private sector services.

The National Academy of Engineering committee on telecommunications recommends several pilot projects for demonstrating various portions of the information utility (*16*). The next step would be to plan in more specific detail a number of demonstration projects in specific communities, some of which might be interconnected by an experimental satellite service. A start has been provided by the recent Mitre Corporation study of cable television for Washington, D.C., and the Rand Corporation study of metropolitan Dayton (*18*). These studies are focused on the economic viability of cable systems rather than on public service demonstration projects, however. Since the major difficulties in demonstration projects are more likely to be social and political than technical, it would be a mistake to plan only one or two such projects. Any single project could fail because of local political or management problems quite extraneous to the national potential being tested. Pilot demonstration systems should be undertaken in perhaps a dozen different locations spanning the major geographic regions of the country, and ranging from inner city to rural locations, from new towns to established communities, and from profit to nonprofit (or municipal) systems of ownership. Although most of the communities used for these projects would be expected to use cable television for the local distribution of information, at least one pilot project should be based on broadband telephone technology (for example, Picturephone). There should be some experimentation with direct access to satellites for remote rural locations as well as with the use of satellites for system interconnection. The technology is available; no breakthroughs are needed. What is required is a systematic mission-oriented research, development, and demonstration program to bring together the hardware components, to develop necessary software and programming, and to study how best they can be made to work in different social, political, and economic settings.

In each of the communities used for pilot projects funds will be needed for upgrading existing or proposed cable television or telephone systems in order to provide sufficient broadband channel capacity and permit two-way communication. Other costs will be incurred in the development and distribution of special user-terminal hardware, such as frame-grabbers and keyboards. The largest portion of the budget will be required for developing the most effective techniques for programming and delivering information over the new utility; these costs will be significantly greater than the cost of developing programs for a known technology, such as one-way television. The cost of developing new computer systems can also be expected to be substantial. Additional funds will be required for social science studies of the utilization and social effects of the information utility.

Several federal agencies may be interested in the development of experimental telecommunications systems in the pilot projects, including the departments of Housing and Urban Development, Transportation, Commerce, the National Aeronautics and Space Administration, and the Department of Health, Education, and Welfare (HEW). Because the information utility's most significant potential lies in the educational services that it can provide, it may be desirable to establish a new organization in HEW to oversee the educational uses to which the utility is put. The proposed National Institutes of Education (patterned after the National Institutes of Health) might be used for this purpose. Because of the interest of many federal departments, a coordinating role would have to be played by some central agency such as the Office of Science and Technology or the Office of Telecommunications Policy.

If a start were made immediately on detailed technical, financial, legislative, and management plans, it might be possible to have new authorizing legislation and appropriations for the fiscal year starting 1 July 1973. Phase 1 (1973–76) could include system development, policy planning, development of a research support program, and actual demonstrations and field tests. Both urban cable systems and low-population density satellite systems could be included in the phase 1 pilot programs. Phase 2 (1976–85) would permit the national implementation of an information utility, making use of the most successful results of the phase 1 pilot programs. Legislation designed to encourage the development of this national telecommunication system may be needed during phase 2 to stimulate local and state development, as was the case for rural electrification and the interstate highway system.

Conclusion

The information utility that we have described is a system designed to provide better quality education and information to everyone in the United States, with unit costs of service substantially less than the costs of present systems. In order to accomplish these positive social goals a detailed plan for federal action and participation is needed. Since most of the funds for this utility will come from the private sector, the principal needs for federal action are in the areas of coordination, policy analysis and assessment, and the funding of pilot projects and demonstrations designed to stimulate the development of new public-sector education and information services.

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5. The capital cost of a cable system per subscriber depends strongly on the density of homes. For typical urban locations with medium to high density, 50,000 homes or apartments can be served by 100 miles (1 mile = 1.6 km) of trunk cable. If we take $15,000 per mile as the cost of the underground trunk line cables, allowing $45 per subscriber for the line from the trunk cable to the house (house-drops), and $50,000 for head-end buildings, antennas, and related costs, a 10,000-subscriber system with 50 percent market penetration would cost $110 per subscriber. These cost estimates are for typical underground systems and are based on information provided by the National Cable Television Association as reported by Comanor and Mitchell (*6*). It should be noted that although $15,000 per mile for underground trunk cables is the present national average cost, $50,000 or more per mile is typical of some metropolitan areas. If $50,000 is used in place of $15,000 in the above cost estimate, the resulting capital cost per subscriber increases from $110 to $250. To convert capital cost to monthly cost, we can assume a system life of 10 years, an interest rate of 8 percent per year, and maintenance cost of 10 percent per year, obtaining a monthly cost of 1/48 of capital cost. The monthly cost that goes with the capital cost figure of $110 is then $2.29 per month per subscriber. If we assume 80 hours per month of usage by each terminal, the average cost per terminal hour is $0.03. If we assume 400 hours per month of transmission on each channel and 24 channels, the average cost per channel hour is $2.38 (*7*).

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NEWS AND COMMENT

Anabolic Steroids: Doctors Denounce Them, but Athletes Aren't Listening

The scene is the auditorium of the Masonic Temple in Detroit, filled to near capacity with a turbulent audience. A brisk succession of scantily clad young men step up onto the spotlighted podium and exhibit, to music, their physical endowment. In a minute's worth of briefly held poses, each displays to best advantage his outsized arm and chest muscles, Herculean thighs, and a back that resembles a tangle of knotted ropes. The victor of this unusual modeling show will be Mr. America 1972. He can cherish the ambition of becoming Mr. Universe, an example to the world of how the human frame can be improved upon by only exercise and temperate living. Except that in recent years several Mr. America's have carried off the proud title not by their own unaided efforts, but with the help of anabolic steroids, powerful drugs that are synthetic derivatives of the male sex hormone.

Anabolic steroids feature heavily in a drug subculture that includes bodybuilders, professional footballers, and strength athletes, such as weight lifters, shot-putters, and hammer and discus throwers. Among U.S. Olympic competitors, particularly the weight lifters, consumption of anabolic steroids is probably reaching a peak this month—in a few weeks, athletes will have to lay off the drug in order to be sure of flushing all traces out of their system before the Olympic games in August. U.S. athletes will have no monopoly on steroids. Rumor has it that the drugs are widely used by South American, Russian, and European athletes. According to one member of the committee responsible for selecting the U.S. weight lifting team, victory in the Olympics has become a question of which country has the best doctors and chemists.

Just what anabolic steroids do to the human frame is a question that receives different answers from athletes, from the sports and medical establishments, and from the scientific literature. The few scientific studies that have been done are a mixed bag, some suggesting that steroids do no good for athletes, others that they are effective. The athletes who take them believe that anabolic steroids help to increase weight and muscular strength. They do so despite the warnings of sports officials and senior sports doctors, who insist that steroids do not increase muscle but do have a variety of unpleasant side effects. The American Medical Association "categorically condemns" the use of steroids by athletes. "Use of steroids is a complete waste of time and money," says Allan Ryan, team physician at the University of Wisconsin and a past president of the American College of Sports Medicine. Daniel Hanley, official doctor to the U.S. Olympic team, believes flatly that steroids have "zero effect" on muscle strength. Hanley is also a member of the International Olympics Committee medical commission, which, in a recent booklet entitled *Doping*, warned: "Anabolic steroids can severely harm the health, causing liver and bone damage, disturbances in the metabolic and sexual functions, and, among women, virilization and menstrual upset."

For a drug that, according to informed medical opinion, is both ineffective and hazardous, anabolic steroids are rather widely used. Any amateur athlete caught taking a nontherapeutic drug is liable to disqualifi-